Mechanical Engineering

The Journal of the American Society
of Mechanical Engineers

Index to Volume 44

January to December
1922

Published by

The American Society of Mechanical Engineers
29 West Thirty-ninth Street, New York

Index to Mechanical Engineering

Volume 44, January to December, 1922

D, denotes discussion; C, correspondence

MECHANICAL ENGINEERING

Volume 44 January, 1922 Number 1

S.P.E.E. Joins A.S.M.E. at Annual Meeting to Consider Engineering Education

A Group of Papers Presented at the A.S.M.E. Annual Meeting, in Which are Presented the Particular Needs of the Industries and the Problems that Confront the Engineering Faculties

ONE of the outstanding features of the 1921 Annual Meeting of The American Society of Mechanical Engineers was the joint session held on December 8 with the Society for the Promotion of Engineering Education, and devoted to a consideration of professional engineering education for the industries. Four papers were presented at this session, over which Prof. C. F. Scott, president of the S. P. E. E., presided, namely: Professional Engineering Education for the Industries, by F. C. Pratt; A National Policy on Engineering Education, by A. G. Christie; College Education as Related to Industry, by J. E. Otterson; and The Engineering School and the Industries, by Dexter S. Kimball, which latter partook of the nature of an introduction to the discussion of the preceding papers. The texts of these papers follow, together with a brief abstract of the discussions which they brought forth.

The session was opened by Professor Scott who presided: he said in part:

The industries constitute the organization through which engineering utilizes the forces and materials of nature and organizes and directs human activities for the benefit of man.

Today the national society of engineering and industry meets with the association of engineering educators; this is a conference between users and producers of human material for leadership in industry.

If producers and users of steel rails were in conference they would discuss the uses which rails are to serve, classifying the kinds of service, considering wherein past products had failed, inquiring as to chemical analysis and metallurgical treatment. They would seek improvement in production and discrimination in use. But the more difficult problem of the human material for technical and administrative leadership has received less attention.

It is easier to analyze steel than students; physical tests are definite—psychological tests are still indefinite; it is easier to specify materials than men; steel is inert and passive—men are alert and erratic.

But when, if ever, have these leading societies in engineering industry and engineering education met together for conference? Each society has been engrossed in its own activities for thirty or forty years. Now they are finding something in common. Users and producers are in conference. Let us try to agree on what we want and then determine how to get it and how to use it. How may boys of differing kinds be individually developed and fitted to varying needs and opportunities?

First, as to the schools. What are they teaching? The distribution of subjects in the four year courses (not including summer work) in mechanical engineering and administrative engineering at Yale is given in the following tabulation:

		Per cent	
		Mechanical	Administrative
General	History and English	13	13
Science	Chemistry, Physics and Mathematics	31	24
Engineering	Drawing, Materials, Mechanics, Power, Electrical Engineering	46	28
Administrative	Economics, Accounting, Management, etc.	8	21
Elective	Engineering, Administrative, etc.	2	14

Second, returning to industry. What is the quality basis of selection of graduates for an industry? Does industry want men familiar with current practice, or men grounded in general principles ready to acquire practical experience rapidly? Industry certainly does not expect any graduate to fill any position irrespective of natural ability, aptitude and preference, but what is the present practice in determining the qualities of the raw material and of adapting it to the needs?

If some men are needed for research and invention and a larger group for general engineering and production and sales and another for executive and administrative functions, are men for each kind of work carefully selected and specially trained? The inventor, the originator is rare. A dozen or a hundred men for general activities are easier found than a single expert or originator. Has not much of the dissatisfaction of the past product of the schools been due to a misunderstanding on the part of industry as to what the college graduate really is and inability to train him in industry and utilize him efficiently?

The technical school has been trying to bridge the old time gap between the formally classical and the rigidly scientific. In forty years it has made a marvelous advance. The goal of its early aims was to produce engineers of materials and forces. But there is a new demand for an engineering type of mind for the organization and direction of men. Can the same raw material and the same educational machinery and methods produce both products? What changes will meet the new situation? Are they simple or radical? These are the things we are here to discuss.

Professional Engineering Education for the Industries

By FRANCIS C. PRATT,[1] SCHENECTADY, N. Y.

DURING the year 1920 the General Electric Company, with which I have the honor to be associated, took into its employ 400 college graduates, of which number—

340 were graduates of electrical engineering courses
20 were graduates of mechanical engineering courses
30 were graduates of business or administrative courses
10 were graduates of miscellaneous courses.

Practically all of the electrical and mechanical engineering graduates entered into the student engineering courses covering a one-year period which have been most carefully planned at the several works of the company, while the graduates of the business or administrative courses became members of its accounting department, taking a two-year course in business administration, higher accountancy and commercial law. Fifteen graduates, including two who had specialized in physics and nine in chemistry, entered the research laboratories of the company.

The records indicate that over a term of years about one-half of the young men entering the student courses remain permanently in the employ of the company in the engineering, manufacturing, commercial or administrative departments of its general and district offices, or of its works.

---

[1] Vice-President, General Electric Company.

In entering into the daily work of a great industrial organization these young men come into contact with actual manufacturing and business conditions and acquire self-confidence and a practical experience which, in my opinion, the colleges cannot and should not seriously attempt to impart.

I regard it as an exceedingly healthy sign that there are so many inquiries being made as to our methods of technical education, but, at the same time, I want to say that the young men who, during the past few years, have entered the employ of the company with which I am associated, have, on the average, been better prepared mentally, physically, and morally than ever before. This is a very broad statement, but a most careful study of the conditions and the many inquiries made of our leading men who have the opportunity to come in close contact with these young men justify this conclusion.

During the past two years we have been engaged in reorganizing one of our most important designing engineering departments, largely increasing the scope of its work and its personnel. In recently looking over a report of the organization submitted by the engineer in charge, I was struck by the references to two young engineers, each of whom had been out of the company's student engineering course for a period of less than a full year. The report referred to one of these young men as proving to be a resourceful and inventive experimental genius along his particular line of work, and to the other as having perhaps the clearest understanding of the mathematics of this particular line of any one in the employ of the company.

The line of work is an exceedingly broad one, the engineer in charge is a particularly discerning man, and I think it a matter of great encouragement that talent of such character is being turned over to the industries by the educational institutions. It is true that the report, in referring to these two young engineers, referred likewise to four somewhat older and more experienced men who were reported as also doing particularly notable work in the department.

Increasing Demand for Trained Engineers

I have recently seen a statement that statistics show there has been a constant decrease in the number of engineers graduated from our American universities. The statistics were not cited in connection with this statement, but if, perchance, this statement holds true, the tendency would seem to be an unfortunate one, in view of the larger demand for engineering activities in our modern life, as partly reflected in the following statistics taken from the official records of Yale University:

Increase in all Yale graduates for years 1904 to 1916:

Law, medicine, ministry and teaching, combined	24 per cent
Manufacturing, finance and mercantile pursuits, combined	83 per cent
Engineering	160 per cent

I have also seen suggestions that the number of so-called cultural studies should be decreased and greater specialization made in the essential subjects of science, mathematics, the native language, and of commercial application of what is learned, and that the colleges should turn out young engineers whose services are of immediate value to the employer without several years of practical experience being necessary.

I have little sympathy with such points of view for many reasons, among which are the following:

While familiarity with apparatus obtained from laboratory work coincident with undergraduate studies is of great value in giving the students more appreciative knowledge of their subjects, as are also frequent visits to, and summer work in, industrial establishments during the undergraduate period, yet I am confident that nothing which the colleges can give can take the place of the practical experience gained in the atmosphere of an industrial organization, bringing with it an intimate knowledge of both methods and men with which and with whom one's life work is to be associated. In my opinion the time in college is so valuable that it should be primarily devoted to those things which can only be acquired later with a great deal of difficulty, the fundamentals necessary to all advanced study.

Earnest efforts are being made to combine the advantages of instruction in theory with those of practical experience by coöperative courses, carried on jointly by educational institutions and industries. A final opinion in regard to the effectiveness of these courses must, it seems to me, be held in suspense awaiting more extended experience with them.

Too Early Specialization Results in Disproportionate Number of Mediocre Ability

My observations also lead me to the conclusion that the percentage of those who fail to attain a reasonable degree of success is greater in the group of men of mediocre ability but narrowly specialized education than in almost any other group coming within my knowledge. Such men, unless extraordinary vigilance is exercised by those in charge, become permanently attached to an organization doing specialized work for which they have no particular adaptability, clogging the opportunities for younger, more able and progressive men to advance. It would have been far better for such a man if the head of department had, at the end of one or two years of employment, recognized the circumstances and frankly informed him that he was not likely to make a success in the professional work which he had undertaken, and advised him to enter into some other vocation.

If I were to make a broad criticism of our methods of engineering education as it exists today, I should base it upon too early specialization of the student, resulting in the turning out of a disproportionate number of men of the class to which I have just referred, i.e., those of mediocre ability and narrowly specialized education.

I should be disposed to strongly criticise another condition in our colleges which I recognize as an exceedingly difficult one to overcome, and that is, as the result of the high degree of standardization, induced perhaps by the numbers who have to be taught, the more brilliant men in the class are retarded in their progress by the requirement of a standard which can be met by the less capable students. If we are not only to attain, but also maintain, great eminence in the engineering professions in America, we should, and I think must, devise some means whereby the more promising students can with greater facility advance with breadth and thoroughness in their work.

It is, I think, significant that in the organization with which I am in daily contact, a noticeable number of our most accomplished theoretical engineers and research laboratorians have either pursued post-graduate studies at European universities, or else have had all of their scholastic training abroad. This may suggest an opportunity for American educational institutions which is not fully met at the present time. In this connection I think that the colleges should sternly resist the temptation to enter into specialized fields which are adequately covered by kindred institutions, and that better results would follow if, in general, each endeavored to maintain the strongest possible staff of teachers to give most thorough instruction in the fundamentals of the sciences, engineering, economics and languages, and confine its specialization to such work as it is preëminently fitted to carry out.

The industries need administrative men well versed in the sciences and in engineering, in order that they may lend appreciative and sympathetic support to the technical developments, which are, in fact, the very life blood of the industry and on which its future primarily depends. That the colleges of the country are alive to this need, is evidenced by the number of courses which have in recent years been established, teaching the fundamentals of the sciences, engineering, economics and languages, and variously referred to under the names of administrative engineering, commercial engineering, or other courses.

While it seems to me probable that a much larger proportion of the graduates of such general engineering courses will be utilized by the smaller manufacturers rather than by such highly specialized organizations as pertain to the electrical industry, yet I want at this point to put in a strong plea for the more thorough appreciation and use of technical graduates by all industries, both large and small. It is, of course, apparent that a college education is not in any sense the only road to industrial accomplishment, and, in fact, some of the ablest engineers and administrators of my acquaintance have secured the fundamental knowledge upon which their life's work has been based while persistently working in practical fields and without having the foundation of a college education. One frequently finds, however, in such cases, that the individual's development had been profoundly influenced by close association in his

work with a master mind, who, in reality, became a great teacher to him.

Need of the Industries for Strong Designing Engineers

The industries need strong designing engineers thoroughly versed in the theory and practice of the art, who have such knowledge of material values and of men as to render their work effective. In general, the industries must look to the colleges for young men who have the knowledge, the enthusiasm for constructive work and the patient tenacity, which alone go to make up a successful designing engineer. In many respects the loss of a good designing engineer to an industry leaves a vacancy which is harder to fill than almost any other, as preëminence in design can only be attained through a happy combination of natural ability and of knowledge and experience gained by years of intelligent and exacting work. Owing to the highly developed state of the art there is undoubtedly a great deal of routine work to be done in designing engineering, which is not inspiring to young men, and experience indicates that a diminishing proportion of technical graduates is drawn toward this most important branch of work. While this must, I think, necessarily be one of the problems for the colleges, it is also one of very immediate concern to the industries, demanding the most resourceful consideration. In general, the goal of success in design work seems more remote to the young graduate than in other branches, and also the character of the work more exacting and confining. On the other hand, this fascinating field of investigation, research, and constructive accomplishment should appeal most strongly to one who has the imagination and courage to look well into the future, and the stamina necessary to accomplish a difficult task. I feel certain that far too many capable young graduates sacrifice their greatest ultimate development by yielding to the temptations of early rapid advancement along the easier lines, without sufficient thought of the future.

I wish only to add one thing more, and that is to point out the wonderful opportunities which modern industry offers in its research laboratories to specially talented and most highly educated technical graduates. The colleges must, I am sure, be most liberal in providing instruction and laboratory facilities for the growth of such picked students, and in inspiring them by the work and example of a few really great teachers.

Summary

1 A careful study of a large number of college graduates employed at the several works of the General Electric Company indicates that our educational institutions are developing young men of real ability for the industry.

2 The suggestion that is sometimes made to reduce the amount of cultural studies in order to more intensively specialize on technical subjects, is not viewed with favor.

3 The time in college is of such value that it should be primarily devoted to those things which can only be acquired later with great difficulty. At best, the student cannot hope to attain in college the well-rounded knowledge and practical experience that are to be gained in an industrial organization.

4 A broad criticism of methods of engineering education is that it undertakes too early specialization of the student. Another is the lack of facility offered to the more capable students to rapidly advance.

5 Suggestions for modification and improvement of American educational methods may be gleaned from the fact that a noticeably large number of accomplished theoretical engineers and research laboratorians have either received all their education or pursued post-graduate courses at European universities.

Best results may be expected if each educational institution will strive to maintain a highly capable staff of teachers in the fundamentals of the sciences, engineering, economics and languages, and restrict specialization to only that work for which it may be preeminently qualified.

6 The teacher in engineering courses should constantly emphasize to those students who show special aptitude the great need among the industries for able designing engineers.

7 Through its research laboratories modern industry offers to specially talented and highly educated technical graduates wonderful opportunities for development.

A National Policy on Engineering Education

By A. G. Christie,[1] Baltimore, Md.

In one of the recent Aldred Lectures, Mr. Arthur West said among other things: "It is to my mind one of the greatest functions of the technical school to seek out from among its students those who have a natural aptitude for the profession and to help these men to the utmost if in addition to their technical abilities they show the character necessary to make such help worth while. I counsel the careful and painstaking education of the best students even at the expense of the mediocrities that exist in all student bodies. It should not be the duty of the faculty to nurse along the 'dubs' of the class to a precarious graduation. What modern civilization needs is not more engineers but better ones."

Dean F. L. Bishop is reported to have stated at a meeting in New York last spring that there is no first-class engineering school to be found in America. Dr. Comfort A. Adams supported this statement and guaranteed that he could prove in a five-minute oral examination that 98 to 99 per cent of the graduates in electrical engineering from any institution in the country did not understand in a thorough fashion the fundamentals of the subject.

One is led to conclude from the above remarks that the engineering world desires only first-class men, but that the engineering colleges of this country are unable to furnish such men. Since the late war this country has been the world's leading nation. If the United States would continue to hold this foremost position it must become a leader in the arts and manufactures, in culture and education, and particularly in engineering education, for our modern civilization depends to such a great extent upon the work of engineers. If it is true that we have no first-class engineering schools, it is time that earnest inquiry should be made to determine wherein we are lacking and what remedies should be immediately applied. This is a national matter, for national leadership in manufacture and commerce depends on engineering achievements. A national policy on engineering education is therefore a pressing need at the present moment.

Work in Foreign Colleges Generally of More Advanced Character

When discussing the requirements of a first-class engineering college, it is instructive to consider the leading engineering colleges abroad. Before the war some of the German technical schools were regarded very highly. Those at Charlottenburg, Dresden and Munich shared with the Zurich Polytechnic of Switzerland the reputation of being in the first class of continental engineering institutions. Foreign students, including Americans, were attracted to these schools in large numbers and this further increased their reputation. These colleges had first-class men on their staffs and in general instruction was of a high order. Particular emphasis was laid on fundamentals of engineering and on research. The German states were liberal in their financial support of such institutions and the professors were comparatively well paid and enjoyed a high social standing. These professors did a relatively small amount of teaching and devoted their time principally to research and to the leisurely study of their specialty, on which they generally wrote extensively.

Much of the actual experimental work in research in these foreign schools was done by graduate students and by paid assistants, of which latter there were sufficient numbers to readily carry on the work. The instructional staff did little clerical work and practically no student advisory work, as we know it in America. Therein lay the weakness of the German system. Great care was taken to impart exact technical and scientific knowledge to the students, but little thought was given to the development of char-

---

[1] Professor of Mechanical Engineering, Johns Hopkins University. Mem. Am.Soc.M.E.

acter and personality. A recent speaker commenting on this fact stated that British and American engineers are frequently placed in executive charge of large enterprises, while continentally trained engineers are employed by them to do the designing and computing, character, resourcefulness and ability to handle men governing the selection.

A factor that has considerable influence on the courses offered in any technical college is the character and degree of advancement of the work done in the preparatory schools. In this particular the continental technical schools are particularly favored, for in general more advanced mathematics and physics, together with more cultural subjects, are taught in their preparatory schools than in American high schools. In fact, the equivalent of the first year's work and often a portion of the second year's work in American engineering colleges is required for entrance to the continental technical school. Consequently the work in these foreign colleges is in general of a more advanced character than here. Furthermore the students are older and more mature at entrance to such continental colleges.

An attempt is being made in Great Britain to build up a first-class engineering school at the Imperial Technical Institute, London. The war, however, prevented full development of these plans as soon as was hoped might be possible.

Conditions in American Colleges

Let us now consider conditions in American engineering colleges. These vary from small, ill-equipped schools to institutions that should be considered among the world's best, both in equipment, ability of staff, and character of instruction. There still appears to be room for all these colleges, even though the character of training varies over a wide range. This is due to the fact that the technically trained man has many fields open to him after leaving college. The demand for men to fill subordinate positions in the industries will always take care of the less able men and those whose training has been inadequate. The more highly trained and more capable men advance to the foremost places in the profession, which generally lead to executive positions of a business character. An increasingly large number of engineering graduates have business and not technical positions as their sole objective. They take the engineering courses in college largely because they believe that the thorough analytical methods taught there and the training in the ability to "think straight" will be a considerable asset in business life. Engineering students may therefore be divided into three general classes: (1) Those of a truly scientific turn of mind who are capable of grasping and developing theories and of applying these to the analysis of engineering problems; (2) men of a practical nature, less capable or insufficiently trained to fall in the first class, yet very necessary for the subordinate positions in industry; and (3) those whose objective is pure business life. The great majority of students fall in the last two classes and this influences the character of college instruction to a marked degree. Practical laboratory and shop courses are stressed in many colleges and there is a steady demand for more and more instruction on the principles of organization and business economics.

The increasing popularity of the engineering courses has led to steadily increasing enrollments in nearly all colleges. Instructional staffs are overworked and underpaid. To care for this influx there seems to be a tendency to organize certain colleges on what would be called in factory organization a "quantity production" basis. Large numbers of students are handled according to definite fixed plans and personal contact is largely lost between instructor and student. A most unfortunate condition exists when an able and inspiring teacher is promoted to the head of a department and becomes so loaded down with administrative details that he does little or no teaching and loses the opportunity to exert his personal influence on students who should normally receive his instruction. The "quantity production" idea gives little or no opportunity for character building, which after all is the true basis for success in after life. Where students are handled in quantity the men automatically recite, work up laboratory reports, and pass examinations with very little opportunity for independent thought or action along technical lines.

Engineers in practice frequently criticize the engineering colleges very harshly for turning out graduates with seemingly inadequate training. Usually these critics have lost their proper perspective or have forgotten just how little they themselves knew of their specialty when they entered college and when they were graduated. They fail to fully appreciate the character of the boy as he enters college and with whom the teaching staff has to deal.

It has already been pointed out that the average student entering American engineering colleges is younger and less thoroughly prepared in fundamentals than the continental student. The American boy has several things in mind when he enters an engineering college: First and foremost, that the training will enable him to earn a better living than if he were without training and therefore he favors practical courses to pure theory; second, that athletics, fraternity life, and other college activities are almost if not actually of equal importance with instructional courses; and third, that his four years in college before entering a cold-blooded business world are going to be the happiest in his life and he must not fail to have a good time during his college career.

What Engineers Demand of the Graduate

Such in general are the motives and ideals of the undergraduate of the technical college. What do engineers demand of the graduate? In the opening paragraph Mr. Arthur West calls for better engineers by a process of selective education of only the most promising men. In what way must he be a better engineer? In the Report of the Carnegie Foundation for Engineering Education by C. R. Mann, it is pointed out that practising engineers stated the desirable qualities of an engineering graduate in the order of their importance as character, judgment, efficiency, understanding of men, knowledge and technique. Particular attention should be directed to the fact that technique, in which the continental graduate excels, is placed at the bottom of the list, while character holds first place. A recent survey by C. E. Magnusson[1] indicates that character is still considered of first importance but should be combined with a truly professional idea of service, and also that thorough training in fundamentals is more necessary than specialization.

Character building, tact, initiative, thoroughness, etc., can be developed best in the undergraduate by intimate contact with high-grade instructors, and by participation in college activities and athletics under more or less faculty supervision. This may be achieved in the smaller colleges, but unfortunately only a few have adequate laboratory equipment and can afford to secure the best men for their staff. "Quantity production" in larger colleges must be replaced by smaller groups of students and larger, less hard-worked, and better-paid staffs if the best results are to be secured. The adoption of a common code of ethics by all national engineering societies and the requirement that every graduate in engineering affirm this code would greatly increase the graduate's sense of responsibility to his profession and would certainly tend to elevate its ethical standards. Thoroughness and accuracy can be developed by problem work, and particularly by recitation courses. Personal contact of students with faculty is probably most highly developed under our American student advisory systems.

A limited student body has been characteristic of certain of our best medical schools. The Engineering Department of Johns Hopkins University since the war has deliberately attempted not only to elevate the standards of instruction, but to limit attendance among the upperclassmen to a small number of men. An attempt is thus made to retain the better men only of the first two years. This permits the most efficient use of facilities without overcrowding, and retains close personal contact between student and instructor. Furthermore, greater emphasis is laid on fundamental theory than on informational and special applied courses, leaving the latter for advanced study.

When due consideration is given to the age at entrance and to the preparatory training of our freshmen, it is obvious that one cannot expect a finished engineer at the end of a four years' course. The criticisms of the undergraduate work of our colleges by Dean Bishop and Doctor Adams seem therefore unfair.

Students in law and medicine are generally required to have a collegiate degree before taking up professional work. Such a requirement would unquestionably produce a better class of graduates if applied also to the engineering colleges. The profession as a

---

[1] *Journal A.I.E.E.*, September, 1921.

whole, and particularly employers of engineers, have, however, offered no special inducement to the colleges to develop such men. In fact, with the large number of graduates of the second and third classes mentioned above, it is doubtful whether the time and expense of such training can be justified or is needed.

Graduate Work Should be Concentrated in Certain Selective Colleges Given Strong Financial Support

What about the highly trained engineer and the research engineer comprising the first class? This is the class of men on whom America must depend for future leadership in engineering. These men form a relatively small proportion of the graduating classes. Their training, however, should be of broad character during the early part of their courses, though in regular undergraduate courses this selective education is seldom possible, and later they should be further developed along certain specialized lines. Such men would undoubtedly benefit by collegiate courses before taking up engineering training. It is not possible however, to select from a group of applicants for admission to college the men who will later develop into the best engineers, and who are worthy of the most extensive training. Some plan must therefore be developed which will permit these specially gifted men to be given advanced training and to carry out research work. Many colleges have neither the money, facilities nor staff to offer adequate graduate work in all branches of engineering. It would therefore seem best to concentrate our graduate work in certain selected colleges which should receive the strong financial support of the industries and of the Government and the moral support of the profession at large. If scholarships to these graduate schools could be provided for the best undergraduates from all engineering colleges, well-developed technical men would be available to the industries who would equal if not surpass the continentally trained men. The requirements for admission at such graduate schools should be very rigid so that only the best men with adequate preparation could enter.

If the industries demand highly trained men from the colleges, they must be prepared to make such training worth while. When a request is made to an engineering school for a man, if a degree of Master of Engineering or Doctor of Engineering is demanded and if such men are given preference for positions and are paid somewhat higher salaries than the ordinary graduate, students will soon desire to get the advanced training. Graduate students in engineering will be few and of mediocre character as a rule until such an attitude prevails on the part of employers.

The new national policy on engineering education therefore requires greater financial support for the colleges, so that an adequate staff of high-grade men may be employed and personal contact with students secured through small classes. Greater emphasis must be given in instruction during the four-year undergraduate period to fundamental courses, leaving special professional training to graduate years. Certain colleges should be designated as graduate schools and adequate provision made for their proper support both by Government agencies, by private endowment, and by the industries. Scholarships should be provided by the state, by industries, or by the profession which will enable eligible undergraduates from all colleges to continue their work in the graduate schools. Finally, employers who desire highly trained technical and research engineers must give first consideration to the men with graduate degrees and must be prepared to reward them financially in proportion to their extra effort and greater expense in educating themselves.

The burden of maintaining America's supremacy in industry and commerce rests largely on the engineer. Let us therefore as engineers place before the American people this new national policy on engineering education so that our young men entering the profession may be the best fitted in the world to carry this burden and to advance still further the art and science of engineering.

Engineering Education as Viewed by the Industrialist

By J. E. OTTERSON,[1] NEW HAVEN, CONN.

THE pedagogue is interested primarily in the process of education. The industrialist is interested primarily in its product. The student upon graduation, must pass from the supervision of the pedagogue to the critical survey of the industrialist.

It seems fair to assume that the purpose of education is something more than the mere acquisition of knowledge. The industrialist is obliged to look for something more. The student is likely to find upon graduation that those things which he has regarded as the purposes of the educational processes through which he has passed, now become only a means for the accomplishment of the real purposes of life. It is in developing this change of viewpoint that the student is likely to meet with disappointment, perhaps discouragement, and during this period the industrialist finds difficulty in adapting the student to his utilitarian purpose.

Knowledge is not of itself a qualification for large responsibility in industry. The encyclopedic type of mind which merely records impressions and facts brought before it may lack those qualities of imagination and initiative so essential to the accomplishment of practical things under adverse conditions, which do not always evidence strict conformity to the laws governing recognized and recorded knowledge. Something more is required than that type of mind which is merely a reservoir containing a large amount of knowledge in a static state. Modern industry is dynamic and moves at a tremendous pace. We want, therefore, the type of mind that will be immediately energized when the current is turned on; the motor type rather than the storage-battery, and when the individual progresses to larger responsibility he may be called upon to animate, magnetize and electrify other minds about him, and to develop the qualities of generation as well as those of motivity.

There are doubtless certain occupations in life where the possession of accumulated knowledge is both desirable and essential, but in industry this quality alone will not carry the applicant beyond the lower orders of subordination. He will take his place among those student clerical types that are the handbooks of industry; much thumbed and used and frequently showing signs of wear and tear and dilapidation; referred to for statement of facts or formulation of laws but in the emergencies of everyday life frequently passed by in the race for accomplishment. Such are not the positions in industry that are difficult to fill. The encyclopedic type is sufficiently common to meet the need and in the search for the type with initiative, vision, imagination and dynamic force, the industrialist must apply other methods than those of the school-room examination. The industrialist is concerned more with the effect of the educational processes upon the habits and character of the applicant than he is with the degree of learning which he has attained. The industrialist is interested in mental, physical and moral character rather than in pure intellectualism; more in the ability to acquire knowledge quickly through application and concentration than in the immediate possession of knowledge.

The habits of industry should have as their foundation the habits of the student who is preparing for industrial work. In passing from student life to industrial life he should be able to do so successfully by continuation of the habits he has acquired in his college training rather than by a radical change that places him in an unfamiliar environment of work and activity.

His college life should be something more than a mere signal drill. He needs the scrimmage and the actual game to develop his full qualities.

Some very practical industrialists hold the view that a college education is a handicap to business or industrial success and they point to the fact that something like 75 per cent of the responsible positions in industry are occupied by men who have not had the benefits of a college education but who have gone through the school of hard knocks; whose qualities are those of character, force, will power, initiative, industry, common sense and human

---

[1] President, Winchester Repeating Arms Co. Mem. Am.Soc.M.E.

understanding. It is indeed questionable whether within the limits of the training and experience of a college education these qualities can be developed with the same intensity and firmness as in the school of life that so closely links accomplishment with survival.

The college education most obviously and surely develops a larger capacity for social and cultured life but the social and cultural taste growing out of a higher education may prove distracting in a competitive field where complete concentration of a very practical kind is essential to success.

Without endeavoring at this point to place the responsibility, the college graduate who is an applicant for an industrial position all too frequently shows no knowledge of the work to be done in the field which he is about to enter. He evidences no particular desire, ambition or purpose and he has little knowledge of the direction in which he is going or desires to go. If an opening is offered him, he has no capacity of judgment as to his adaptability. He is generally quite willing to leave the question of his future work in life to the hurried determination of the industrialist, who in a ten-minute interview may attempt to analyze his character and assign him to a task in which all parties concerned hope that he may be successful. Obviously this is an uncertain and unscientific method of directing the human forces set free by college education.

Small wonder that so many find themselves in uncongenial employment, ending in discontent, perhaps discouragement, changing from one class of work and finally from one job to another without direction or control.

A force is defined by its magnitude and direction. I am not complaining as to the magnitude of this tremendous human force launched into the world with each graduating class, but I do regret the wasted energy that results from its lack of direction. Whose responsibility is it then to give it direction? Who is to sight the gun? Who is to lay it upon the target? Some such directing hand is necessary if we are not to be content with mere intellectual fireworks.

Development of Personal Talents

It is of course a question as to how far the college is expected to go in fitting men to take their places in a particular line of industry. In the ordinary four-year college course it is fair to assume that the college can do little more than lay the foundation for subsequent intensive training and development for a particular work. I am very definitely opposed to the shaping of educational processes toward training for a specialized type of work before there has been laid a foundation of general knowledge and comprehension. The specialization should come after a certain degree of intellectual maturity has been reached. I do feel, however, that at the same time the mind is being molded and stored with knowledge, an effort should be made to determine the talents and characteristics that must be the controlling factor in the student's later life, and an opportunity given for the development of those qualities that will ultimately express the real character of the individual.

Our college tests and examinations are primarily directed toward the determination of mental attainments as measured by the extent of acquired knowledge. I am making a plea for the development of tests of a different character calculated to determine the student's potentiality rather than his static state. These tests would be in the nature of or the basis of a psychoanalysis of the student's character through observation of his manner, personality, physiognomy, heredity, environment and college career. These should be matters of constant observation and record, with particular reference to progress and development. These observations and records should be the constant study of a skilled psychologist or psychoanalyst who would take occasion to periodically counsel with the student as to his predominant characteristics and talents, assisting and directing him to their higher development.

At a later point in the student's career, an organized effort should be made to acquaint him with the opportunities in the field which he is by character qualified to enter, his qualifications being determined not by the character of acquired knowledge that he possesses as defined by the usual academic classification, but rather by the qualities of mind and character that give direction to his energies.

It is not my purpose to attempt to define the organization or system by which this may be accomplished nor to attempt to detail the method of character analysis to be pursued. Presumably a broad general classification will be first attempted, to be followed by more detailed effort.

Types of Men in Industry

For example: Two distinct types are constantly being recognized in industry, namely, the engineering type and the executive type.

The engineering type of man works for the solution of a single technical or engineering problem and is concerned with the determination of the solution rather than the application of that solution to practical activities. The true type has the capacity to concentrate continuously on a single problem until the solution has been reached. He is interested in the determination of cause and effect and of the laws that govern phenomena. He is disposed to be logical, analytical, studious, synthetical and to have an investigating turn of mind. The predominating characteristic that distinguishes him from the executive is his ability to concentrate on one problem to the exclusion of others for a protracted period, to become absorbed in that problem and to free his mind of the cares of other problems. He does not submit readily to the routine performance of a given quantity of work. He deals with laws and abstract facts. He works from textbooks and original sources of information. Such men are Edison, Steinmetz, the Wright brothers, Curtiss, Bell, Pupin, Fessenden, Browning. These men are the extreme of the engineering type, they have enormous imagination, initiative, constructive powers.

The executive type takes the conclusions of the engineer and the laws developed by the engineer and applies them to the multitude of practical problems that come before him. His chief characteristic is that he works with a multitude of constantly changing problems at one time. He concentrates on one problem after another in rapid succession. In many instances he has not the time to obtain all of the facts and he must arrive at a conclusion or make a decision based upon partial knowledge. He must rapidly assimilate available facts and fill in what is lacking from the ripeness of his own experience, frequently calling upon his powers of judgment, and even intuition. He is a man of action, boldness, ingenuity, force, determination, aggressiveness, courage, decision; he is possessed with the desire to get things done, impatient of delay. He works from a handbook, a newspaper or nothing at all. Such men are Schwab, Goethals, Pershing, Farrell, Hindenburg, Hoover.

If we have accomplished nothing more than to assist the boy to determine whether he is a potential engineer or an executive, it seems to me that we have gone a long way.

The question of whether a man has been trained in mechanical engineering or electrical engineering is not half so important as whether he is a real engineer or a real executive. I am sure that we are all acquainted with hundreds of young men who have made their success in some other branch of engineering endeavor than that in which they received technical training, and I feel quite safe in saying that the qualities of character determine a man's success rather than the particular kind or extent of technical knowledge that he has received in his college course.

Perhaps at the same time that the suggestion is made for the amplification of college training so as to include the psychoanalytical treatment of the student, it would not be out of place to suggest that industry take up a similar work on its own account and for its own purposes, with a view to confirming or supplementing the determinations made in the course of college life. It seems obvious that there is a community of interest as between the student, the pedagogue and the industrialist, in that all are seeking the same end, namely, the development to the full capacity of the individual for accomplishment.

We seek only to avoid the wasted energies, the wasted years and the wasted lives; the discredit to educational institutions and the loss to industrial and national life. The limitation upon industrial accomplishment today is men and the industrialist is calling for your assistance in minimizing this limitation. We require men rather than students and intellectualists. Will you give thought to the direction of the human forces which you generate?

The Engineering School and the Industries[1]

By DEXTER S. KIMBALL,[2] ITHACA, N. Y.

ONE of the most remarkable developments in the last fifteen years, perhaps, has been the spread of the use of the word "engineering." The reason for its present extended use is no doubt because we lack some adequate term to employ in its place. What it means is, we are going to extend the methods of engineering to all human activity. First, we have applied it to industry. Now, we are going to apply it to management and then to finance, then to the human element, and lastly to religion. With all this has come also a clear recognition that there is such a thing as the engineering type of mind as contrasted with the legal or medical type. It is a distinct type of mind, one that employes a certain method of attacking problems.

Every graduate of a technical institution views the matter of education through spectacles of his own making. He has some criticism to make or some suggestion for his school's betterment, and many of these have been most useful. Every university faculty welcomes criticisms and suggestions, because they serve to enlighten them as to where they are going and as to what should be done with their curriculum.

In this country the average young man arrives at a university at the age of 17 or 18, and is usually graduated at about 22 or 23. It is not good to have boys stay in the university too long, for their vertebrae become stiff. In the four years allotted to the educator, he must take this young man and try to teach him mathematics and engineering subjects, train his character; he must further teach him English, of which he knows nothing. That, it should be noted, is a criticism on the lower grades of school. He must also teach him something of the classics, and lastly, must turn him out a finished engineer.

The list of things that must be instilled into these young men in four years is a long, long one, and if the faculty to which I have the honor to belong should undertake to incorporate in its curriculum the one hundredth or thousandth part of the suggestions they receive, nothing but chaos would result.

No man can properly be called an engineer who has not studied mathematics, physics and the mechanics of engineering. When it comes to the amount or quantities of these subjects, however, most men who have given much thought to this problem will probably agree that three years are sufficient to give a man a thorough grounding in these essentials of engineering training. This will leave a year in which the boys may be given some knowledge of the other fields about which they apparently ought to know something.

One of the first things that was brought to our attention as a requisite for the engineer was economics. That was not difficult to incorporate. Every engineer is by nature an economist. Every great power house is a problem in economics. The engineer studies economics quite willingly, and it has become a large part of the engineering curriculum.

The next demand—and an insistent one—was for a large amount of work in management, administration. We now have as a last demand this matter of human engineering. The engineer ought to know a great deal about the human element in industry, but generally speaking, he has not in the past been concerned with the human element. It has only been in recent years that he has been brought into touch with this problem; and, it may be said that he has been a little cold-blooded about it. He wants to get things done, and means are ways to an end.

If you are going to have the type of man that does things—and remember that engineers are the great ways and means committee of civilization—you may do other things, but you may not take away those fundamentals and get what I call the engineering type of mind. If I were to make any reply to the industrialist who adds that we do many of these things in the hope of getting men more closely adapted to their requirements, I would say that they, as a rule, have not appreciated either this problem or its solution. The industrial leader has seen fit to criticise the university without offering many constructive suggestions as to how the problem can be solved. One of our great industrial leaders some time ago remarked that if he had his way he would put industrial leaders at the head of all universities. His argument was that the universities are too far away from industry. Well, I hope that they may, in some respects, stay away from industry, and I hope there will always be in this great land universities where teachers are free to teach the truth as they see it. I am free to admit that one of the things that must be done is to give these young men some knowledge of the human problem and related problems, but I do hope there will never come a time when institutions will be adopted by industrialists, who have only in mind the peculiar problems of industry, and have not clearly in mind that the great hope of civilization lies in the engineer, and in making him as ideal as we possibly can.

ENGINEERING EDUCATION DISCUSSION

Dean A. A. Potter of Purdue University submitted a written discussion, in which among other things, he said that our curricula are in general designed to teach students basic subjects which they cannot acquire by their own efforts after they graduate from college.

Mr. Pratt had stated that the engineering schools undertake too early specialization. While the pressure from the outside was great for specialization, a study of the present curricula of engineering schools would reveal the fact that the tendency was to reduce specialization and to broaden the training of the undergraduate.

Carefully kept personnel and academic records should enable engineering educators to discover men who are of the inventive type and who can be developed into inventors, designers and research engineers. The inventive type of student usually shows his talents when very young and his training must be entirely different from that of men who are to enter the fields of production, sales or of public service.

A curriculum which provides no contact with engineering problems during the first two years is bound to discourage many of the more practical and ambitious students.

There is too much tendency in our entire educational system to encourage the development of "one text book" people and without basing the instruction upon the students' ability, aptitude, knowledge and experience. Apparently very little effort is being made to discover and to develop the student's talents.

Statements have been made that there is a distinct need for more highly trained engineers. He would like to have the opinions of Mr. Pratt and of others from industry as to whether we are justified in encouraging students to devote two more years to their preparation. To be more specific, what inducements could industry offer to our exceptional students if we encouraged them to spend five or six years at college instead of four?

M. W. Alexander[1] said that meetings like the one in session were highly desirable, but they would not bring results. It was necessary for the engineering professors and the industrialists in each community to come in close touch, so that the former might learn from the latter of the progress made in the art and the application of the science and of the adjustment that the engineering schools should make as rapidly as possible in order to catch up with the rapidly advancing industries.

A. M. Greene, Jr.,[2] speaking of the demands on the colleges for specialists, said that these were being met by training men whose fundamental work was of such a nature that it prepared them so that they were able to think, reason and apply. Personal contact was one of the most important parts of the work, but, with the increase in size of classes it was growing rather impossible. Some of the best work done in preparing men to go out and solve the

(Continued on page 42)

---

[1] Introduction to discussion of the preceding papers on engineering education. Slightly abridged.

[2] Dean, College of Engineering, Cornell University, President Am.Soc. M.E.

[1] National Industrial Conference Board, New York, N. Y. Mem. Am.Soc.M.E.

[2] Professor Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. Mem.Am.Soc.M.E.

President Carman's Address

ANNUAL MEETING, 1921, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

A.S.M.E. Has Emerged From First Epoch Related Principally to Scientific Advancement of Material Things and Now Faces Second Epoch—the Problem of Human Relationships

BEFORE discussing the main theme of my address I desire to relate some of the principal Society activities of the past year. In the year 1920 the spirit of unrest that characterized the human mind as a result of the years of warfare was at its height, and gave expression in most walks of life. It was rampant in engineering society circles, and it is with great pleasure tonight that I give expression to my findings covering the operation of the affairs of our Society.

Our Society is democratic in organization, representative in government—its operation is coöperative—its activities extend into every part of the United States and are within reach of almost every member, and its accomplishments are contributions to the welfare of mankind.

As President I have traveled over twenty thousand miles. I have visited and addressed local sections and business organizations, carrying the message of engineering ability and its relation to the great economic problems of the day.

I have failed to find "politics," or any group of men, or any one man, governing the affairs of our Society.

The San Francisco man has as "much to say" as the New Yorker, and the West Coast members of Council and committees are as conspicuous as those from any other section; North and South, East and West, are united.

There is not anywhere apparent group or faction, friction or discord, except the friendly differences of opinion. We are all one large family, its members helping each other, all working for the upbuilding of our Society.

One year ago The American Society of Mechanical Engineers celebrated its fortieth anniversary. The Local Sections in forty cities held meetings, and with glad hearts told of the accomplishments of the past forty years.

FORTY years of Society activity, and
FORTY cities celebrating;
FORTY—a cardinal number with great significance.

The "Fortieth" Anniversary is used many times to indicate completeness. Israel's greatest kings each reigned forty years, the ancient Venetian court was composed of forty.

Do these first forty years represent the first epoch in the history of our Society?

Has the epoch been completed? All indications point that way, and if it has, then we are now closing the first year of the *second* epoch. In the years ahead I believe there will come the realization that a year ago marked the distinct closing of the *first*, and beginning of the *second*, epoch.

The important accomplishments of the first epoch related principally to scientific advancement of material things. What is to be our aim for the second epoch?

The beginning of the first epoch was coincident with the beginning of a constantly and greatly increasing demand for mechanical equipment and allied engineering projects.

The American Society of Mechanical Engineers has been a splendid copartner in all the technical and scientific developments. It has rendered, and still is rendering, a valuable service to industry.

It was, at its beginning, organized to assist in the solution of the great problems of its day. These problems were technical and scientific in their nature, and their solution contributed to the rapid increase in quantity production, through the aid of mechanical appliances. So rapid and complete was the development that many operations were accomplished with little effort on the part of man. But in many instances the elimination of the effort produced an operation of drudgery—and drudgery always creates dissatisfaction and strife.

If we are to follow the policies of the founders of our Society, we, too, must assist in the solution of the greatest problems of our day.

You will agree with me, I am sure, that the greatest problem of today is neither technical nor scientific, as applied to material things. It is one of human relationships.

If the problem were only the relationship existing as man to man, then it would not be one to be considered by engineers. But our problem is more than one of man to man; it involves not only the relation of man to man, but also the relation of man to production—to intense and mechanical production—of man to waste of production and consumption, of man and his relationship to industry, and of industry and its relationship to man.

In the early developments, engineers as a whole gave attention, in machine design, or plans for large projects involving labor, to the producing of results, regardless of their effect on the person or persons engaged as operators or workmen.

Today it is and should be necessary to consider the human side of quantity production, and since this can best be done in connection with technical and scientific progress, it follows that the engineer, whether he so elects or not, must be the one to assume the responsibility, as the technical, scientific, material and human elements of progress must be considered collectively.

Our problem of today had its beginning in the introduction of machines and mechanical appliances to production; and with the introduction of the labor-saving devices there also began that kind of intense, nerve-racking, vitality-consuming labor that has been constantly continuing and increasing, until it has produced one of the greatest problems that has ever vexed mankind. This problem is commonly called "Industrial Relations."

It is true that the origin of labor trouble can be traced back through centuries, but those are not the labor problems that give expression in organized labor today.

Coincidently with the demand of civilization for great quantities of the articles of its consumption came the necessity for larger industries. As these industries became more numerous, many of them combined and formed large organizations for the purpose of self-protection, self-advantage, and control of markets.

Likewise the bringing together of many workmen, each with a certain and definite task to perform, gave opportunity for an interchange of grievances and a combined or group effort which has resulted in the labor organizations we have today.

Thus we had, growing side by side, two distinct organizations or classes: one, Industry or Capital, the other, Labor Unions or Labor. Not only have both of these organizations increased in size, but each has combined and federated with others of its kind, until both are unwieldy—overgrown, unable to control or direct their followers—each seeking the advantage over the other, and both actually taking advantage of the great consuming class, the Public.

We have still another complication, a third party—the Government—attempting to direct the other two, and the result is more deplorable than ever.

Since the Government is administered by a class which we in America call "politicians," and since each class has its own interests to protect, it follows that no one class should attempt to control the other two.

What, then, is the solution? After years of struggle, after countless endeavors from many different angles, the problem remains unsolved, and growing worse. There must be some method that will solve it.

The party most vitally interested, when rightly led, will be the deciding factor—*public interest is paramount.* What group of men is best fitted for leadership?

The great depression of today has seemingly lessened the apparent necessity for urgent consideration of the problem, but the problem is still with us, unsolved, and with the revival of business it will become more acute than ever.

I recognize in society today the existence of three laws: the

(Continued on page 74)

Prevention of Wastes in Industry

By FRED J. MILLER,[1] NEW YORK, N. Y.

THE Committee on Elimination of Waste in Industry devoted most of its attention to wastes of time and effort because these are far more important than wastes by direct loss of materials.

I think I need not discuss the grosser forms of industrial wastes that come from loss in various ways of supplies and materials. Such losses are relatively unimportant and means of preventing them are now very generally understood and are in use in practically all establishments in which it is realized that the safeguarding of such things that cost money is as important as the safeguarding of money itself.

I am asked to discuss, not simply wastes in industry, but incentives for the prevention of such wastes, and here we are confronted with the anomaly that those who would be supposed to have the greater incentive for the prevention of industrial wastes are found to be responsible for the major portion of the wastes that occur. Responsible, I mean, in the sense that they, the owners and directors of industries, are the ones and the only ones, who can adopt effective means to stop these wastes.

This seems to indicate that not only must there be incentives for the avoidance of waste, but there must be also a clear realization that preventable wastes are occurring and a general understanding of the reasons for them and of the means by which they may be prevented.

It is natural for the normal man to be active in some way—either mentally or physically, or both. There is scarcely a greater punishment that can be inflicted upon him than complete, enforced idleness, such as results from solitary confinement in a dark cell.

It is perhaps industry's chief problem to conserve, develop and make use of the natural desire of the normal individual to be accomplishing something, and, further, to relieve workers so far as possible from such conditions of work as are deadening to ambition, to initiative and to the creative instinct. Far more can be done along that line than may seem possible at first sight, and the results of even the simplest efforts in that direction have, in many cases, been very excellent for all concerned.

In a recently published magazine article the difference was clearly shown between having a foreman tell a group of workers that they must work overtime and, on the other hand, allowing the workers themselves to pass to each other and read a letter from a customer saying that unless his order was shipped by a certain date he would consider himself at liberty to cancel it. The workers themselves decided to work overtime to prevent cancellation of the order. And in all such cases the more ambitious workers can exert an influence upon the others far more effective than any other that can be brought to bear upon them.

Incentives in Industry Defined

Incentives may be grouped in two general classes which may be called the "penalty" class and the "reward" class.

The penalty incentives, in the form of the lash or other gross physical punishments, were more common in slave times than they are now, but the penalty incentive still persists here and there in various forms and there are still too many in our industries who seem to recognize no other kind; not knowing it is still true that "he who owns a slave is himself in chains."

Incentives of the penalty class make people afraid not to do the things they are ordered to do. Incentives of the reward class tend to make people want to do the things that are expected of them. These two classes of incentives of course differ widely in their nature; but they differ no more than the results that are obtained by them.

I do not know what course the discussion of this question may take here today, but I prefer to confine myself to discussion of the reward class of incentives as being the only one worthy of consideration in connection with industries carried on in an enlightened age and in dealing with free men.

The reward class of incentives may be divided into two subclasses that may be called respectively "group" rewards and "individual" rewards.

Profit sharing, group insurance, employee representation or participation in management, most of the so-called welfare work, general or so-called horizontal increases in wages, bonuses paid to all employees alike, etc., are and are intended to be group incentives; while individual increase of wages, piece work, bonuses to individuals for specific individual attainments are, of course, individual incentives.

Whether group or individual incentives should be employed in a given case depends of course upon the circumstances of that case; but my own experience and observation lead me to the belief that, after we have established good working conditions, such as well-lighted, heated and ventilated work places; done what we can to keep them in good sanitary condition and as free as possible from danger of accidents; and have foremen and other executives who have been selected and trained to take an enlightened and "human" attitude toward employees, the rest of the way to the best possible general results is through individual reward incentives; which may take the form of higher hourly wages paid to individuals for individual attainments, a bonus paid for definite attainment, advancement from the ranks to successively higher executive positions, or all of these together with, so far as I have been able to perceive, about equally good results when applied intelligently. And they can be applied intelligently only when means are provided for having a continuous record of every employee's performance with reference to established standards; so that reward incentives will not be based upon any executive's prejudices or whims but upon actual and demonstrated service rendered in doing the work for which the plant is operated.

As a consequence of the acute situation and the very troublous times we have been, and still are, passing through, there has been, I think, some tendency to overelaboration in certain of the measures taken to overcome our industrial difficulties. As for me, I still have faith in the comparatively simple means of enlisting the enthusiastic coöperation of minor executives and employees, and an essential part of this is to give them such treatment as every man likes to receive from those with whom he comes in contact; always remembering that workpeople are not, after all, essentially different from other people; are at least as readily responsive to candid, fair and courteous treatment as are other people, and also as well able to judge whether or not they are receiving it.

Causes of Industrial Wastes Itemized

And along with this there must be avoidance of the large industrial wastes that come from overloaded inventories; slow movement of materials through the successive operations of manufacturing; unskilled, because inadequately studied, and developed, manipulation of materials; inability to definitely and promptly place responsibility for delays; failure to clearly distinguish between those things which are the worker's responsibility, the foreman's responsibility, the superintendent's responsibility, and the owner's responsibility.

That all these, as well as the designing engineer, have their separate responsibilities is, in a general way, well recognized; but in our manufacturing establishments there is usually no means for definitely assigning responsibility in such manner that a record is made, clearly showing to all concerned where the responsibility lies and whose duty it is to take steps to correct the defect, assuming it to be remediable. Such a record does away with arguments and the attempts to shift blame from one to another, until finally it rests upon the man who cannot "talk back," or is canny enough not to do so and must bear it, smarting under the belief that he is unjustly blamed; and being disheartened and perhaps alienated by what he regards as being grossly unfair to him.

The major cause of waste in manufacturing lies in defective administrative methods, for which in general no one is to be seriously

---

[1] Past-President Am.Soc.M.E.

Address delivered at the session on Elimination of Waste in Industry of the Annual Meeting, December, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

blamed, for they are the methods that have the sanction of long usage and by them, or rather in spite of them, many successful enterprises have been, and are being, conducted.

Certainly owners and managers are not to be blamed in the moral sense for following well-established methods and practices, and of course they should follow them until they become convinced that there are better methods and practices that are open to them. On the one hand we see employers who are too easily prevailed upon by charlatans to take up methods that are little better than a group of unrelated "stunts," and on the other hand those who always delay progress along new lines until pretty nearly every one else is far in advance of them.

It is the work of engineers to educate and to show the better ways, and I predict that as time goes on our industries will be more and more directed by engineers who know how to direct them for production and who will regard production and service as the prime objects to be attained by an industrial organization. When this change has been effected, one of the greatest causes of waste will have been removed.

I could mention entire industries that are in the control of men who are little if at all interested in production, but devote their entire attention to high finance, which is often crooked finance.

Human Element must be Recognized

All signs point to new conditions under which our industries must be conducted. Improved methods of administration may go very far, but however, along with them, and an essential part of them, if we are to attain the highest immediate success and prepare for still further progress in the future, must be full recognition of the transcendent importance of the human element in our industries, and means simply must be found to remedy and avoid the condition into which so many of our industries have fallen and in which the attitude of employers and employees toward each other ranges from indifference or suspicion to more or less open and avowed hostility and a keen desire for revenge of wrongs, real or imaginary.

Ambitious men must be expected to have ambition for the welfare of their families, and from the social, political and industrial standpoints this is desirable and indeed necessary if our industries are to thrive by rendering service to society.

Foremen must be looked upon and must regard themselves as leaders, inspirers and teachers of their men rather than mere drivers; means must be provided by which the value of workers with respect to a fair standard can be indubitably ascertained and each should be unfailingly rewarded in proportion to his attainments.

Numerous examples, some from my own experience, might be given of the successful working of these principles, but as an illustration of what I mean, I prefer to go back to an incident related by Frederick W. Taylor, mainly because it is exceedingly plain and simple and also exceedingly enlightening to those who will study its full significance.

You will remember that at Bethlehem, Taylor, by patient, careful and really scientific study determined the best type of men, tools and methods for unloading ore from railroad cars. As results, the men were paid considerably higher wages than before, the cost of unloading cars was materially reduced, the men were not worked too hard for their physical well being, and all concerned were satisfied.

An establishment located elsewhere learned of this and hired some of these trained men, Taylor consenting to their going and at the same time telling them he would be glad to have them return if, for any reason, they were not satisfied in their new place.

The men went to work there, working as they had been trained to work, but found they could make no showing because they were only a few working with many others; their contribution to the total work done being therefore relatively small and indistinguishable from the work of the group. In other words, they could make no showing of their abilities.

They asked that they be assigned to definite cars which they could unload by themselves—as they had been accustomed to do at Bethlehem—and were brusquely told to mind their own business and work as directed.

They quit and went back to Bethlehem, and thus the effort to transplant the methods so carefully developed there failed.

And it failed simply because the human nature of these ore shovelers had been ignored; the management did not do its part by establishing the conditions that had been found necessary to success. It was a clear example of the old idea that industrial efficiency is to be secured by simply hiring the best workers available at as low a wage as they feel compelled to accept and then driving them as hard as possible. There may have been also a thought of the pace-making game which has been so much employed and which is still believed in by some employers, though it is extremely crude and the workers have very generally taken such measures as they can to protect themselves against it.

It must be recognized that even in the simplest work pride of achievement can usually be developed, and that often men will work their best only when they are not hampered by conditions that limit their achievements or that prevent them from being credited with their achievements; especially when they know, or believe, that these hampering conditions can be removed.

It would, I think, surprise a great many of us if we could know just how much of the wastes of industry that are caused by careless, inefficient work have a deeper underlying cause in a feeling created by the conditions under which men work, that make them believe they cannot do what they should do, and for reasons entirely beyond their control.

In a certain government establishment to which many good workers came during the war, mainly for patriotic reasons, quite a number of these men quit because conditions there were such that they could not do a fair day's work, no matter how much they might try. They did as much as was customary there, but so much less than they had been accustomed to do that they became disgusted and could not bear to remain.

It is by no means always easy to say where the blame lies for industrial wastes that come from slackness of workers and executives.

Take the case of a machine shop in which it is apparent that not much more than half the work is turned out that should be done. In many such cases the work has been brought up to the full standard by a change in the management, with or without a change in staff personnel, but employing the same workers as before.

Better Management Often Reduces Waste

Too many there are who would, with all the assurance in the world, blame the previous inefficiency entirely upon the employees, but the hard fact that such inefficient establishments have been in many cases vastly improved by change of management or of management methods must be squarely faced if we are to comprehend our problems or succeed in materially improving conditions.

Especially do we need to adopt such methods of management as will enable the facts to be fairly presented to both sides in every difference that arises between employer and employee; and experience shows that when we have done that, both the employer and the employee are far more reasonable and considerate than either usually imagines the other to be.

It is at least as important that all the elements of an industrial organization should work together harmoniously and without friction as that the different parts of a finely designed and constructed machine should do so. When either does not function properly, it is a case for the use of intelligent discrimination in finding out the real cause of the trouble and the proper remedy. Usually the bludgeon treatment only makes things worse, no matter which side resorts to it.

Production has been and is restricted by workers, both organized and unorganized, and most of such restriction is of course wrong, from the economic standpoint, if not ethically.

In most industries, however, I think it can easily be shown that restriction of production by workers is insignificant compared with the restrictions caused by financial juggling of one kind or another; by avoidable irregularity of employment of labor and of plant by presidents or managers who are temperamentally unable to make decisions and then stick to them, or are unable to do so because they are under the control of men "higher up" who know nothing of industrial science, or even that there is any such thing; by unnecessarily large inventories and consequent tying up of capital that could be otherwise usefully employed; by inadequate con-

(Continued on page 42)

Forty-Second Annual Meeting of the A.S.M.E.

Sessions Held Under Auspices of Professional Divisions Consider Elimination of Waste in Industry—Honorary Membership Conferred Upon Past-President Henry R. Towne

FIVE solid days of professional and technical features characterized the Forty-second Annual Meeting of The American Society of Mechanical Engineers, and in this respect the meeting was far greater than any yet held by the Society. Not to speak of the social and entertainment features, into these five days were crowded over a hundred professional events. The social events were dovetailed in quite satisfactorily, and though the program was so very full, a well-arranged schedule insured the comfort of all members and guests throughout the week, with the result that there was unanimous agreement that the meeting was a great success. The thanks of the entire membership are extended to all committee members who contributed in any way to this result.

Dexter S. Kimball President, 1922
The American Society of Mechanical Engineers

Notwithstanding the general situation in the engineering industries and the surtax on transportation—the two factors still operating to flatten the attendance curve—the registration was 1854, which compares very favorably with that of previous years. As it was, the facilities of the building were utilized to the full, the auditorium and the meeting rooms on the fifth floor, as well as the "best parlors" of the other societies in the building being in use all the time.

With one set of professional sessions on Monday and Tuesday and another set on Thursday and Friday, and with an all-day Business Meeting in between, there were virtually two "peaks" in the week, and most members from out of town welcomed the opportunity thus afforded to take care of their business and other affairs.

Of the nineteen professional sessions, nine were conducted by the new Professional Divisions, with the result that the technical information brought out was of a high standard.

The Annual Conference of Local Sections delegates was attended by representatives of 44 Local Sections. A more complete treatment of this meeting was given in the first number of the *A.S.M.E. News* issued late in December. It may be said here, however, that in addition to considering the organization problems of the Local Sections, a considerable amount of time was devoted to the proposed Constitution of the Society.

The entire day of the Business Meeting was given over to the new Constitution and two amendments to the present Constitution. The meeting voted to refer the amendments relating to the voting of Junior members and the mechanism of amending the constitution to the membership by letter ballot. The proposed Constitution was referred to the Constitution and By-Laws Committee for further revision and the discussion was carried through purely for the guidance of this committee.

At the Business Session the first award of the A. S. M. E. medal was made to Hjalmar G. Carlson for his invention and part in the production of 20,000,000 Mark III drawn steel booster casings used principally as a component of 75-mm. high-explosive shells, but also extensively in gas shells and bombs. The annual prizes for best papers were also presented at this session.

The meeting of the 1921 Council, with President Carman presiding, was held on Monday, and that of the 1922 Council, with President Kimball in the chair on Friday. The A. S. M. E. delegates to the American Engineering Council attended the Monday meeting and a large part of the time was given over to a discussion of the affairs of The Federated American Engineering Societies. On Monday the Council, the Local Sections delegates and the American Engineering Council representatives met at lunch.

Twenty-seven committee meetings were scheduled on the program, and at least a dozen others were held impromptu. The Society flourishes in proportion to its committee work—the labors of the seven hundred-odd members who contribute their time and experience.

The leading social event was the Dinner-Dance at the Hotel Astor on Thursday evening. Four hundred participated in this delightful affair. The Smoker for the men this year was held at the Fifth Avenue Restaurant, and those who were fortunate enough to attend enjoyed songs, a few clever stunts and a first-class dinner. The President's Reception and the Ladies' Tea were equally enjoyable; they were held on the fifth floor of the Engineering Societies Building which was attractively decorated.

The formal excursions included visits to the Seaboard By-Product Coke Company, the Essex Street Station of the Public Service Corp. of N. J., The Davis-Bournonville Company, the Ford Motor Company, the oil-burning plant of the Singer Building and the S. S. *Olympic* of the White Star Line. The latter was the most popular for ladies as well as the members, and places in the party were at a premium. The steamship company provided tea, and the excursion was delightful as well as instructive.

An innovation this year was a graphic exhibit of the several activities and functions of the Society. This was arranged in the Society's rooms and attracted a great deal of attention and favorable comment.

The account of the Annual Meeting published here deals particularly with the business and professional features. Some of the papers have already been published, others are included in this issue, and the remainder will follow later.

President's Address and Honorary Membership Award to Mr. Towne

ON TUESDAY evening of the Annual Meeting, after an inspiring address in which he portrayed the Society as having completed its first cycle and emerging into a new era, Mr. E. S. Carman relinquished the chair in favor of Dean Dexter S. Kimball, whom the membership had selected to head the Society during 1922.

President Carman's address is published in full in another column of this number.

The ceremony of introducing the new president was carried out after the chairman of the Tellers of Election, Dr. H. G. Tyler, had announced the result of the letter ballot of the membership, taken in the fall, to fill all the annual vacancies on the Council, as well as to elect the A.S.M.E. representatives for the year on the American Engineering Council, the governing body of the Federated American Engineering Societies. The names of all the successful candidates for office were read, and the announcement made that they had been elected by practically unanimous vote.

The new president was escorted to the platform by Past-Presidents Charles T. Main and Fred. J. Miller. In accepting the office, Dean Kimball said that the honor that had been bestowed on him held a peculiar significance, because one of his distinguished predecessors, Professor Sweet, was one of the first teachers at Cornell University, and another, his great predecessor in office at the University, Dr. R. H. Thurston, was the first president of the Society. With the honor, however, he acknowledged a great responsibility and pledged his very best effort to the members and to the Council in keeping the A.S.M.E. in the forefront as the highest representative of best engineering thought in the country.

Henry R. Towne

Past-President Henry R. Towne Honored

A further ceremony of the evening was the bestowing of Honorary Membership in the Society on Past-President Henry R. Towne.

In making the award President Carman expressed great pleasure at the opportunity of reviewing the achievements and attainments of Mr. Towne, and his work for our Society since 1882, two years after its foundation.

Mr. Towne is a Life-Member. He was vice president from 1884 to 1886 and three years later served as president.

In early association with Robert Briggs he carried out numerous experiments in leather belting which were accepted as the standard for twenty years. He formed a partnership with Linus Yale in 1868 which resulted in the organization of the Yale & Towne Mfg. Co., which Mr. Towne directed as President until 1915, since then acting as Chairman of the Board. Mr. Yale having died in 1869, the responsibility and credit for the success of this firm is due largely to Mr. Towne, who greatly amplified original features and embodied with them radical departures in design and workmanship, especially in methods of production which have become accepted standards of the industry. During thirty-six years almost every improvement in locks or lock-making machinery came from the Yale & Towne Mfg. Co. Besides locks as such, Mr. Towne has become famous also as a manufacturer of complete post-office equipment, chain hoists and all manner of art hardware.

Mr. Towne's unusual combination of business and mechanical ability, his keen vision into the future and his untiring efforts to create and maintain a product and service of excellence, have made him the recognized principal factor in the growth and present high position of the lock art.

His contributions to technical literature and especially to the Society's publications have been numerous and basic.

Mr. Towne's Reply

In expressing his appreciation of the honor conferred on him, Mr. Towne recalled some of the early days in the Society, recording how it performed a function of usefulness especially to its younger members, as it does today. Then, as now, it trained its members in the habits of preparation for the meetings and of presenting their work so as to be of interest to others and, he hoped, to the community. In other words there has always been the thought of service. In this Society service belongs properly first to our fellow-members, then to the Society as a whole, the profession, and lastly to the community.

He thought that young men were apt not to realize this possibility of service in their work, and yet it underlies work of all kinds, and especially that of the engineer.

During the latter half of the long period of his membership his time and attention had been turned largely from purely engineering matters to those connected with the great city of New York, and sometimes to affairs of the nation. But in all these duties in which he had been able to render service, he had been aided by the fact that he had not only a technical training but also considerable experience in the practice of engineering and in the art of management. Therefore those of the younger men who have similar training and experience are particularly qualified to act as leaders in civic affairs, and he urged that without slighting their professional work they seek opportunities to engage in activities of this kind.

Reception of New Officers

Following the exercises in the Auditorium the company adjourned to the reception rooms where the new officers received the members of the Society and the ladies. Then came the customary informal get-together, with the renewal of old associations and the formation of many new ones. Music was provided, and the evening ended with an informal dance.

Opening Session on Waste in Industry

In announcing the general topic of the Annual Meeting of The American Society of Mechanical Engineers as Elimination of Waste in Industry, President Carman voiced the sentiment that in the years to come the deliberations of this convention would be looked upon as the inauguration of a practical program for waste elimination, not only in industry, but in all walks of life. It was traditional that the American people were wasteful, probably because of the great wealth of their resources, but he emphasized that the present was witnessing the inauguration of a program of economy which would redound to the credit of our nation.

Explaining that elimination of waste is largely a matter of management, the President said that the Management Division of the Society, now numbering upward of 1600 members, had contributed the program of this session, and he therefore introduced as presiding officer former chairman of the Division, Mr. L. P. Alford, vice-president of the Society.

Mr. Alford told of the interest, publicity and favorable comment that has been accorded to the report of the Committee on Elimination of Waste in Industry appointed by the American Engineering Council of The Federated American Engineering Societies. He felt, however, that if elimination of waste is to be put into practical effect in American industry, this must be done through

the individual acts of the engineers in the several professional societies.

Turning to the program, Mr. Alford then presented Past-President F. J. Miller, whom he also introduced as contributing to the Report by taking charge of the field investigations in the metal industries. Mr. Miller's message to the convention appears in another column.

Prevention of Waste of Power

In introducing the next speaker, Mr. Alford said that Major Miller had stressed the human waste in industry; Prof. L. P. Breckenridge[1] would present another point of view—the elimination of waste of power, to be made possible by a proposed consolidation of all sources of power in the country's great industrial zone from Boston to Washington.

Professor Breckenridge, speaking as chairman of the Advisory Committee of the Superpower Committee, described how emissaries from the Engineering Council had appeared before Government authorities and helped to secure an appropriation for a research or survey to determine what, if any, waste might be prevented by the development of what has come to be known as the Superpower System. The report of this survey,[2] made with the coöperation of 18 railroads, 558 public-utility companies, and the information reported through the census of 76,000 industries using power within the zone, is now available. The essential elements of the superpower plan are:

(*a*) Generation of power in plants of large capacity and high economy
(*b*) Locating those plants advantageously relative to coal, mines, condensing water, load centers and coal distribution
(*c*) Electric trunk lines in connection with the generating stations, both steam and water
(*d*) Unified system of control in charge of a power despatcher
(*e*) Delivery of primary power to electric public utility
(*f*) Local distribution of energy by the public utilities.

This latter includes the essential element of a superpower plant in this or any other zone.

Predicated upon curves extended into 1930, the expected economies are:

(*a*) Annual saving of 50,000,000 tons of coal
(*b*) Annual saving of $240,000,000
(*c*) Elimination of coke and its attendant wastes
(*d*) Elimination of waste of water power.

The other important effects will be:

(*a*) Material reduction in price of power
(*b*) Considerable transfer of coal transportation from land to water
(*c*) Increased flexibility of power distribution
(*d*) Opportunity for coal storage, tending to stabilize production
(*e*) Establishment of chemical, metallurgical, and other metal industries needing large power supply and high temperatures.

The superpower zone covers two per cent of the area of the United States, contains 32 per cent of the population, and manufactures 44 per cent of the products of the country.

The scheme of the superpower system is a large one, but it is the next logical step in the conservation of power resources. Following the survey of the facts will come studies of the local conditions under which the system can be installed, and finally the study of the financial conditions to take care of it.

Prevention of Waste of Money

The third speaker was E. F. DuBrul,[1] who directed attention to the tremendous wastes in industry caused by industrial depressions in business cycles. Within a century this country has passed through fourteen periods of depression of greater or less extent, but all involving serious loss to the investor in industrial enterprises.

Liabilities of concerns which failed in the past ten months of 1921 aggregated $591,000,000, but even this figure does not represent the wastes of investment, loss of useful values, loss of profits and wages in concerns which did not reach the bankruptcy court.

On all sides we are told that these losses are due to maladjustment of supply and demand, but this occurs because those responsible for supply know so little about the demand for their product that for considerable periods they purchase far more supplies than they need, and they waste capital in building plants to supply a non-existing demand.

If there are 9,000,000 automobiles in the country, each consuming four tires a year, or 36,000,000 tires in all, is it not waste of capital if 75,000,000 tires are manufactured for replacement?

This kind of error must be placed at the door of management, and can be avoided only by the coöperation of managers with each other in a study of the facts as to supply and demand of the commodities they produce.

However, the new economic conditions are compelling attention and business cycles are being studied as never before. Men are beginning to promulgate a fallacious gospel—that the end of business must be *service*, not production, not profit. Service is a means of gaining profit, and all business without profit dies—the controlling factor in management must be a financial factor—it stands the losses and it gets the profit where there is one.

In the last analysis, therefore, the controlling waste in industry is financial waste, and it seems not to be asking too much to ask management to eradicate this waste by recognizing its duty of adjustment of supply and demand.

Discussion of the Three Papers

The meeting was fortunate in having in attendance Mr. W. S. Murray, the Director-Engineer of the Superpower Survey, who supplemented the remarks of Professor Breckenridge by a visualization of the "point to be striven for" by the coöperation and coördination of all utilities within the zone, finally producing on the map such a system as some 500 engineers had agreed upon as a good mark for which to aim.

Mr. Murray was followed by Mr. H. W. Flood, secretary-engineer of the Survey, who demonstrated that the concentrated-power system, besides reducing fuel costs to about one-half, would also reduce labor, maintenance and supplies to about one third of those for independent operation as of 1919; accordingly, in discussing waste, it is important to add to the conservation of fuel, the saving of labor and capital.

Mr. J. Parke Channing, Chairman of the Committee on Elimi-

---

[1] Professor Mechanical Engineering, S.S.S., Yale University. Mem. Am.Soc.M.E.

[2] Professional Paper No. 123, U. S. Geological Survey.

[1] Manager, Natl. Machine Tool Builders' Assn. Assoc-Mem.Am. Soc.M.E.

Group of Members and Their Guests on Board the S. S. Olympic

nation of Waste, said that in stating that management is responsible for 50 per cent of the waste in industry, it is fair to say that all men who represent management are not engineers. In those industries in which engineers are prominent as managers and directors, there is and will be less waste than in those in which engineers do not fill their proper place.

Mr. W. N. Dickinson,[1] referring particularly to Major Miller's paper, said it was not brought out clearly that one of the incentives of industry is pride. Belief that industry is moving toward some worthy goal, and pride that his organization is a leader in that progress, will work as fully in a man's mind as the promise of financial recompense.

Lewis F. Lyne, Jr.,[2] said that he had "boiled down" the *causes* of waste to negligence, lack of initiative, ignorance and poor service, and the *remedy* to replacement of management by people who have the necessary ability to handle these inherent discrepancies.

Speakers on Elimination of Waste at Leading Session of A.S.M.E. Annual Meeting

Left to right, back row: Ernest F. duBrul, L. P. Alford; front row: E. S. Carman, L. P. Breckenbridge, W. S. Murray, F. J. Miller.

George Vangelder[3] stressed the sociological side of waste. Is the problem the question of handling material and planning production, or should we use these things for the purpose of building up a better manhood in the country?

The incentive which made every worker in this country produce in the war is the incentive that the manufacturer must give his employee now—to produce, not for profit alone, but for building up industrial America.

R. A. Wentworth[4] combined the service and the profits motives of industry, disagreeing with Mr. DuBrul that the aim of industry is profit. This speaker referred to the work of the late Mr. Gantt, whose life was founded on the principle of service.

In his own experience he had never seen any deviation from the truth that sufficient knowledge of the problem, adequate observation of the facts and sufficient initiative in applying the remedy, could keep any business out of its trouble.

Mr. DuBrul, in his closure, challenged the discussion of his statement that the end of business was profit. He agreed that the means for profit was service, but that did not change the fact that the end of business was profit. There was never a business started for any other reason than profit.

Education and Training in the Industries

Monday evening was given over to a session dealing with the vitally important problem of education and training in the industries. The program was arranged by the Committee whose activities have been devoted to this subject under the chairmanship of W. W. Nichols.

An unusually interesting paper was presented by Dean R. L. Sackett, who outlined methods of education and training actually being used in industry in this country and abroad. The development of education and training in the railroad field was treated by D. C. Buell. These papers and the strong discussion incited thereby will appear in the February issue of Mechanical Engineering.

Public Hearing on Proposed Code for Unfired Pressure Vessels

An important hearing was held on Monday, December 5, by the A.S.M.E. Boiler Code Committee to discuss a code for unfired pressure vessels, a preliminary draft of which has recently been issued. This pamphlet was the result of over two years of investigation and conferences with allied organizations.

The contributions of the Sub-Committee on Welding to this code are shown in the proposed specifications for autogenous welding, forge welding and brazing. While there was the attempt to render the code comprehensive, every detail of either the construction requirements or the various specifications on which there had been lack of agreement, was omitted. These points of possible disagreement were presented for discussion in a list of fourteen questions at the end of the report.

This preliminary report had been distributed in advance of the meeting to nearly 500 individuals and concerns known to be interested in the manufacture or use of unfired pressure vessels. The result was an attendance averaging nearly 200 during the entire day.

The preliminary draft of the proposed code was read paragraph by paragraph and discussion invited on each detail. The responses to the fourteen questions at the end of the report furnished the Committee with data valuable for use in shaping the code into final form. The Boiler Code Committee will give this data immediate and careful consideration so that the revised Code will be presented for further discussion, possibly in connection with the Spring Meeting of 1922.

Power Session

Four notable papers giving actual heat balance figures in three large public utility plants and the proposed scheme in a plant under construction were presented at the Power Session on Tuesday morning.

These papers presented valuable data that had not previously been made public and drew, therefore, a wealth of discussion. The three following papers appeared in the December issue:

Among Those Who Spoke at the Power Session

Left to right, back row: Geo. A. Orrok, J. Anderson, O. F. Junggren, N. E. Funk, R. J. S. Pigott, Leo Loeb, F. R. Low, W. M. Keenan; front row: J. H. Lawrence, A. G. Christie, C. H. Berry, E. L. Hopping.

Auxiliary System and Heat Balance at the Delaware Station of the Philadelphia Electric Company, E. L. Hopping
Heat Balance of Colfax Station, C. W. E. Clarke
Heat Balance System for Hell Gate Station, J. H. Lawrence and W. M. Keenan

The final paper by D. H. Berry and F. E. Moreton giving the Heat Balance of the Connors Creek Plant of the Detroit Edison

---

[1] Consulting Analyst, New York, N. Y. Mem.Am.Soc.M.E.

[2] Pres. and Genl. Mgr., Oil Specialties & Supply Co., New York, N. Y. Assoc-Mem.Am.Soc.M.E.

[3] Sales Dept., Industrial Extension Inst., New York, N. Y., Mem. Am.Soc.M.E.

[4] Factory Mgr., American Everready Works, Long Island City, N. Y. Mem.Am.Soc.M.E.

Company appears in this issue of Mechanical Engineering. This paper is followed by the discussion at the entire session.

MACHINE SHOP WASTE SESSION

At the Machine Shop Waste Session, held on the morning of December 6, F. O. Hoagland presiding, two papers were presented, namely: Salvaging Industrial Wastes, by J. A. Smith, and On the Art of Milling, by John Airey and Carl I. Oxford. In addition to these two papers, which were published in abstract form in the December issue of Mechanical Engineering, an inspiring address on Waste in the Machine Industry was made by Mr. J. J. Callahan.[1] Mr. Callahan told of the benefits that had been derived in numerous instances by enlisting the interest of the workers in the problems of the management.

Discussion on Salvaging Industrial Wastes

Luther D. Burlingame[2] said that true salvaging might come by not having the scrap heap but by having parts so available that they were not to be had by merely picking in a pile. High-priced executives of shops or mechanics hunting for such things meant a waste of money. Another point was the importance of impressing on foremen, executives and others, the real value of salvaging materials.

A. L. De Leeuw[3] told of experiences with the Singer Manufacturing Co., where for a number of years several of his staff were constantly engaged in attempting to save some of the materials that were constantly being used in the shops, such as cotton waste, lubricating and cutting oils, belting, metal chips from machine tools, etc.

F. Eberhardt[4] discussed briefly waste prevention in machine castings. Carl G. Barth[5] gave examples of waste he had encountered in a large car works.

Discussion on the Art of Milling

Professor Airey in presenting his paper called attention to some experiments made since this paper went to press, which related particularly to the consumption of power to cutters. The particular type of cutter compared is known as the right- and left-hand spiral cutter. It is an alternating spiral where successive teeth are formed on the opposite spiral. They had compared this type of cutter with one having all the teeth running in the same direction and found the alternate spiral to show a saving of between 20 and 30 per cent, depending on the material being cut. That represented considerable saving where a cutter consumed a lot of power. A cutter consuming 15 hp. in a nine-hour day would require 100 kw-hr. Effecting a saving of 20 per cent in the power required for that particular operation, would be a saving of 20 kw-hr., which at the Detroit rate of 3 cents per kw-hr., would be 60 cents per day on one small milling operation.

A. L. De Leeuw submitted an extended written discussion of the paper from which extracts follow:

It is to be regretted that the authors did not go a step further and attempted the separation of a chip by a very slow process, so as to enable them to observe the deformation of the metal at the different stages of separation, either by direct observation or by the moving-picture method.

The authors' determination of the direction, location and magnitude of forces in horizontal and vertical directions is somewhat along the line of Nicolson's experiments and, in the writer's opinion, deserves the same criticism. One of the chief requirements of machine-tool construction is rigidity, because it is well recognized that the lack of this rigidity increases certain of the forces or at least increases their effect on the work to an extent altogether out of proportion to the amount of lack of rigidity. Therefore, to place the work on movable pistons is to go away from the very essence of machine-tool design.

A milling chip tends to start with a zero thickness and, consequently, the cutter must slide over the work for some distance before it will be able to penetrate. The tooth, however, enters the work suddenly, so that, as a matter of fact, the chip as it is actually produced does not start with a thickness zero. Instead of having the theoretical shape as shown in Fig. 1, it will actually have the shape as cross-hatched in Fig. 2.

The observations about rake are closely in accord with the results the writer found in tests made between 1907 and 1914. The existing differences may be explained away by the fact that in his experiments part of the power consumed was used for feed.

Referring to the paragraph entitled, Effect of Clearance: Previous tests have shown the same result brought out by the authors namely, that clearance has no effect on the power consumption. However, it does have an effect on the life of the cutter and the finish produced. It seems that gritty materials require more clearance than those which will produce a continuous chip.

Early in the paper the authors state that as a chip thickens, metal is removed more easily per unit volume. As a practical rule, this statement is acceptable and meets all shop conditions. As a statement of accurate fact, it may be doubted. A number of observations made by the writer of this discussion showed that the efficiency increases when the cross-section of the chip approaches more and more a perfect square.

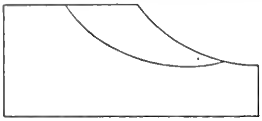


FIG.1.

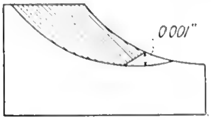


FIG2.

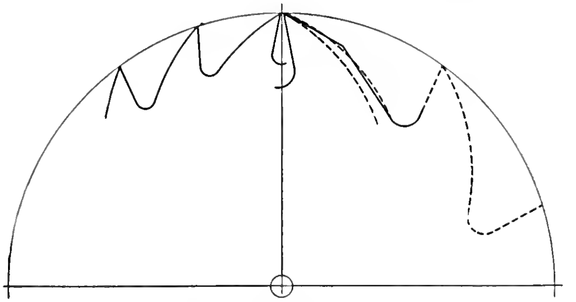


FIG.3.

Fig. 1 Theoretical Shape of Chip; Fig. 2 Actual Shape of Chip; Fig. 3 Recommended Proportions of Teeth

The writer must take issue with the statement contained in Par. 50 and following paragraphs. If the only point for consideration were the power required to remove a cubic inch of metal, the conclusions reached by the authors of the paper would be quite correct. However, in practice this power consumption was only one of the elements to be considered and not necessarily the most important one.

In a large portion of all milling work, one cut only is taken which is required to produce a finish of sufficient fineness. This finish depends on the number of revolution marks per inch. As a matter of fact, in a large percentage of all cases, the feed per revolution is limited by the desired finish at least as much as by the ability of cutter or machine to take the cut. The authors of the paper seem to be under the impression that the underlying idea for the introduction of the wide-spaced cutter was to supply sufficient chip space. As a matter of fact, this consideration only explains their origin. It was the observation of a case of insufficient chip space which induced the writer to try a somewhat wider spacing. Subsequent tests with these wider spaced cutters brought out further advantages.

In selecting the proper kind of cutter for a milling job, the following line of reasoning may be considered typical for a majority of cases:

The nature of the work compels us to limit the distance between revolution marks to, let us say, 0.050 in. In order to do the job as quickly as possible we must have as much feed per minute as

---

[1] Employees Representation Service, New York, N. Y.

[2] Industrial Supt., Browne & Sharpe Mfg. Co., Providence, R. I. Mem. Am.Soc.M.E.

[3] Consulting Engineer, New York, N. Y. Mem.Am.Soc.M.E.

[4] Newark, N. J. Mem.Am.Soc.M.E.

[5] Philadelphia, Pa. Life Mem.Am.Soc.M.E.

possible. The feed per minute depends on two elements: cutting speed, and size of cutter. With the material to be cut and considering the depth of cut, we will be limited to a cutting speed of, let us say, 70 ft. per min. We must now select the smallest possible cutter which will do the work in order to get the greatest possible number of revolutions which will give 70 ft. cutting speed. Now enter such considerations as size of arbor, depth of teeth, size of keyway—all of which may prevent us from making the cutter as small as we would like to have it. If, for instance, we are compelled to use a fairly long arbor, we must make that arbor of sufficient size to avoid excessive bending and torsion. Having considered all these items we finally decide on the size of cutter. As we want to do the job with as little power consumption as possible, we must provide for taking the heaviest possible chips, and this in its turn means the smallest possible number of teeth in the cutter. It will be noticed that this line of reasoning is almost diametrically opposed to that followed by the authors of the paper. There are certain limiting conditions which prevent us from making the number of teeth as small as might be desirable. To have too great an angle between two adjacent teeth would mean that in practically no kind of cut would we have more than one tooth buried in the metal. To avoid the resulting hammer blow, we must put a sufficient number of teeth in the cutter.

Some of the Participants in the Machine Shop Session
Left to right, back row: F. K. Hendrickson, H. S. Beal, C. J. Oxford, H. J. Eberhardt, front row: H. P. Fairfield, Carl G. Barth, F. O. Hoagland, John Airey.

The original reason for the reduction of the number of teeth of a cutter was chip space. Soon afterward it was found that the power consumption was smaller and that, as a result, a given-size milling machine was capable of taking heavier roughing cuts with the wide-spaced cutter than with the older type. Other advantages showed up later on. Among these advantages are the fact that under many conditions a wide-spaced cutter will finish more pieces before it becomes necessary to resharpen it.

Not only does a wide-spaced cutter require less sharpenings, but it will stand many more sharpenings. Furthermore, it requires less time to sharpen a cutter with few teeth than one with many. It should be understood, however, that Mr. De Leeuw does not recommend the widest possible spacing for all imaginable cases of milling.

Besides the reasons mentioned, there are other reasons which may prevent us from taking the heaviest possible chips. In many cases it is not possible to clamp the work down in a sufficiently rigid manner to withstand the pressures accompanying heavy chips. In other cases, the piece of work may be of such a character as not to allow heavy cuts to be taken, either because it is too frail or because the heat generated will distort the piece, or both. In order to obtain the greatest possible economy in the milling operation, we must give the cutter the greatest possible number of revolutions and, after we have selected the smallest practical cutter, there is only one source of economy left and that is to increase the cutting speed. It was considerations like these that led up to the system of stream lubrication whereby unusually high speeds can be obtained with some intelligence and care. As stream lubrication not only prevents the cutter from heating unduly, but also keeps the work cool, it has a double effect on the economy of milling operations.

The foregoing considerations led the discussor to take exception to the statements contained in Par. 62. (As many teeth as possible.)

Fig. 3 shows the proportions of teeth as recommended by Messrs. Airey and Oxford, and also those recommended for wide-spaced cutters. The sketch shows a $3^1/_2$-in. cutter enlarged four times. The left-hand side shows the teeth as formed by the formula given in the paper and with twenty teeth in the cutter. The right-hand side shows the teeth, in black, as they are actually made; and in broken line as they would be made according to the formula given in the paper. It will be seen that there is but little difference between these two shapes—the actual shape being slightly the stronger. The main difference, however, lies in the fact that the broken-line shape requires a specially made cutter for generating the backs of the teeth, whereas the black shape can be formed by any cutter. When the land, as originally furnished, becomes too wide, it is a simple matter to grind the backs of the teeth with a cup wheel and to repeat this action as often as is necessary. So long as the size of the land is not reduced beyond the original size, the strength of the tooth will not be impaired. It is this practical reason which makes me advocate the shape as shown on the right hand side of the sketch.

Earle Buckingham,[1] who orally discussed the paper, was very much interested in the results obtained when using a spiral cutter, and offered the following explanation why these should show less effective results, namely, that the area of the surface of the cutter in contact with the chips becomes greater as the rake angle is increased thus creating more friction. This might explain the results obtained from using lubrication. The chips from some materials curl up more than those from other materials. If the chip clung closely to the face of the cutting edge, the lubricant might cause the chip to wring to the face in much the same manner as two gage blocks are wrung together, thus greatly increasing the friction. An analysis of the character and shape of the chips produced from different materials with the use of cutters of varying rake angles might shed some light on this.

The authors state that "the fine-tooth cutter will wear longer between grindings, due to the decrease in cutting speed." Too much emphasis cannot be given to the fact that a decreased cutting speed greatly increases the life of a cutter between grindings. The proportional increase in life is much greater than the proportional increase in speed. The speaker is acquainted with some very interesting tests made some five years ago to determine the effect of cutting speed on the life of a cutter. Tests were made at speeds of 70 and 80 ft. per min. with high-speed steel cutters on small nickel-steel forgings. The results were very consistent and showed that when running at 70 ft. the cutter would mill over twice as many pieces as when running at 80 ft. Thus two cutters of the same diameter, taking the same feed per tooth so that each would remove the same amount of material in the same time, etc., but with 21 teeth in one, for example, and 24 teeth in the second, would show a great difference in their life between grindings. If the conditions were identical to those mentioned above, the 24-tooth cutter would mill twice as many pieces. Thus should make apparent the importance of tooth-numbers in milling cutter design.

Frank B. Gilbreth[2] called attention to the fact that there was a field open to the makers of machine tools today which had not been utilized in the least, namely: The photographic record of the behavior of a tool and of the chip. It was now possible to take 2500 pictures per second stereoscopically with a penetrating screen.

Professor Airey, in closing the discussion, said that stereoscopic recording suggested by Major Gilbreth was the logical next step. They had done some slow-speed work in that field. They had taken ten or fifteen minutes to take out one chip, and had made records taking it in instalments.

Regarding Mr. De Leeuw's remarks on rigidity he was in accord with those. That was a fundamental, regardless of the particular cutting tool. As for the sharpness of the tool, not being capable of being absolutely definite, the test of that was in the machine

---

[1] Engr., Pratt & Whitney Co., Hartford, Conn. Assoc-Mem.Am.Soc.M.E.

[2] Pres., Frank B. Gilbreth, Inc., Montclair, N. J. Mem.Am.Soc.M.E.

belt. The author had realized that that was a possible source of trouble. They took from fifty to one hundred tests, and found they had to take a great number of chips, but there was no change in the energy, which was proof that the sharpness remained unimpaired. The chip thickness was zero at times, but it was known that the cutter could not get under the surface all at once. Just when it did get under we do not know, probably the photographing would clear that up.

Railway Session

The problem of eliminating waste in locomotive and car design and operation was given intensive treatment at the Railway Session on Tuesday morning. Two of the papers which were presented at this session had appeared previously in Mechanical Engineering. These are Avoidable Waste in Locomotives by James Partington, in the November issue, and Avoidable Waste in Car Operation, by Walter C. Sanders, in the December issue. The remaining paper, on Avoidable Waste in Operation of Locomotives and Cars, by William Elmer, will appear in the February issue with an abstract of the entire discussion at this sesions.

Gas Power Session

The Gas Power Session was the first to be held by the reorganized Gas Power Division of the Society. With B. P. Flint, a member of the Executive Committee of the Gas Power Division, in the chair, two papers were presented, one by Louis Illmer, on the Porting and Charging of Two-Stroke Oil Engines, and the second by Elmer A. Sperry, on Compounding the Combustion Engine. There was practically no discussion on Mr. Illmer's paper and the meeting accordingly took up Mr. Sperry's paper, which appears elsewhere in this issue of Mechanical Engineering.

In the opening discussion George A. Orrok[1] called particular attention to the transfer valve between the high- and low-pressure cylinders, which in Mr. Sperry's engine is the solution of a particularly severe problem. Mr. Orrok also emphasized the importance of mechanical atomization of fuel which has proven so successful when using fuel oil under boilers. He pointed out that the engine described by Mr. Sperry followed canons of steam-engine design.

Francis Hodgkinson[2] pointed out as important the increase of the size of compression space, which leads to detonation and is a remarkable aid to good combustion. A number of questions were asked as to the efficiency that could be obtained in this engine, and in closing the discussion Mr. Sperry stated that its thermal efficiency approaches the theoretical air-cycle efficiency, while the mechanical efficiency in the engines thus far constructed has been about 93 per cent. Mr. Sperry also outlined the possibilities of increasing the sizes of the compound engine and stated that with a 29 in. cylinder and a piston speed of from 800 to 900 ft. per min. there would be no difficulty in getting an 8000-hp. engine.

MANAGEMENT SESSION

The MANAGEMENT Session at the Annual Meeting was presided over by Mr. L. P. Alford, Vice-President of the Society and former chairman of the Management Division.

As a basis for discussion of the central theme of waste elimination by efficient management, three papers were presented: Making Work Fascinating as the First Step Forward Reduction in Waste, by Walter N. Polakov; Process Charts, by Frank B. and L. M. Gilbreth; The Rochester Shoe Wage Arbitration, by Sanford E. Thompson, and two reports: Report of the Sub-Committee of the Management Division in Management Terminology, and Report of the Sub-Committee in Measuring Managerial Ability.

Mr. Polakov's paper was published in the December issue of Mechanical Engineering; that by Mr. and Mrs. Gilbreth appears in this number, and Mr. Thompson's will be published later.

Written Discussion is Voluminous

Mr. Gompers wrote that the human element in production is the most important one, and labor realizes that upon management devolves the responsibility of developing the technique necessary to provide the methods whereby the creative ability we seek to conserve shall be released through opportunity to use brain, skill and human power in production.

Some of the written discussions of Mr. Polakov's paper were papers in themselves. For instance Mr. A. L. De Leeuw contributed a discussion of 3600 words, ascribing the entire causes of unrest to the demoralization of the world, and criticizing most palliative systems as failing to touch the underlying foundations.

Like Mr. De Leeuw, most of the discussors agreed with the author and their contributions were therefore more of the nature of supplements to the paper. However, L. W. Wallace, while praising the paper highly, could not concur in the statement concerning time studies. He wrote that he had not realized that there was any conscious effort being made towards decentralization of planning, nor of reuniting, instructing and inspecting functions of foremanship nor of substituting time-study with direct interchange of workers' skill and intelligence. It seemed to him that conscious effort in this direction would be a backward step and not absolutely necessary in removing the element of monotony.

Ralph L. Paddock wrote that the paper was filled with many opportunities for differences of opinions. However, he granted that by keeping well within the bounds of well-known facts the author proved his point.

Flattering the individual worker by calling him a "super-animal" and making his job more interesting, Reynold A. Spaeth agreed was essential for successful production, but he thought he saw signs of a deeper dissatisfaction—the monotonous grind of working perpetually for the interests of others, never for oneself.

Dr. H. S. Person[1] said he could not speak too strongly of his agreement with the central idea of the paper, but he told Mr. Polakov he intended to emphasize the points of disagreement. He thought the author used unnecessary philosophy, that he weakened his argument by a one-sided industrial history, that he explained the Taylor philosophy and system of management incorrectly, and that he did not concede to the personel manager sufficient credit in solving the problem of management.

Process Charts, by F. B. and L. M. Gilbreth

Characterizing Mr. Polakov's paper as being concerned with the "why," Mr. Karl G. Kaisten wrote that Mr. and Mrs. Gilbreth's paper dealt with the "how." Mr. Polakov promised mankind a social system, while Mr. Gilbreth's paper "disclosed marvelous powers of dissecting human motion and activity." One paper was a "telescope" and the other a "microscope" and argument between them would be absurd.

Fred. Colvin[2] wrote that the authors' methods overcame the one great trouble with most records which are usually so delayed that they become merely post-mortems after the job is finished, and are not even always of value for the next job. It is not easy for either executives or workers to change their methods and habits, and an understanding of this phase of human nature is the first step toward efficient management.

M. L. Cooke[3] asked for information regarding the relation between the process chart and the route and instruction chart, and Mr. Gilbreth replied that the process chart is a definite scheme of visualizing the thing to be done. After the process chart comes the route chart and thirdly the instruction chart.

Elimination of Waste Through Wage Adjustment

Mr. Sanford E. Thompson[4] was introduced as an arbitrator selected by the United Shoe Workers of America, in the Rochester Shoe Wage arbitration. His paper, which will appear later, described the events leading up to this arbitration and says "In the arbitration proceedings which resulted, there was presented by the workers as a substitute for wage reduction, a plan designed to lead up to the elimination of waste in manufacture through scientific methods, and the adjustment of wages on a scientific

---

[1] Consulting Engineer, New York, N. Y. Mem.Am.Soc.M.E.

[2] Chief Engineer, Westinghouse Elec. & Mfg. Co., Lester, Pa.

---

[1] Managing Director, Taylor Society, New York, N. Y.

[2] Editor, Amer. Machinist, New York, N. Y. Mem.Am.Soc.M.E.

[3] Finance Bldg., Philadelphia, Pa. Mem.Am.Soc.M.E.

[4] 136 Fedral St., Boston, Mass. Mem.Am.Soc.M.E.

basis involving job analysis and time study." Then follows the award, a description of the Arbitration Board, and a brief treatment of the proceedings.

Mr. Thompson then discussed the two broad questions of: (1) Must wages come down, and if so how much, and when? Shall it be a flat charge or a real adjustment? (2) How should the workers themselves share in wage determination; illustrating his points with examples for the Rochester case.

As bearing in the problem of elimination of waste, Mr. Thompson quoted in extenso the proposal of the Arbitration Board for the permanent solution of both the wage and production problems:

"(1) That no wage reductions be recommended by the Board

"(2) That the existing piece-work and wage rates be placed on a strictly scientific basis as rapidly as the organization of joint administrative and technical machinery to this end will permit.

"In order to accomplish the purpose outlined in this proposal, the Shoe Workers request that joint administrative and technical machinery be established, based on the early recommendations of three technically qualified individuals, one selected by the manufacturers, one by the shoe workers and the third by the Arbitration Board. The duties of this committee are to be:

(*a*) To make a rapid survey of the Rochester Boot and Shoe Industry, *from the point of wastes and inefficiencies* and industrial relations.

(*b*) To determine the type and detailed organization of the coöperative administrative and technical machinery which the manufacturers should adopt for the purpose of establishing production standards.

(*c*) To suggest ways and means for *permanently remedying existing wastes and inefficiencies* in the local shoe industry.

(*d*) Pending the establishment of the scientifically correct production standards, and the elimination of wastes and efficiencies, existing piece work and wage rates shall not be lowered.

Reports of Subcommittees Presented

Mr. F. E. Town,[1] in presenting the progress report of the Joint Committee on Management Terminology, defined the scope of this work:

(*a*) to define management, and list and define the terms and phases of management

(*b*) to extend the Dewey decimal classification to cover management literature.

He described the organization of the committee—with six societies participating, each with two representatives and an alternate, and then outlined the work that had been done to date.

Four sub-committees were appointed, on Society Coöperation, on Ways and Means, on Finance and on Program.

The committee has succeeded in making a master alphabetic list of management terms, also a list classified under four groups for convenience, and these lists have been sent out to some 230 colleges which have promised to coöperate in supplying definitions of these terms and doing the necessary research work.

A vote of thanks was extended to the committee for their progress so far.

The second report presented was a prelimary report by the Sub-Committee in Standardization of Graphics. Mr. J. J. Swan[2] presented this subject, stating that the purpose of this committee was to standardize the "short-hand methods of presenting business, industrial and technical data."

The work of the committee was only just started, and the members would be very glad to receive suggestions from anyone in the Society.

The third report, on a Study of the Units and Methods of Measurement of the Managerial Function, was presented by Mr. A. L. De Leeuw.

The functions of management consist of three items: Promotion (and Extension), Production and Sales. In order to confine itself to that part of the investigation which would offer the best promise of results in the near future, the Committee had worked only on the managerial function concerned with Production. This in turn is manifest in three directions: Organization, Preparation and Direction.

Under the heading of Organization we have the Evaluation Chart, prepared by the Waste Committee, under Preparation, we have such items as Time Study, Motion Study, Basis of Wages; and under Direction, we find control charts.

The report recommends the consideration of ways and methods to obtain the necessary data required for:

Organization
  Balance of Responsibility and Authority
Preparation
  Effectiveness of purchasing
  Adherence to standards
  Basis of wages in Industry
  Balance of sales and production
Direction
  Labor stability—factor and data
  Labor attendance—factor and data
  Continuity of working conditions—factor and data
  Material turnover period—factor and data.

At the close of the discussion of this report the following motion was passed:

That a vote of appreciation be accorded the committee, and that they be asked to continue the study and present their conclusions to the Management Division, and thirdly,

That the Executive Committee of the Management Division consider the advisability of asking the American Engineering Council to undertake an investigation of a basis for wages in industry.

Forest Products Session

The problem of conservation of forest products was given careful consideration at the meeting of the Forest Products Division. The principal speaker was David L. Goodwillie of Chicago, Ill., who told of the work being done by the United States Chamber of Commerce in their appointment of a Commission on Conservation and Reforestation. This Commission of twelve has traveled through thirty-seven states and has met with the men in the different branches of the lumber industry who are interested in a national policy for forest conservation. The effect of taxation on conservation, the importance of waste utilization, the control of competition and the restriction in timber cutting were all discussed. Mr. Goodwillie told in detail of the project at Bogalusa, where every portion of the lumber and waste is being utilized in factories where the handling is done entirely by machinery. The plans are laid with remarkable vision and the regrowth of timber in a comparatively short time is actually being accomplished.

Dr. Hugh P. Baker, of the American Paper and Pulp Association, told of the various methods of reforestation that will permit of a greater utilization of waste timber land. Discussion was contributed at this meeting by Joseph H. Wallace, George M. Hunt, Paul Porter, and Dr. Cruikshank on various methods of increasing the utilization of forest-products waste. Mr. Goodwillie's talk and the consequent discussion will be given more complete treatment in a later issue of Mechanical Engineering.

Fuel Session

The Fuel Session was held Thursday with Professor L. P. Breckenridge, Chairman of the Fuels Division, acting as presiding officer. The program of excellent papers filled the auditorium and elicited a great deal of interesting discussion. Abstracts of the papers have appeared in Mechanical Engineering. The paper by Victor J. Azbe on Boiler Plant Efficiency appeared in the November issue as did the papers by Joseph Harrington on Fuel Saving in Relation to Capital Necessary and by W. B. Chapman on Gas Producers and Industrial Furnaces. The masterly contribution by Dr. D. S. Jacobus appeared in December Mechanical Engineering. An account of the discussion will be brought out in the February issue.

Elimination of Waste Through Efficient Materials Handling

THE Materials Handling Division of the Society, comprising 1400 members, staged a session on Thursday afternoon of the Annual Meeting, devoted to Materials Handling an Important

---

[1] 250 Eleventh Ave., New York, N. Y., Mem.Am.Soc.M.E.

[2] 30 Church St., New York, N. Y., Mem.Am.Soc.M.E.

Factor in the Elimination of Industrial Waste. Mr. Robert M. Gates, the active chairman of the Division, presided, and Mr. H. V. Coes, a member of the Division's Executive Committee, presented the one paper of the afternoon, which was discussed at great length. This paper was published in the December issue of Mechanical Engineering.

In presenting the paper, Mr. Coes stated that there was a great lack of information as to the best materials-handling equipment for a given purpose. He thought professional engineers could perform a great service if they could show the means available for handling materials.

Mr. Coes illustrated his remarks with a series of lantern slides, showing the evolution of such familiar apparatus as the portable belt conveyor, the stevedore truck, etc., and including practically all of the present methods of mechanical handling.

Mr. Coes predicted that mechanical handling of materials would be extended considerably within the next few years, and that problems now outstanding would be solved. It is the duty of engineers who lay out plants to insist at the start that designs provide for proper handling of materials.

Discussion

Mr. J. A. Shepard[1] agreed with the author's statement that "modern civilization is the direct result of the application of the principles of the sub-division of labor." He pointed out, however, that each sub-division of labor introduces an intermediate materials-handling problem which, if not properly solved, partially neutralizes the undoubted advantages of the sub-division. "Handling 168 tons of materials per ton of finished castings" summarizes the problem as it affects the foundrymen, but this statement gives no indication of the further problem of handling the casting through sub-divided finishing processes to wholesaler, retailer and finally consumer—rolling up a grand total of materials handling. Yet this is the situation concerning practically every commodity before it reaches the ultimate consumer. Mr. Shepard enunciated the following principle:

At the Materials Handling Session

Left to right, back row: W. N. Dickinson, M. F. Lawrence, R. H. McLean, H. E. Whitaker; front row: F. A. Wardenberg, H. V. Coes, R. M. Gates, N. C. Johnson, K. Dodge.

> "Owing to the great number of relatively simple handling operations entailed by the sub-division of labor, efficient handling, together with a low capital cost for handling equipment, is likely only through the choice of a type of handling machinery capable of the greatest possible flexibility and mobility, thus enabling each unit of handling machinery to perform the maximum number and variety of handling operations.
>
> "Moreover, the extent to which any type of handling equipment will occupy building or yard room which would otherwise be available for production processes, must necessarily become an important factor in making a choice."

Sam L. Libby,[2] following Mr. Shepard, criticized the manufacturers of materials-handling equipment whose attitude, he said, had been to sell as much of their machinery as possible. He thought one of the best things the Materials Handling Division could do would be to bring all the manufacturers to agree in a broad viewpoint of the problem.

H. M. Lane[1] emphasized, first, the need for coöperation, between the material handling people of radically different classes so as to get the right equipment for a given set of conditions; and second, the importance of the coöperation of the architect, without whom the plans of the materials handling man could easily be set at naught.

W. N. Dickinson, R. H. McLean, J. G. Hadfield, M. F. Lawrence, Wm. F. Hunt, and W. C. Brinton, also contributed to the discussion, and all agreed that the problem upon which Mr. Coes had concentrated attention was worthy of further consideration and detailed study by the Materials Handling Division of the Society.

Students Conduct Important Session

Under the auspices of the Committee on Relations with Colleges and under the direct supervision of Dr. H. G. Tyler of this committee, the members of the Student Branches of the Society conducted a session on Thursday morning. An innovation in the meeting activities of the Society and in its relations with students, this session considered two technical papers and a statement of the problems of Student Branch operation in a manner equal to if not better than some of the sessions conducted by mature members of the Society.

Before the session opened, prominent members of the Society and the profession mingled with the students and explained the ideals of the Society and its scope of activities.

Dr. W. H. Kenerson, newly elected chairman of the Committee on Relations with Colleges, presided at the formal presentation of the following papers: Draft-Tube Design with Reference to the Hydraucone by W. K. Ramsay of M. I. T.; and Flow of Water in Hydraulic-Turbine Draft Tubes by George E. Lyon of R. P. I. Both papers were presented by the authors. They will appear in a later issue of Mechanical engineering with the pertinent discussion.

The balance of the three hours devoted to this session was given over to a discussion of the problems of Student Branch organization and operations. J. M. Spitzglass of Chicago told of the successful methods used at the Armour Institute Student Branch.

Over two hundred students attended and while the representation of New York schools was high, there were still a great many from outside, some coming from Atlanta, New Orleans, Pasadena and Cincinnati.

Conference on Research

A better interchange of scientific and research information through the agency of the Engineering Division of the National Research Council is within reach if the ideas developed at the Research Conference of the Annual Meeting and transmitted to Mr. A. D. Flinn, vice-chairman of the Division, who was present, are carried out.

This conference, held Thursday, December 8, was conducted by Prof. A. M. Greene, Jr., chairman of the Society's Research Committee, and the attendance of over forty included many authorities on engineering research. Two sessions were held, culminating in the organization of an Advisory Committee to help the National Research Council in the correlation of research data as well as to make suggestions to hasten the completion of the Council's scheme.

It was generally conceded that publicity would be the most effective method of eliminating waste in research, caused chiefly by duplication of effort, by lack of a coördinated and coöperative research program and by failure to adequately define the research problem before inaugurating experimental work.

To circumscribe the discussion somewhat and to confine it to the Annual Meeting topic—elimination of waste—four items were scheduled on the program, two being technical papers and two reports of committees. The papers were Elimination of Waste in Industry through Research, by F. A. Wardenburg,[2] and Research in Leather Manufacture, by Arthur W. Thomas;[3] the re-

---

[1] Vice-Pres. and Ch. Engr., Shepard Elec. Crane & Hoist Co., Montour Falls, N. Y. Mem.Am.Soc.M.E.

[2] Managing Engineer, Hoist Dept., Sprague Elec. Wks., Bloomfield, N. J. Mem.Am.Soc.M.E.

[1] Pres., Lane & Bodley Co., Cincinnati, Ohio. Mem.Am.Soc.M.E.

[2] Asst. Ch. Engr., E. I. duPont de Nemours & Co., Wilmington, Del.

[3] Professor Food Chemistry, Columbia University, New York, N. Y.

ports were those of the Sub-Committee on Lubrication and of the Sub-Committee on Steam Table Research. Messrs. Wardenburg and Thomas presented their papers in person. The lubrication report was presented by Mr. Albert Kingsbury, Kingsbury Machine Works, Philadelphia, chairman of the committee, and the steam table report by Mr. George A. Orrok, consulting engineer, New York, and by Dr. H. N. Davis, Harvard Engineering School, who is conducting a portion of the steam-table research.

Mr. Wardenburg detailed the possibilities of research work in the reduction of manufacturing costs, citing several examples in the war which had resulted in the saving of millions of dollars. He then described a plan for conducting commercial research work under the commercial incentive, and secondly a suggested coöperative plan for conducting general research work. As an element of the latter he suggested the collection of a large fund for research to be placed under the jurisdiction of some central body, like the Research Committee of this Society, which would plan and carry out the research program.

Mr. Thomas then presented his paper on research in leather manufacture, concluding with the significant statement that though leather had been in use for many centuries, we are only just beginning to find out the elementary chemistry of the reactions involved in its manufacture. He quoted this as an example of the magnitude of the general research problem in the industries.

The question of duplication of research was discussed considerably at the meeting; but when the ideas of all the speakers were brought out, the impression was left that though almost every problem is being investigated by more than one agency, the phases are all different and each investigation practically constitutes a separate piece of work. Mr. Flinn described how the "card-index" of the National Research Council would furnish an excellent means of posting everyone on what everyone else was doing.

In presenting the progress report of the Sub-Committee on Lubrication, Mr. Kingsbury pointed out the inherent difficulties in undertaking any measurements in a film of lubricant within a few thousandths of an inch of space. He described the experimental work of the committee in the field of increase of pressure on lubricants. He illustrated his remarks by means of curves prepared by Mr. Mayo D. Hersey, professor at Massachusetts Institute of Technology, Department of Physics, who was doing the experimental work.

In connection with the steam-table research Dr. Davis said that he felt "very hopeful" that his organization would soon be able to get something on the Joule-Thomson effect, which was his assignment in this research. Dr. S. W. Stratton, director of the U. S. Bureau of Standards, supplemented Dr. Davis by telling just where the Bureau stood in its part of the investigation, and Mr. Orrok closed by reporting how the money was coming in, stating that the prospects were very bright for the collection of the seventy or eighty thousand dollars necessary, and for the completion within three years of this very necessary extension of the upper limit of the steam tables.

Among other prominent speakers at the session were Prof. H. F. Moore, of the University of Illinois, who is in charge of the important research on Fatigue of Metals being conducted with the assistance of Engineering Foundation; Dean Anderson, in charge of the research program of the American Society of Heating and Ventilating Engineers; H. C. Dickinson, research director of the Society of Automotive Engineers; and Prof. P. C. Walker, dean of the Engineering School of the University of Kansas.

Professional Engineering Education for the Industries

The Society for the Promotion of Engineering Education joined Thursday afternoon with the A.S.M.E. in a session of three papers on the relations between engineering education and the industries as follow:

Professional Engineering Education for the Industries, F. C. Pratt,
A National Policy on Engineering Education, A. G. Christie,
College Education as Related to Industry, J. E. Otterson,

Professor Charles F. Scott, President of the S.P.E.E. presided. The three papers with the ensuing discussion opened by Dean Dexter S. Kimball are published on the first pages of this issue.

Credit is due Professor Dugald C. Jackson who arranged the program which attracted large attendance and developed exceedingly interesting discussion.

Stresses in Flat Cylinder Heads

The able paper by Major Gilbert Dudley Fish on Stresses and Deformation in Flat Circular Cylinder Heads was presented on Thursday afternoon at the first General Session of the Annual Meeting. Professor Robert H. Fernald presided.

Major Fish's paper was a mathematical analysis of form and loading of elastic disks where the thickness is uniform and where all strains are within the limits of true elasticity. Although of great value, the paper was highly specialized in its contents and the discussion could be entered into only by those who had actually attacked similar problems. An abstract of the paper with a résumé of the discussion presented will appear in a later issue of Mechanical Engineering.

Motion Pictures of Combustion

On Thursday afternoon R. Sanford Riley of Worcester, Mass., presented moving pictures showing actual conditions in a stoker-fired furnace. The great interest aroused in this exhibition made its repetition necessary. There was universal comment as to the value that these pictures will render in the development of a science of furnace combustion and in a later issue of Mechanical Engineering there will appear an account of the preliminary work done by Mr. Riley in determining the successful methods of preparing the motion pictures.

Motion Pictures of Handling Materials

Following out the custom inaugurated at the Spring Meeting the Materials Handling Division enjoyed an exhibition of motion pictures which showed the development of apparatus for handling coal and lime stone by machinery. These pictures, displayed by the Robbins Conveying Belt Company, were shown in place of the usual excursion.

Second General Session

The Second General Session of the meeting was held Friday morning with Dr. D. S. Jacobus in the chair. Of the three papers presented, one by Paul A. Bancel on Steam Condensing Plants appeared in the November issue of Mechanical Engineering. The paper by F. W. Dean on Testing Emergency Fleet Boilers using oil fuel will appear in the February issue of Mechanical Engineering and the paper on the Vertical Triple Expansion Pumping Engine by L. A. Quayle and E. H. Brown will appear in the March issue. The discussions pertaining to each of these two papers will appear with them. The present account will therefore only include the discussion on Mr. Bancel's paper.

In a written discussion, Professor A. G. Christie complimented the author on the presentation of new ideas on condenser operation and design, especially of the air cooler. He asked for additional information about the causes and nature of tube corrosion and for data on water velocity, on pressure loss through a single-pass condenser with high water velocity, and on methods of obtaining higher heat transfer through the tube surface.

D. K. Dean,[1] in a written discussion, combatted Mr. Bancel's statements regarding the tube layouts in which steam lanes are used to assist steam distribution, on the ground that there was lack of test evidence in the paper. He stated that the Bancel design is deficient in that it is difficult to distribute the steam equably to the ends of the condenser. Mr. Dean also made a detailed comparison of water temperature distribution in a double-pass condenser with the distribution in the single-pass condenser advocated by Mr. Bancel. He showed that the single-pass condenser gives a poor division of work along the tube length. He further pointed out that the ratio of cooling surface to the amount of steam condensed is well established and requires the use of two passes to utilize commercial tube sizes.

---

[1] 88 Broad St., Boston, Mass.

Mr. John F. Grace[1] criticized Mr. Bancel's use of a small tube, single-pass condenser with a high water velocity through the tubes on the grounds that small tubes clog and require high-power circulating pumps. He deemed it wise to use a moderate velocity and to clean the tubes occasionally. He stated that it was his experience that tube losses increase as the tube surface is decreased.

A written discussion by Mr. P. E. Reynolds[2] reviewed developments in condenser design which have followed a seemingly aimless path. He stated his belief that the design of Mr. Bancel permitted heat transfer in an atmosphere of pure steam. He regretted the lack of data about this feature. Mr. Reynolds touched on the relative merits of single- and double-pass condensers and pointed out that the double-pass type gives equal distribution of condensation over the tubes.

Mr. E. B. Ricketts[3] decried the lack of test data on the heat transfer in this type of condenser.

At the end of the discussion, Mr. Bancel promised to answer the questions in a written closure.

Aeronautic Session

Joseph A. Steinmetz, Chairman of the Aeronautic Division, opened the Aeronautic Session on Friday morning with an optimistic word for the future of aviation and for the future of the work of the Division in assisting the development of aviation especially for commerce. He then turned the meeting over to Professor E. P. Warner, Chairman of the Aeronautic Papers Committee who took the chair. In his opening remarks, Professor Warner explained the principal purpose of the Aeronautic Division to be the dissemination of facts regarding aerial transport.

The titles and authors of the papers presented at this session were as follows: Commercial Operations of Airplanes, by L. B. Lent, Air Lines and Some of Their Problems, by R. B. C. Noorduyn, Study of the Elastic Properties of Small-Size Wire Cable, by R. R. Moore, Tests of Plywood Webs With Lightening Holes Arranged as in Airplane Ribs, by D. T. Brown and R. J. Diefenbach.

The paper by Major Lent appears in another column of this issue. The other papers will appear in a later issue accompanied by the discussion relating to them.

Major Lent's paper presents data of great value to the problems of commercial aviation and with Mr. Noorduyn's paper, it incited discussion that indicated great possibilities in commercial aviation in the immediate future. In closing the discussion, Major Lent emphasized the seemingly important point that the aeroplane offered greater commercial possibilities as a freight express or mail carrier than in transportation of passengers.

Lieutenant E. E. Aldrin, Secretary of the Division, newly arrived from a trip abroad was at the meeting and he gave some interesting first-hand information relative to commercial flying in Europe.

Textile Waste Session

Mr. Charles T. Plunkett, Chairman of the Textile Division presided over this Session on Friday morning at which the Textile Division presented a program dealing with wastes in the textile industry. The papers on Hidden Wastes in Textile Plants by T. P. Gates and Economy in Textile Drying by B. R. Andrews will appear with their discussion in the March issue of Mechanical Engineering.

Charles T. Main opened the meeting with a report of the World Cotton Conference held in England last summer which he attended as a delegate of the Textile Division of the A.S.M.E. Mr. Main emphasized the fact that the British cotton manufacturers have joined in contributing about one million dollars for cotton research work. They have planned a large laboratory and they expect to take up the problems bearing on the manufacturing and finishing of cotton. Mr. Main spoke also of the movement on foot in this country to unite all bodies engaged in textile-research work in coöperation with the International Cotton Research Committee. The Cotton Conference itself impressed Mr. Main by the opportunity it offered for men from widely separated parts of the world to come together and partake of the wealth of information offered at the formal meetings of the conference and informally in the social gatherings.

Ordnance Session

The first session of the Ordnance Division held at an Annual Meeting of the Society was called to order on Friday morning by Waldo H. Marshall, Chairman of the Division. General Guy E. Tripp, Chairman of the Board of the Westinghouse Electric and Manufacturing Company, made the opening address in which he emphasized the responsibilities of the Ordnance Division and all those who have had experience in the production of ordnance material in the development of an organization to supplement the permanent staff of the Ordnance Department.

The principal paper of the session was delivered by Colonel J. W. Joyes, Chief of the Technical Staff, Ordnance Department, U. S. A. Colonel Joyes discussed the conditions in the past in the Ordnance Department and present indications of an effort to practice economy and save money. He discussed the limitations of tolerance in ordnance material which were somewhat troublesome during the war and indicated that the present effort is to study carefully the producability of the various articles of ordnance. The coöperative work between the army and navy in matters of design of ordnance was briefly reviewed. The showing was very satisfactory and duplications and wastes of effort in design are generally being avoided. The development of the Ordnance Department organization to prevent waste in overlapping was also explained by the speaker. He closed his address with an explanation of the policy of the Ordnance Department in investigating the possibilities of commercial articles before taking the design for strictly military uses.

Chairmen of the Sub-Committees of the Annual Meeting

Left to right, back row: G. R. Tuska, *President's Reception;* J. I. Lyle, *Informal Get-Together;* L. B. McMillan, *General Chairman;* W. S. Bowen, *Information;* H. D. Edwards, *Excursions;* Mrs. F. T. Chapman, *Ladies' Tea;* Mrs. Nixon Lee, *Ladies Acquaintanship;* Miss Burtie Haar, *Ladies Excursions;* E. Van Winkle, *Dinner Dance.*

Discussion at the session was contributed by Frank B. Gilbreth, Carl G. Barth, Fred J. Miller, F. G. Spencer, Captain Kimberly, R. D. Coleman, H. C. Spaulding and E. L. Sherwood who contributed problems relating to the design, specifications and manufacture of ordnance material.

---

[1] Harrison, N. J. Mem.Am.Soc.M.E.

[2] 95 Liberty St., New York, N. Y. Mem.Am.Soc.M.E.

[3] 241 East 15th St., New York, N. Y. Mem.Am.Soc.M.E.

Heat Balance of the Connors Creek Plant of The Detroit Edison Company

By C. HAROLD BERRY,[1] and F. E. MORETON,[2] DETROIT, MICH.

THE term "heat balance" is currently used in two different senses. At times we speak of the heat balance when we mean a physical condition in the plant whereby there is a balance of certain heat-absorbing and heat-developing capacities. Again, by heat balance we mean a thermal balance sheet which records the ultimate disposition of all the heat developed from the fuel used.

This paper discusses the heat balance in both senses for the Connors Creek Plant of The Detroit Edison Company. We shall first describe briefly the apparatus in the plant, following this by a discussion of the ideal operating conditions, and finally presenting actual results. The plant is considered just as it stands, without reference to changes now under consideration or construction.

Description of Equipment

The main turbo-generators are six in number—three[3] of 20,000 kw. capacity, one of 30,000 kw. capacity, and two of 45,000 kw. capacity, giving a total installed capacity of 180,000 kw.[4] The turbines are served by fourteen boilers, each of 2365 boiler hp. builder's nominal rating.

The boiler-feed pumps are steam-turbine-driven, with the exception of one which is motor-driven. One general-service water pump is steam-turbine-driven. All other plant auxiliaries are motor-driven, some by alternating-current motors, some by direct-current motors, the choice depending upon the nature of the driven unit. As it works out, those auxiliaries whose uninterrupted running is essential to plant operation are all driven by direct-current motors, while auxiliaries whose stoppage does not immediately affect the rest of the plant are driven by alternating-current motors. This division is not due to any belief in the superior reliability of direct-current motors, but is due to the fact that most, if not all, of the essential auxiliaries are of such character as to require or benefit from widely variable speed. Such are stokers, blowers, hot-well pumps, dry-vacuum pumps, circulating pumps,[5] etc.

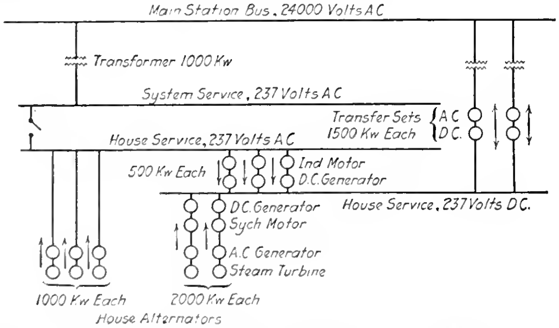


Fig. 1 Arrangement of Auxiliary Electrical System, Connors Creek Plant

The arrangement of the auxiliary electrical system is shown in Fig. 1. Alternating current for auxiliaries is available from either of two buses: (*a*) The "system service" bus, which is fed through a transformer from the main station bus, or (*b*) the "house service" bus, which is fed by three 1000-kw. turbo-generators. A tie switch is provided whereby these two buses can be connected. When this tie switch is closed, such of the 1000-kw. house alternators as are running must perforce operate in parallel with the main units. When this is done (and it is common practice at Connors Creek), the governors of the small units are set for a speed slightly above system frequency, and the house units are operated on the hand throttle, with constant steam flow and virtually constant load.

Direct current is available from a single bus (actually constructed as a ring). Owing to the importance of continuous service from the motors connected to this bus, it is fed from four sources:

a Two 1500-kw. steam-driven direct-current generators. Each of these consists of a turbo-alternator permanently connected (by bolted links) to a synchronous motor-direct-current generator set, so that the combination is merely a steam-driven direct-current generator with an electrical speed reduction instead of gears.

b Three 500-kw. motor-generator sets (induction motors) driven from the house-service alternating-current bus.

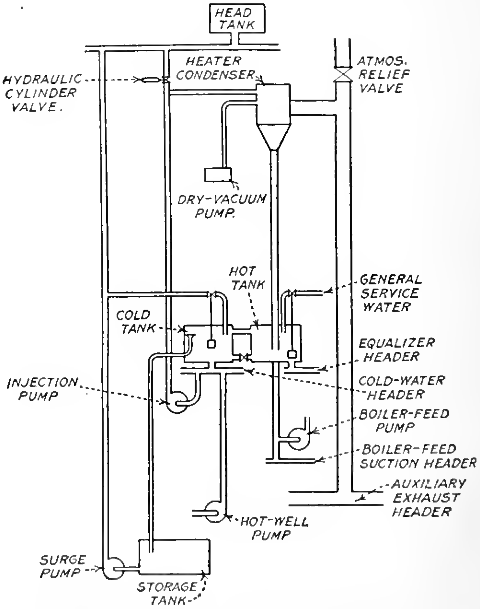


Fig. 2 Arrangement of Auxiliary Exhaust-Steam and Feedwater Heating Apparatus, Connors Creek Plant

c Two 1500-kw. motor-generator sets (synchronous motors) driven from the main station bus. These sets have characteristics and controls such that they may deliver power in either direction, wherefore they are known as "transfer sets."

d A storage battery of 1500 amp-hr. capacity.

An important characteristic of a system of this sort is that the load on the auxiliary steam turbines is independent of the auxiliary power demand of the station. With the tie switch closed between the system service and house-service buses, and with the transfer sets operating between the main system and the house-service direct-current bus, the house-turbine loads may be adjusted at will, within limits set by the capacities of the apparatus.

The function of the house turbines is twofold:

a To furnish a standby source of power for station auxiliaries in the event of a system failure, and

b To furnish exhaust steam for boiler-feedwater heating.

Fig. 2 shows the arrangement of the auxiliary exhaust-steam

---

[1] Engineer, Vice-President's office, The Detroit Edison Company.

[2] The Detroit Edison Company.

[3] At the present writing one of these is in the manufacturer's plant in the course of rebuilding. A 10,000-kw. unit stands in its place.

[4] For the time being 170,000 kw.

[5] At the time of writing, the older of these pumps still have induction motors, which are to be displaced by direct-current motors.

Abstract of the fourth of a group of papers presented at the Power Waste Session of the Annual Meeting, New York, December, 1921, of The American Society of Mechanical Engineers. The other three papers appeared in the December, 1921, issue of Mechanical Engineering, pp. 790–795.

and feedwater-heating apparatus. The auxiliary exhaust heater receives the exhaust steam from five house turbines, from six boiler-feed-pump turbines, and from one general-service-pump turbine, as well as the vapor formed in the boiler-feed make-up evaporators. This steam passes upward into five barometric-condenser heads, where it meets condensate from the main condensers. The resulting hot water is discharged into the hot boiler-feed tanks, whence it is pumped into the boilers. The cold condensate piping and tanks are designed to care for variations in the volume of water in the boilers at times of variable plant load, and to safeguard the boiler-feed pumps against failure of the supply. Inasmuch as these barometric condensers serve as condensers for the auxiliary system and as feedwater heaters for the main system, they are known as "heater condensers."

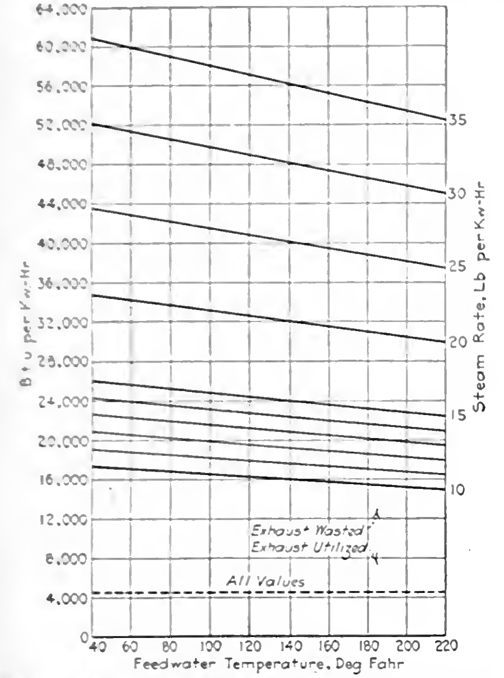


Fig. 3 Computed Cost of Power for Variable Turbine Steam Consumption and Boiler-Feed Temperature, with Fixed Initial Steam Conditions

(Steam pressure, 240 lb. per. sq. in. abs.; superheat, 200 deg. fahr.; boiler-room efficiency, 0.75.)

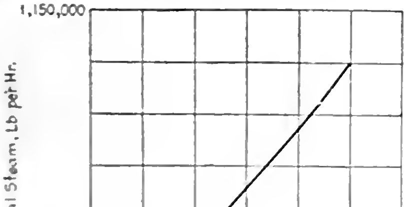


Fig. 4 Total-Steam Curve of Main Unit

Theory of Operation

There are two viewpoints from which to state the gain in station economy due to the operation of a system of this kind:

a A simple but approximate view—the substitution of cheap power for costly power

b A complicated but exact computation—a saving due to increased feedwater temperature, offset by an increased station steam consumption.

The matter will be discussed from each of these two points of view.

In the chart shown in Fig. 3 the full lines show the computed cost of power for variable turbine steam consumption and boiler-feed temperature, with fixed initial steam conditions. If we assume that all losses in the turbine appear as heat available from the exhaust steam, that is, if we neglect radiation losses, and if we recover usefully and credit to the turbine all of the heat available from the exhaust steam, then the cost of power is constant for all conditions, and is equal to the heat equivalent of a kilowatt-hour (3415 B.t.u.) corrected only for boiler-room losses. For the assumed boiler-room efficiency of 0.75, this gives us a cost of power of 4550 B.t.u. per kw-hr., and this is shown plotted in Fig. 3 as a dashed line.

In the case of a plant like Connors Creek, the main units have a steam consumption of, let us say, 12 lb. per kw-hr., wherefore power generated by them costs from 18,000 to 21,000 B.t.u. per kw-hr. The house turbine, whose exhaust heat we may assume to be fully utilized, produces power at a cost of 4550 B.t.u. per kw-hr. Clearly, the displacement of a portion of the power generated by the main units at high cost by power generated by the house turbine at much lower cost will result in a gain in station economy. From this it would appear that the maximum house-turbine output is to be striven for. But the matter is not so simple, for here we meet the outstanding feature of the system—the auxiliary exhaust pressure may be adjusted to any value between the lowest attainable absolute pressure and atmospheric pressure. If we operate at a very low pressure, the auxiliary exhaust steam, and therefore the boiler feedwater, are at low temperature, with a resulting high cost of power from the main units. Further, with a small temperature rise of the boiler feedwater, very little exhaust steam can be condensed, wherefore the output of the house turbine is small. As the auxiliary exhaust pressure rises, the boiler-feed temperature rises, lowering the cost of power from the main units, and at the same time the heat absorption of the boiler feedwater increases, condensing more auxiliary exhaust steam and permitting the generation of more cheap power by the house turbine. As the auxiliary exhaust pressure continues to rise, however, another influence enters: the steam consumption of the house turbine increases, that is, the power output of a given steam flow will be less. This reduces the proportion of cheap power generated, and eventually a point is reached at which an increase of auxiliary exhaust pressure will decrease the station economy. Our problem is to locate this point of maximum station economy. It will be worked out in the more exact analysis which follows.

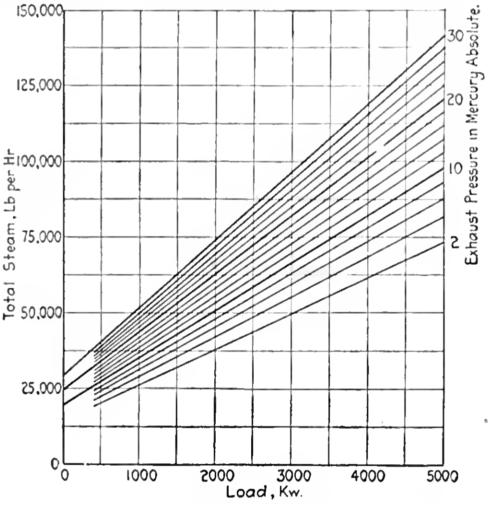


Fig. 5 Total-Steam Curves of House Turbine

As is pointed out below, in discussing the results of this study, a complete analysis of this problem requires a large fund of infor-

mation, which unfortunately is not yet available for the Connors Creek plant. We shall therefore carry out this study for an assumed plant with characteristics consistent with the performance of Connors Creek. The results obtained will serve to define the problem rather than to present a solution for the actual plant. The following data are assumed:

Total station load, including auxiliary power demands, constant and equal to 100,000 kw.
Main unit steam consumption assumed to conform to the total-steam curve of Fig. 4
A house turbine of 5000-kw. capacity, whose performance is shown by the total-steam curves of Fig. 5[1]
Initial specific total heat of steam at 225 lb. per sq. in. gage and 200 deg. superheat = 1313 B.t.u. per lb.
Temperature of condensate leaving main unit condensers = 70 deg. fahr.
Boiler feedwater leaves the heater condensers at a temperature 10 deg. fahr. below the boiling point corresponding to the auxiliary exhaust pressure
Boiler-room efficiency equal to 0.75
Radiation neglected.

Our first step is to develop a very interesting relation which applies to any steam prime mover whose exhaust is wholly used for heating water. If the water is heated from a constant initial temperature to a constant number of degrees below the boiling point corresponding to the exhaust pressure, then a curve plotted between the turbine load and the quantity of water capable of being heated will have the same shape as the curve plotted between turbine load and total steam. Proof of this fact is given in one of the appendices of the complete paper, where the relations involved for the conditions assumed above are developed. For these conditions the curves of Fig. 6 have been prepared.

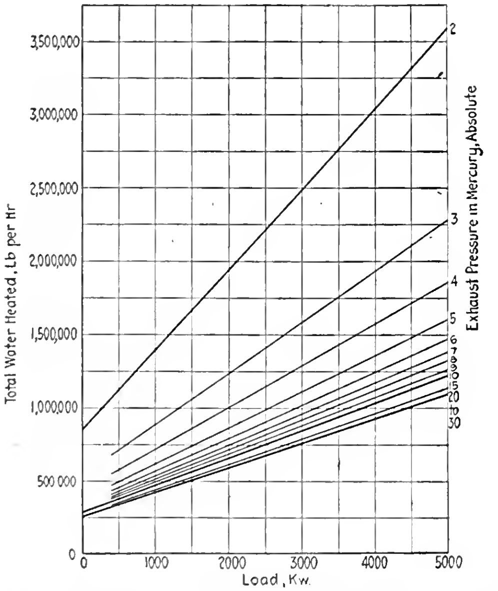


Fig. 6 Water Heatable by Exhaust Steam from House Turbine

We are now in a position to determine the cost of power for variable house-turbine load. Another appendix of the complete paper indicates the method and gives the computations in detail. The principal results are shown in Figs. 7 and 8. From the curves it is clear that the best station economy is obtained with a house-turbine load of 4500 kw. and a boiler-feed temperature of 160 deg. fahr. In Fig. 7 the small circles at zero house-turbine load indicate conditions with the house turbine shut down.

In interpreting these results, attention must be directed to the fact that the curve of cost of power is rather flat. Operation at a condition somewhat removed from the best point results in only a small increase in the cost of power. However, modern power-plant operation is largely concerned with small increments, and a gain of even 100 B.t.u. per kw-hr. is not to be neglected.

Attention must further be called to the fact that the computations here given are based on one set of assumed conditions. To carry out this study in general would require much detailed information. We should need the total-steam curve for the main units running in various combinations over the entire range of plant load. We should also need the total-steam curves for all house turbines (at Connors Creek, five house alternators, six boiler-feed pumps, one general-service pump—twelve turbines in all) over their entire range of load and exhaust pressure. We should then have to develop combined curves for various load distributions among these auxiliaries, and for each of these we should have to compute results for various plant loads and main unit distributions, for various values of the condensate temperature and for various values of the interval *d* by which the boiler-feed temperature is below the boiling point corresponding to the auxiliary exhaust pressure. This is obviously a large undertaking, and one for which we have not yet secured adequate data.

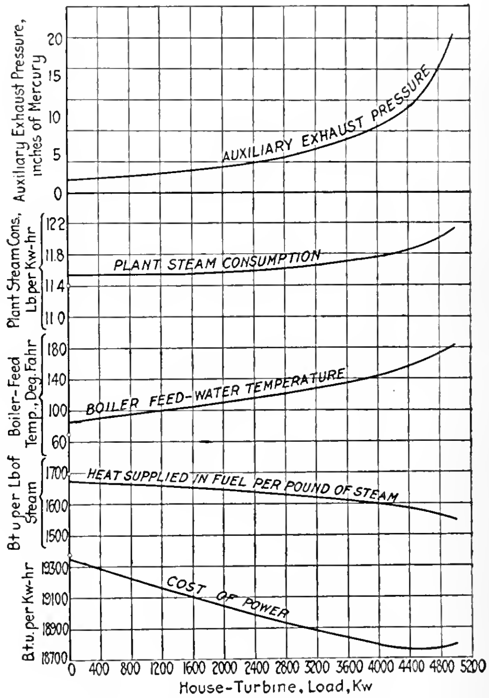


Fig. 7 Cost of Power for Variable House-Turbine Load

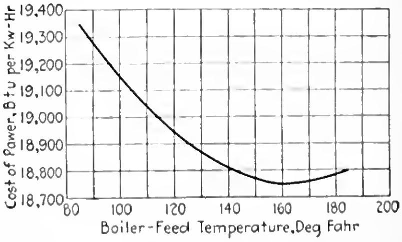


Fig. 8 Variation of Cost of Power with Boiler-Feed Temperature

The main facts, however, are clear. For a system of this type there is a best point, and it is just as wasteful to heat the feedwater to a higher temperature as to a lower. We believe that for the Connors Creek plant the best economy is obtained with a boiler-

---

[1] These curves are based on an actual test of a 1000-kw. set, and probably indicate a higher steam consumption than is normal for a 5000-kw. unit.

TABLE 1 THERMAL BALANCE SHEET FOR APRIL 1921, THE DETROIT EDISON CO., CONNORS CREEK POWER HOUSE

The month of April, 1921, represents neither the best nor the current plant performance. At that time the plant was still operating with crippled units and with much equipment still in progress of recovery from post-war conditions.

Apparatus	Debit				Credit								Efficiency of Apparatus
					Useful				Lost				
		B.t.u. per lb. of coal	Per cent of heat value of coal	B.t.u. per kw-hr		B.t.u. per lb. of coal	Per cent of heat value of coal	B.t.u. per kw-hr.		B.t.u. per lb. of coal	Per cent of heat value of coal	B.t.u. per kw-hr.	
Boiler	Coal	12349	100	20140	Steam to mains (sup.)	9875	79.97	16175	Moisture (hyd.)	560	4.53	914	$\frac{10454-1180}{12349} = 75.1\%$
	Air Main Alternator	59	0.48	96	Steam to mains (sat.)	579	4.69	945	Moisture in air	25	0.20	41	
	Air House Alternator	2	0.02	3					CO	65	0.53	106	
	Boiler Feed	1180	9.55	1927					Carbon in ref.	370	3.00	604	
	Radiation from Mains	33	0.27	54					Radiation	225	1.82	367	
	Work by B. F. Pumps	8	0.06	13					Dry gases	1932	15.65	3152	
		13631	110.38	22233		10454	84.66	17060		3177	25.73	5181	
Steam Mains	Steam from Boiler	10454	84.66	17060	Steam to turbines	9843	79.72	16070	Heating system	35	0.28	57	$\frac{9843+82}{10454} = \frac{9925}{10454} = 94.9\%$
					Steam to evaporators	82	0.66	134	Flue blowers	61	0.49	100	
					Radiation (mains)	33	0.27	54	Soot blowers	120	0.97	196	
					High press. Traps	5	0.04	8	Leaks (restaurant, etc.)	265	2.15	433	
					Heating system traps	10	0.08	16					
		10454	84.66	17060		9973	80.77	16282		481	3.89	786	
Turbines	From Steam Mains	9160	74.18	14960	Energy to shaft	2205	17.86	3600	Bearing friction	40	0.32	65	$\frac{2205}{9160-484} = \frac{2205}{8676} = 25.4\%$
					Packing loss	196	1.59	320	Radiation	10	0.08	16	
					To condenser	6709	54.33	10950					
		9160	74.18	14960		9110	73.78	14870		50	0.40	81	
Condenser	From Turbine	6709	54.33	10950	To condensate	484	392	790	To circ. water	6421	52.00	10480	
Condenser	From Turbine Packing	196	1.59	320									
		6905	55.92	11275		4.84	392	790		6421	52.00	10480	
Main Alternators	Energy from Shaft	2205	17.86	3600	To switchboard	2106	17.04	3437	Bearing friction	30	0.24	49	$\frac{2106}{2205} = 95.5\%$
					Ventilating air	59	0.48	96	Exciter loss	10	0.08	16	
		2205	17.86	3600		2165	17.52	3533		40	0.32	65	
House Turbine	Steam from Mains	568	4.60	927	Energy to shaft	51	0.41	83	Bearing friction	5	0.04	8	
					To heater-condensers	507	4.11	828	Radiation	1	0.01	2	
									Packing loss	4	0.03	6	
		568	4.60	927		558	4.52	911		10	0.08	16	
House Alternator	Energy from Shaft	51	0.41	83	To switchboard	43	0.35	70	Bearing friction	5	0.04	8	$\frac{43}{51} = 84.3\%$
					Ventilating air	2	0.02	3	Exciter loss	1	0.01	2	
		51	0.4.	83		45	0.37	73		6	0.05	10	
Heater Condenser	From House Turbine	507	4.11	828	Feedwater	1185	9.60	1934	Radiation	5	0.04	8	
	From B.F.P. Turbine	106	0.86	173									
	Condensate	484	3.92	790									
	Evaporator	78	0.63	127									
	Storage Tank	15	0.12	24									
		1190	9.64	1942		1185	9.60	1934		5	0.04	8	
Boiler-Feed Pump Turbines	Steam from Mains	115	0.93	188	Heater-condensers	106	0.86	173	Radiation	1	0.01	2	
					Work on feed water	8	0.06	13					
		115	0.93	188		114	0.92	186		1	0.01	2	
Evaporator	Steam from Mains	82	0.66	134	To heater-condensers	78	0.63	127					
	Heat in Raw Water	1	0.1	2	To storage tank	5	0.04	8					
		83	0.67	136		83	0.67	135					
Boiler-Feed Tanks	From Feed Water	1185	9.60	1934	To boilers	1180	9.55	1927	Radiation	10	0.08	16	
	From High-Press. Traps	5	0.04	8									
		1190	9.64	1942		1180	9.55	1927		10	0.08	16	
High- and Low-Pressure Traps	From Steam Mains	5	0.04	8	To B.F. tank	5	0.04	8					
	From Heating System	10	0.08	16	To storage tank	10	0.08	16					
		15	0.12	24		15	0.12	24					
Storage Tanks	From Heating System	10	0.08	16	To heater-condensers	15	0.12	24					
	Evaporator	5	0.04	8									
		15	0.12	24		15	0.12	24					
Switchboard	From Main Alternators	2106	17.04	3437	Energy sent out	2093	16.95	3415	To stoker motors circulators coal handling blowers compressor D.V. pumps transmission miscellaneous gen. service pumps	56	0.45	91	Ratio Auxiliary to Net delivered kw-hr. $= \frac{656}{2093} = 2.68\%$
	From House Alternators	43	0.35	70									
		2149	17.39	3507		2093	16.95	3415		56	0.45	91	
Totals		47731	386.52	77901		37474	303.50	61164		10257	83.05	16739	

feed temperature lying between 160 and 180 deg. fahr., and in this range we try to operate.

Balance Sheet

The preparation of the accompanying balance sheet, Table 1, calls for the exercise of considerable judgment in selecting data, and even for some "directed guessing." The major items are, of course, taken from direct observations, but such things as radiation and drip losses are not susceptible of measurement by practical means, and must be estimated on the basis of other observed data or simply on general considerations.

DISCUSSION OF THE POWER WASTE SESSION

The Power Division held a session on Tuesday morning, December 6, devoted to the subject of power waste. Prof. A. G. Christie, Johns Hopkins University, presided at the meeting. Papers were presented as follows: Auxiliary System and Heat Balance at the Delaware Station of the Philadelphia Electric Company, by E. L. Hopping; Heat Balance of Colfax Station, by C. W. E. Clarke; Heat Balance System for Hell Gate Station, by J. H. Lawrence and W. M. Keenan; and Heat Balance of the Connors Creek Plant.

of the Detroit Edison Company, by D. Harold Berry and F. E. Moreton. The meeting was then thrown open to a discussion of the general subject of heat balance.

Prof. Arthur M. Greene, Jr.,[1] read a written discussion by John A. Stevens[2] in which he criticised the four plants discussed in the papers for operating at such low pressures and temperatures. He called attention to the recommendation in the report of the Superpower Survey of a pressure at the throttle of 300 lb. per sq. in. and a superheat of 230 deg. fahr., and submitted figures of the pressures and temperatures of important steam plants of this country, England and Europe. He expressed a belief that American engineers were following rather than leading English and French engineers in the development and use of high-pressure steam.

J. R. McDermet[3] read a written discussion of Mr. Hopping's paper with special reference to the proposed air extractors mentioned by the author. Mr. McDermet divided systems of driving central-station auxiliary apparatus into three groups, (1) by steam, (2), by house turbine with electric distribution and (3), by extraction heating. He said that it was possible by rather complicated mathematics to show that with an infinite number of extraction heaters following the turbine expansion, the power-station cycle reduces from the Rankin to the Carnot. While from practical considerations this infinite number of heaters is impossible, the extraction heater method has certain advantages which, he pointed out, made it an attractive method of obtaining heat balance.

The value which Mr. Hopping gave to vent loss from the heater appeared to Mr. McDermet to be roughly correct although possibly too low. The installation of air extractors as proposed in the Delaware Station has three advantages: first, elimination of vent loss heat in the operation of the heater which in the proposed installation should be reduced to approximately 0.5 per cent instead of 5 per cent; second, the loss of water through the heater vent in the form of steam will also be eliminated; and third, the reduction of temperature of feed from 210 to 140 deg. will give an added economizer effect and probably increase the boiler efficiency about one per cent. The air extractor which should be used operates upon the Elliot system of explosive boiling.

James M. Taggart,[4] in commenting on Mr. Hopping's paper, said it would be of interest to know the amount of increase in heat return realized by lowering the feedwater temperature to 140 deg. He also commended Mr. Berry's emphasis of the importance of speed control of auxiliaries. He considered that only a doubtful increase in reliability was being obtained at the Colfax Station by the use of turbine drive for forced draft fans and boiler feed pumps and that the sacrifice in economy was considerable.

John Anderson[5] asked why banking coal losses had not been included in Fig. 3 of Mr. Hopping's paper. He thought Mr. Hopping had used too high an economizer efficiency in view of the feedwater temperature of 210 deg. If pulverized coal had been used in the Delaware Plant a figure of 16,900 B.t.u. per net kw-hr. might have been obtained instead of the 17,982 B.t.u. actually obtained.

N. E. Funk[6] suggested that the Society standardize heat balance as it had standardized boiler testing, pointing out that in the papers presented three different methods had been used in presenting heat balances so that comparisons were difficult. He did not wish the impression carried away that the Philadelphia Electric Company was averse to electric drive for auxiliaries. He thought that automatic control appratus which could be started and stopped by push buttons was entirely satisfactory and would relieve operators of any except the most simple duties.

Mr. Funk was not in accord with the trend toward higher temperatures and pressures unless they were necessary in reducing the actual cost of producing current. The cost involved in operating under high boiler pressures and temperatures must be figured when any theoretical saving due to these changes is proposed.

Leo Loeb[7] spoke of the considerations involved in selecting drive for station auxiliaries and presented a summarized heat balance covering a week's operation at the Delaware Station.

Francis Hodgkinson[8] spoke of the delusion under which engineers had formerly labored that so long as steam from auxiliaries was condensed in the feedwater heater the water rate of these auxiliaries did not matter. Nine or ten years ago he had devised a series of valves for accomplishing heat balance which provided for bleeding the main turbine at a time of least efficiency in heating feedwater and supplying steam to the turbine when the reverse condition existed. One reason for leaning toward the electric drive was the elimination of undesirable conditions in the basement containing steam-driven auxiliaries. He thought that engineers generally were favoring the house turbine heat-balance scheme.

H. R. Summerhayes[9] also spoke of the necessity of having steam-driven auxiliaries of the highest economy if economy of the main unit is desired.

R. J. S. Pigott[10] pointed out the fact that the heat consumption of a plant varies with the load and that in order to determine the most economical combination of auxiliaries it is necessary to study more than one load. One system for obtaining heat balance might be the best for a given load while another system might be the best for a variety of loads.

L. P. Breckenridge[11] said that he was impressed with the desirability of serving industrial areas by power plants in which the heat energy of the coal could be converted into electric energy in the most economical way and called attention to the report of the Superpower Survey.[12]

T. E. Keating[13] spoke of the most economical boiler feed temperature which, he said, should be between 160 and 170 deg. if economizers are used.

Joseph Pope[14] said that the duplex drive offered difficulties in shifting load from the steam to the electric ends. He also spoke of the lack of speed control on large turbines at the auxiliary steam inlet connection which might result in overspeeding in case of a very light load on the turbines and a large supply of low pressure steam.

J. B. Scott[15] asked if the authors of the papers would install the systems of heat balance described by them in case the stations were to be redesigned.

George A. Orrok[16] spoke of the possibility of approaching the Carnot cycle in the power plant. He believed that the load factor at which the station was to run was the determining factor in choosing the auxiliaries to be used in working out a heat balance.

Closure

E. L. Hopping, in closing the discussion on his paper, and in answer to a question which had been asked about burning oil, said that the furnaces at the Delaware Station were designed so that, with few alterations, oil or pulverized fuel might be used in place of stoker-fired coal. In answer to Mr. Anderson, he pointed out that the figures given in the paper included the standby losses. He called Mr. Hodgkinson's attention to the cleanliness of the auxiliary basement at the Delaware Station where steam-driven auxiliaries are installed. As Mr. Piggott had advised, a complete study of economics at all loads was entered into in deciding upon the auxiliaries for this station. In designing a new station, the speaker said, he would use all of the experience gained at the present and other stations in making a choice of auxiliaries.

C. W. E. Clarke, in referring to Mr. Stevens' suggestion of using

(Continued on page 74)

---

[1] Professor Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. Mem.Am.Soc.M.E.

[2] Consulting Engineer, Lowell, Mass. Mem.Am.Soc.M.E.

[3] Research Engineer, Elliott Co., Jeannette, Pa. Mem.Am.Soc.M.E.

[4] Consulting Engineer, Taggart & Perry, New York, N. Y. Assoc-Mem.Am.Soc.M.E.

[5] Chief Engineer, Milwaukee Elec. Ry. & Light Co., Milwaukee, Wis. Mem.Am.Soc.M.E.

[6] Operating Engineer, Philadelphia Electric Light Company, Philadelphia, Pa. Mem.Am.Soc.M.E.

[7] Day and Zimmermann, Inc., Philadelphia, Pa. Mem.Am.Soc.M.E.

[8] Chief Engineer, Westinghouse Elec. & Mfg. Co., Lester, Pa. Mem.Am.Soc.M.E.

[9] General Electric Company, Schenectady, N. Y.

[10] Crosby Steam Gauge & Valve Co., Boston, Mass. Mem.Am.Soc.M.E.

[11] Professor Mechanical Engineering, Sheffield Scientific School, Yale University. Mem.Am.Soc.M.E.

[12] Professional Paper No. 123, U. S. Geology Survey.

[13] General Manager, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. Mem.Am.Soc.M.E.

[14] Betterment Engineer, Stone & Webster, Inc., Boston, Mass. Assoc. Mem.Am.Soc.M.E.

[15] Consulting Engineer, Philadelphia, Pa. Mem.Am.Soc.M.E.

[16] Consulting Engineer, New York, N. Y. Mem.Am.Soc.M.E.

Compounding the Combustion Engine

By ELMER A. SPERRY,[1] NEW YORK, N. Y.

To engineers versed in the problems of selecting and designing prime movers, the advantages of the compound combustion engine are readily apparent. It is light compared with the normal Diesel, being in special cases, according to the author, less than one-tenth, and in some instances less than one-twentieth, the weight for the same output. Its mechanical efficiency is extremely high, and a distinct gain in overall efficiency from fuel to shaft is said to have been made, as well as a very definite gain in simplicity, direct performance and smoothness of the crankshaft diagram. This has been achieved while adhering to the best practice, namely, four-cycle operation.

This paper presents the results of research by the author extending over a series of years, during which it is claimed that not only has the high-pressure principle been thoroughly established, but all the important requirements have been worked out, and finally an engine embodying practically all the advantages has been subjected to long continuous runs.

THE high-compression or Diesel cycle in combustion engines has worked nothing short of a revolution, having brought to the prime mover its choicest heritage, the highest thermodynamic efficiency known. The fuel economies of these engines have forced them to the front. They have become extremely reliable and easy to operate; instances are becoming common of long runs without overhaul—long-continued performance without shutdown or forced stop of any kind.

As experience is gained with these engines, however, there have developed some objectionable features which are serious. Though they occupy somewhat less space than boilers and engines, the weights of Diesels are on a par with, if not somewhat in excess of, those of reciprocating engines with their boilers and decidedly in excess of those of water-tube boilers and turbines. The standard product of the largest builder of Diesel engines for the merchant service weighs about 450 lb. per shaft horsepower and is large and bulky. A substantial increase in tonnage of freight carried is only one of the gains that would be secured, could these engines be made much lighter and smaller for the same power.

The weight is not the only difficulty with these large engines, however, for they cost more than steam equipment of equal power. One instance of $200,000 excess for a 3500-s.hp. ship is cited. In another ship for the same service and of the same power the weight was 60 per cent in excess of the turbine equipment and the cost 212 per cent, amounting to $306,000 excess. Notwithstanding this extra capital charge, the first ship at three-fourths capacity in the Far East trade can earn nearly double net (83 per cent) over its turbine competitor of the same power and construction and with its machinery weighing a third more than steam equipment.[2]

Again, it has been found that almost without exception a grade of fuel oil known as Diesel oil must be employed. This is a partially refined product costing upon the present market considerably more than bunker oil burned under the boilers.

The fuel-oil problem in itself renders some advance absolutely imperative. Conservation of our oil should be backed by Government enforcement to stop the prodigal waste which results from bulk or furnace firing of enormous quantities of these highly concentrated fuels, destroying three to five times the quantity, power for power, required by steam, especially now since the cheapest petroleum can yield to the full its wonderful store of energy in the most direct way possible by being burned drop by drop directly in the cylinder and practically at the point where the work is to be done.

COMPOUNDING AS A REMEDY FOR INHERENT DIFFICULTIES WITH DIESELS—THE AUTHOR'S EARLY WORK

In a report made by a group of engineers in 1900, it was stated that if the combustion engine could be successfully compounded, a most important gain would be made in its weight and size. The fact that compounding presents other advantages has been known to engineers for a number of years, but the difficulties have been looked upon as insurmountable.

A year ago Professor Watkinson, director of the important engineering laboratories of Liverpool University, in discussing an epoch-making paper by Engineer-Commander Hawkes on the Admiralty's extensive research on Diesels, stated, in substance, that we must recognize that the combustion engine in its present state was very crude and in compounding only lies the line along which the next great step in progress would be made. And he also stated that much greater results are bound to follow the compounding of combustion engines than were ever realized by compounding steam engines; first, because of the very much greater range of pressures available, and secondly, because the great enemy to compounding in steam, viz., condensation, is not present.

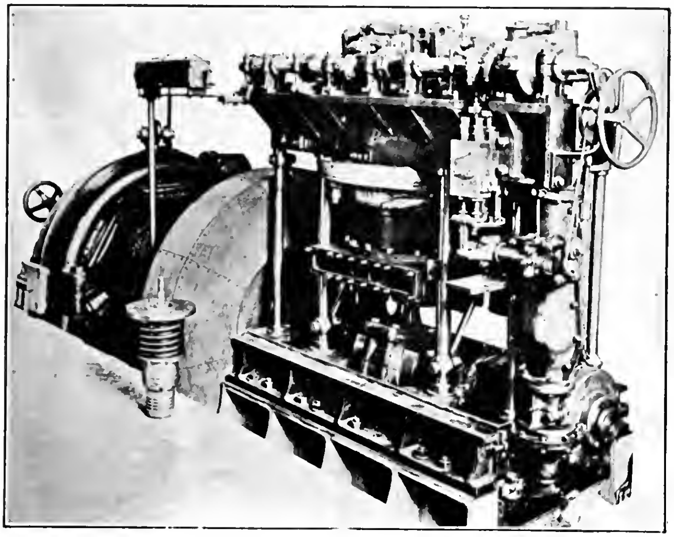


FIG. 1 10 : 1 MARINE-TYPE COMPOUND OIL ENGINE BUILT FOR HEAVY DUTY

Activity in this field is now prodigious and workers in various parts of the world are commencing to realize that a great advance step is imminent. In America, a group headed by the author has been engaged on this problem for upward of thirty years. Starting in 1890, his first compound was running before the World's Fair. The patent records give evidence of this early work under date of December 10, 1892. A number of engines have steadily followed each other, each involving improvements resulting from previous experience, until the essential problems have been conquered. Not only has the principle been thoroughly established, but all the important refinements have been worked out, and finally an engine embodying practically all the advances has been subjected to long continuous runs. Data almost invaluable to the art have been secured, together with a series of indicator cards and diagrams that exceed a thousand in number.

The outcome has been that the various prophecies of thoughtful engineers in the past have been more than fulfilled and there is every evidence that the heavy-duty compound combustion engine is everything that was hoped for. It is light compared with the normal Diesel, being in special cases less than one-tenth, and in some instances less than one-twentieth, in weight for the same out-

---

[1] President and Engineer, The Sperry Gyroscope Co., Brooklyn, N. Y. Mem.Am.Soc.M.E.

[2] See paper by Metten and Shaw before Society of Naval Architects and Marine Engineers, May, 1921.

Abstract of a paper presented at the Annual Meeting, New York, December 5 to 9, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

put. Its mechanical efficiency is extremely high and a distinct gain in overall efficiency from fuel to shaft has been made, as well as a very definite gain in simplicity, direct performance and smoothness of the crankshaft diagram. This has been achieved while adhering to the best practice, namely, four-cycle operation.

COMPOUNDS LIGHTER AND CHEAPER—MUCH LARGER UNITS POSSIBLE

The lightness and simplicity of the compound solves the capital-charge factor automatically. Engines of this type weighing only a fraction of the weight of the present Diesel will inevitably be found to be much less in first cost as well as in cost of upkeep.

Much higher powers than are now available are thought to be of extreme importance and much interest is centered upon the question; in fact, the more advanced among the Diesel builders are today concentrating upon ways and means to attain still higher powers from a single cylinder working on its present cycle. Of course this will increase instead of decrease the weight per horsepower. It is to the compound that we must look for a solution of this problem, for the reason that within present cylinder and cylinder-wall limitations, powers in excess of 10,000 hp. per engine are entirely practicable and are accompanied by all of the proportionate savings in weight, space and capital charge that have been pointed out.

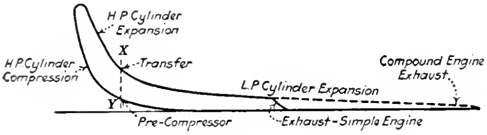


Fig. 2 Indicator Card of Diesel Engine

Our own Government has watched the progress of this work for a number of years, inspected the development in its various stages, and has come forward with orders for an initial engine which, together with orders from other sources, is now under construction. To illustrate to what low figures the compound principle can be relied upon to bring the heavy-oil engine, it should be stated that among these orders is one now under construction to weigh about five pounds to the brake horsepower. This may be looked upon as extreme, but the designed weights and finished parts as they now stand are below this figure. This brings us within striking distance of aviation engines, where the fire risk through the presence of gasoline and the electric ignition system constitutes one of the greatest menaces to aviation progress. The remarkably high mean effective pressures of the heavy-oil compound will give us the aviation engine and entirely eliminate both these sources of fire risk.

The reason for the great weight in all classes of Diesel engines is apparent when it is understood that they are designed around an extremely small quantity of air and oxygen at each stroke, an amount so minute as to be quite surprising when compared to the ponderous engine itself. The volume of the power gases available to do work is limited to the size of the combustion space, and when it is remembered that this is confined to a small crevice in the end of the cylinder of the order of one-twentieth of the travel of the piston, the limitation is at once seen. Attempts to make it larger produce both compression and ignition temperatures that are too low and we have semi-Diesel and surface-ignition engines confined to smaller sizes with tendencies to a lower grade of performance. Such engines are difficult to start and represent no gain in weight.

Two of these volumes are sometimes combined as in the opposed-piston Junkers engine. The size of the combustion space, though still minute, is known to give some small advantages over the regular engine which has only one-half of this space, but has the disadvantage in common with all two-cycle engines of the fractional piston-ring support practically without lubrication on the hot bridges as the exhaust port is uncovered by the piston.

SEPARATE CYLINDERS SUITED TO PRESSURE RANGES—TWO-STAGE COMPRESSION SECURES LARGE WORKING VOLUMES

Take, for instance, the Diesel indicator card, Fig. 2. Draw the vertical line XY and it is easy to see that the expansion pressures to the left are high and should do their work in a high-pressure cylinder, whereas those to the right, especially following the dotted extension line of expansion, are definitely low pressures and should do their work in a low-pressure cylinder suitable for the purpose. This is practically all that is attempted in compounding combustion engines. The vertical line XY also divides the compression curve into two stages, low and high, the latter taking place in the combustion cylinder proper as a second stage. No compressor delivering 500 or more pounds per square inch will undertake to do so in a single stage; there would be at least two stages. The old single-stage compression is discarded in the compound and this modern method of two-stage compression is adopted.

Supercharging or compressing in two stages gives the controlling advantage in that a very much larger unit volume of gases may be handled. The clearance spaces may be many times the size of those in the Diesel, and yet it is perfectly simple to bring these large volumes up to the requisite pressure and incandescent temperatures at the instant of fuel injection.

The large volume of power gases in the combustion chamber of the compound at once solves a number of important problems, makes the light engine easy of accomplishment, and overcomes a number of other difficulties at the same time. No longer is the chilled perimeter per unit volume of gas the controlling factor, as it is in the Diesel. The chilled walls are retired into the background as the large volume asserts itself, as compared with the small crevice indicating the total volume available in the normal Diesel (shown at C in Fig. 9), where the chilled areas exposed are very large and the volume very small. At a glance it will be seen that all this is reversed completely in the large dome-shaped clearance space D in Fig. 9, where the volume has increased very much more rapidly than the perimeter. This is again vastly increased in the low-pressure cylinder, where an extremely large volume exists with still smaller ratio of chilled perimeter. Taking all of the chambers into consideration, it is found that while retaining all of the chilled walls that are necessary for proper handling of the lubrication, still a gain is made on the order of 60 per cent in the extent of these chilled walls in the compound as compared with the simple engine.

With the large clearance volume we no longer have difficulty with solid injection, nor do we have any difficulty in using a wide range of heavy fuels. It has been known for years that as soon as the oil spray encounters chilled or even red-hot walls, the efficiency drops.[1] Here the oil fog may penetrate the deep masses of hot compressed air with instantaneous effect in every direction from the spray nozzle without encountering chilled walls and instantaneous and very complete combustion results. In the compound engine the clearance volume is so large that the entire high-pressure piston displacement causes it to lose only a fraction of its pressure, thus bringing to the second stage, or low-pressure, both ample volume and pressure so that this piston (representing 6, 8 or even 10 times the area of the high-pressure) is driven to the end of its stroke with pressures still above the atmosphere.

MUCH GREATER EXPANSION, HIGHER EFFICIENCIES

In this way the engine yields an expansion ratio based on gage pressures, which instead of being 3 or 4 to 1, as in the case of the automobile engine, or about 12 to 1 as in the Diesel, can be made as high as 120 to 1, yielding a higher return and greater efficiency from the fuel because of the lower temperature of the exhaust. The great volume in the combustion space furthermore allows this space, without distortion, to extend easily out over the top of the low-pressure piston, making a most direct connection therewith through a short transfer port (see L, Fig. 9).

THE COMPOUND CYCLE

Fig. 3 shows the cycle card without fuel, taken from the high-pressure cylinder in a 10 : 1 compound. The first-stage compression enters the cylinder at point A on its out stroke with the pressure about 113 lb., giving a power stroke indicated by line A'. At point B the induction valve closes and on the in stroke the compression proper starts and rises on line B' to Diesel values at C. There being no fuel injection, the receding stroke brings the pressures down on practically the same line B' to point B (E in Figs. 5

---

[1] See Eng-Comdr. C. J. Hawkes' Admiralty paper: Some Experimental Work in Connection with Diesel Engines, November, 1920.

and 6). Here the transfer valve opens and the gases pass on the in stroke to the low-pressure cylinder on line *D*. This is the out stroke of the low-pressure, the pressures sinking to a trifle below atmosphere before the final exhaust valve opens and continues open nearly during the entire next stroke of the low-pressure piston, which is, however, never shown on this high-pressure card but on the low-pressure card, Fig. 8.

Fig. 4 is the air-pump card representing the first stage of the compression which delivers air to a small receiver, from which air is delivered during the induction stroke, on line *A′* of Fig. 3, which, it will be observed, is a power stroke with a high mean effective pressure, thus recovering some of the power of the pump.

Fig. 5 is the same as Fig. 3, except that fuel has been injected, and shows the regular slow Diesel burning common to all early cards of these compounds, where from point *C* a perfectly level line is often drawn to point *C′* which marks the point of "cut-off." The gases then expand on line *C″* to point *E*, where the transfer valve opens and the gases continue to do work on the large area of the low-pressure piston, indicated by line *D*. The exhaust valve opens with pressures only slightly above atmosphere at point *D′*. The ordinary slow Diesel burning has the objection of lower efficiencies and allowing the heat to be added to the gases out nearer the exhaust end of the stroke.

Utilizing the Detonation of Fuels

Through a research extending over a year and a half or more, conditions were discovered by means of which "detonation" of the fuels may invariably be secured. This extends to a large variety, including of course the heavy fuels. While automotive engineers have adopted extreme measures, even lowering compression, "doping" fuels, etc., etc., in order to avoid the detonation, we have been working in the opposite direction. We have found that the *thermodynamic efficiency is higher in case of high detonation diagrams* than with low. Our work has been toward realizing these high efficiencies by developing instead of suppressing this high-intensity combustion. We have therefore sought to harness and utilize to the full the detonation phenomenon for the reasons and with the results outlined herein.

Fig. 6 is a typical card taken under the same conditions and the same engine as Figs. 3 and 5, exhibiting "detonation" and showing the quick burning, piling the heat up at the beginning of the stroke and as far away as possible from the exhaust end, giving also a very much truer Carnot-cycle card. All recent running of the compound engines has been in accordance with this card. One of the achievements of high-intensity combustion is better thermal efficiency and a still further reduction in the exhaust temperatures. The engine with this type of card is lifted from the old constant-pressure to the superior constant-volume performance which frees the compound from all speed limitations. The detonation characteristics, e.g., the vertical rise on the diagram, persist even at very high speeds. This card also insures operation at lower fractional powers without indication of carbon deposits.

Fig. 7 is given as showing the range of control of the peak and shape of the card at will under the same operating conditions and with the same spray nozzle.

Elimination of Losses in Transfer

In early attempts at compounding, principally layouts, it was found that prohibitive losses would occur in the transfer, due to the falling pressures while filling the low-pressure clearances. A complete solution of this is found in a special adaptation of the process of "cushioning"—closing the exhaust valve at a predetermined point before the out-stroke end, trapping a little of the hot gases and cushioning them up to the transfer pressure so the transfer valve opens under conditions of equal pressure on each side. There are practically no losses sustained in cushioning; the power of compression is returned very completely on expansion. The additional advantage is secured of preventing all erosion due to high velocities of the hot gases over the transfer seats. These seats are amply jacketed and are found to remain smooth, bright and perfectly sealed over long periods. It is incidentally found that in cushioning, the adiabatic compression of the hot gases brings with it an equality of temperatures as well as pressures, so there is neither loss in pressure nor temperature at this critical point of transfer and the efficiencies are carried at high values throughout the cycle.

Fig. 8 shows the low-pressure card, indicating the same power-pressure line *D* as Figs. 3, 5 and 6. On this in stroke the exhaust valve opens at *D′* and closes again at point *G* on the out stroke, giving rise to the cushioning curve *H*, terminating at the same pressure and really the same temperature as at *E* in the high-pressure cylinder.

The Transfer-Valve Problem

The point *X* in Fig. 2 will be recognized as being the same as point *B* in Fig. 3 and point *E* in Figs. 5 and 6. The transfer valve considered as an exhaust valve is here called upon to handle much hotter gases than ever heretofore. It must be remembered, however, that compression in the compound is by the modern two-stage method. Air is admitted to the combustion chamber under comparatively high pressure and although it is warm, yet with each atmosphere of pressure its cooling powers are doubled. Air at 100 lb. thus has seven times the cooling power of atmospheric air, seven times the weight and seven times the molecules in contact for cooling. In forcing the high-pressure piston down on pressure line *A′* in the above figures, air must pass some port in entering. Now, as a matter of fact, this port is in line with the transfer port and the induction valve itself rides on the back of the transfer valve in the form of a hollow sleeve *I* (Fig. 9) seated directly on the top of the transfer valve *T*. The back of the transfer valve is provided with greatly enlarged radiating and cooling surfaces presented to this cooling air and powerful convection currents are constantly acting when sealed. Moreover, this air when entering is at high velocity and gushes down through and bathes the deeply serrated surfaces of the back of the transfer valve, licking up the heat very completely in its inward rush.

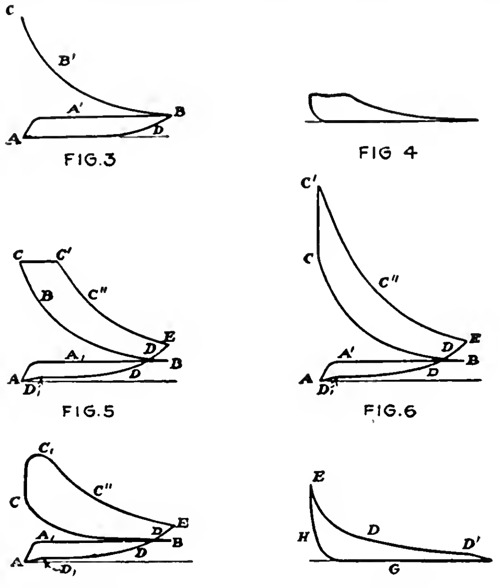


FIG. 3 FIG 4 FIG. 5 FIG. 6 FIG. 7 FIG. 8.

Figs. 3–8 Indicator Cards of Compound Cycle

Now in following out the cycle, it will be noticed that this is the very step that follows directly on the heels of the transfer of the hot gases (*D*, Fig. 3) and continues throughout the next quarter cycle (see *A′*, Fig. 3) and through the entire descent of the high-pressure piston, which in this way delivers a real power stroke to the crank with mean effectives in some instances greater than the mean effective pressures of the ordinary Diesel, thus returning some of the power taken to drive the supercharger or first-stage pump. If the transfer valve is intensely heated on its under surface (see *T*, Fig. 9) and is then instantly intensely cooled on a surface five times as great, it will certainly strike and maintain a heat balance which in practice is found to be extremely low, only about one-half the

temperature of the Liberty valves, nowhere nearly approaching red heat nor the temperature of normal Diesel exhaust valves under load conditions.

Again, the heat in these gases absorbed from the hot valve is useful inasmuch as it is the auto-ignition temperatures as well as pressures that are required at the end of the compression curve B'. Here a useful heat transfer and pure regenerative process is carried out. The seats give no trouble because they are backed by the ample water jackets and, in fact, the whole transfer valve gear operates continuously and successfully and is found to be in perfect condition after hundreds and even thousands of hours of operation.

How Lightness is Obtained in the Compound Engine

The question often asked is, To just what is due to smallness and lightness of the compound engine? It is this: In the four-cycle Diesel we have the tonnage of metal due to the presence of high pressures operating at a ridiculously low material efficiency because these high pressures persist only about $2\frac{1}{2}$ per cent of the total time. The Diesel card rises abruptly and immediately falls. All the rest of the time, over 95 per cent, either low pressures or no pressures at all are present, whereas in the compound the pressures *persist* and we are dealing with great blocks of power, as can be seen from the power curve C''. Although the pressures are not materially higher than in Diesel practice, they are made to persist practically clear across the card, producing a very large gross mean effective. This is instantly followed by another line clear across the card, again producing another large gross mean effective in the low-pressure cylinder when referred to the high-pressure area, all from a single fuel injection. Instead of 60 to 70 lb. net mean effective to the crank, delivering its power through a few degrees only of one stroke in four, in the compound we have two net mean effectives, each of 300 or 400 lb. per sq. in., succeeding each other and covering two strokes out of the four from a single fuel injection, giving very much better crank-effort distribution for power purposes. The point of paramount interest is that these two large blocks of power are secured *not by any material increase of pressures*, but by using large quantities of power gases, and "hanging on" to the pressures we have in those gases throughout practically two complete strokes, clear across the card twice, thus abstracting much more of the power they contain before exhausting. Suppose these to be 330 lb. per sq. in. each. Added they make 660, which is easily ten times 62 lb., a net mean effective not infrequently met with in ordinary Diesels. In an engine of simple construction giving ten times the net mean effective to its crankshaft and well distributed, there should be no good reason why it should weigh more than one-tenth the weight of the present Diesel.

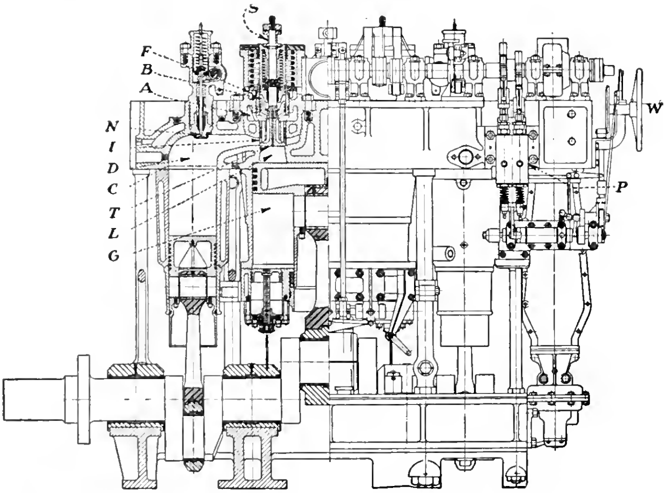


Fig. 9 Section and Elevation of Compound Oil Engine, Showing Construction

The power gases work in the Diesel about 120 deg. of arc and in the compound 315 deg., or 2.6 times as long; or, considering the points of "cut-off" in each, the true expansion curve is $3\frac{1}{3}$ times as long, which accounts for its large mean effectives and higher economies.

Proper Ratio for Compounds

As to the proper ratio for compounds, engines of 10 : 1 ratio of low-pressure to high-pressure cylinder areas, also 8 : 1 and 6 : 1 have been made, operated and studied, the smaller ratios being at present considered more desirable. The weight factor does not change materially with changes in ratio in this region. The low-pressure piston operates two-cycle. The power distribution and the weight of the reciprocating parts both equalize best at about 6 : 1. This makes a perfectly balanced unit, the end masses equaling and also moving oppositely to the central. The two full power impulses following each fuel injection are also about equal. Thus full *four-cylinder performance* is secured with only three cranks and two extra power impulses are delivered on the induction stroke (see line A', Fig. 3), making six power impulses for each cycle.

Another unusual advance should be noted, viz., complete reversibility and self air starting are secured without additional valves or cams over the simple, one-way engine without air starting, there being no difference in this regard. Again comparing the full-reversing, air-starting compound unit with a similar four-cylinder Diesel of any prominent make, delivering the same number of primary power impulses to the crank, the latter has 16 valves and 32 cams. The former operates the same cycle with two extra power impulses over the Diesel with 5 cams driving 7 valves.

Doing away with the three-stage air injection pump, its intercoolers and general complexity is another important simplification. One United States builder stated recently that an excess of 11 per cent of the entire power of the engine is absorbed for driving these pumps.

Marine Type of Compound Engine

Fig. 1 shows a 10 : 1 compound engine built for heavy duty. Although this is a small marine type with high-pressure cylinders 7 in. by 11 in. running at 400 r.p.m., yet the size of the crank-pitman end in the lower center of the engine reveals the ruggedness of these parts. The fuel pumps are also shown here and the connection to the governor. The camshaft is on a shelf at the top of the engine to one side and is driven by skew gears. The electric generator forming the full load of this engine is shown in the background and one of the transfer valves with its bonnet cover stands on the floor in front of the engine. The comparatively small size of the engine, although in the foreground, is notable and stands out in marked contrast with the engine of Fig. 10, the product of the largest Diesel builder. This is the standard marine engine for some seventy ships. The electric generator forming the full load of this engine (so marked) is also in the background, as in Fig. 1. The generators in the two cases of course being standard, give an unusually excellent basis of comparison. The compound works at a piston speed of about 700 feet per minute and its generator would be still smaller in comparison, should it be worked at the piston speed of about 900 feet per minute of the large engine. Incidentally, in the foreground of Fig. 10 there is also an excellent illustration of the three-stage, intercooled, high-compression air pump for spraying the fuel into the cylinders.

The large size and weight in the Diesels extends to all makes in somewhat different degrees. A line of Diesels made in the United States are reported to weigh 512 lb. per b.hp. The engine of Fig. 10 weighs 450 lb. per b.hp., while the compound in Fig. 1 weighs less than 30 lb. per b.hp.

Internal Construction of the Compound

Now as to the construction of the compound, Fig. 9 shows an elevation to the right of the center, and longitudinal section to the left, of the engine shown in Fig. 1. The two high-pressure or combustion pistons on their out stroke are at the ends and in the center the low-pressure at its extreme in stroke. The sturdy construction is indicated by the size of the crankshaft, about 50 per cent larger than in any other combustion engine of which the author has knowledge, approaching, as it does, the bore of the combustion cylinders

themselves. The fuel pumps *P* and the control and manipulating wheel *W* are shown in elevation to the right. To the left the large dome of clearance *D*, forming the combustion chamber of the compound, stands out in marked contrast to standard Diesel practice, which is shown by the little space *C* between the solid horizontal line at the base of the clearance and the dotted horizontal line just above. The dome is large and forms an upward extension of the combustion cylinder, extending also to the right in a large sweep surrounding the transfer valve *T* which seals the transfer port *L*. The sleeve-like induction valve *I* is shown seated on top of the transfer valve and is controlled by the cam-operated fork *F*. The transfer valve and sleeve are lifted by a fork not shown, located in thimble *S* near the top of the stem. The first-stage annular compression pump *G* surrounding the trunk piston below the low-pressure piston proper, delivers its air to a small receiver, which in turn discharges to the cored port *A* surrounding the induction sleeve *I*, the cooling action of which has been described. The little balancing cylinder *B* sustains a permanent connection with the low-pressure cylinder. The solid-fuel injection valve and nozzle *N* are placed approximately over the center of gravity of the large masses of air in the clearance dome *D*.

The comparison with the large dome constituting the clearance and combustion space in this compound with the small distance between the solid horizontal line at the base of the combustion space in Fig. 9 and the dotted line indicating the combustion space *C* in the normal Diesel, is simple to make and is significant.

It is understood that the two high-pressure cylinders are operating four-cycle, one 360 deg. back of the other, discharging alternately into the low-pressure, which therefore works two-cycle and delivers power on each down stroke. The cycle has been pointed out and the general operation will be apparent from this figure.

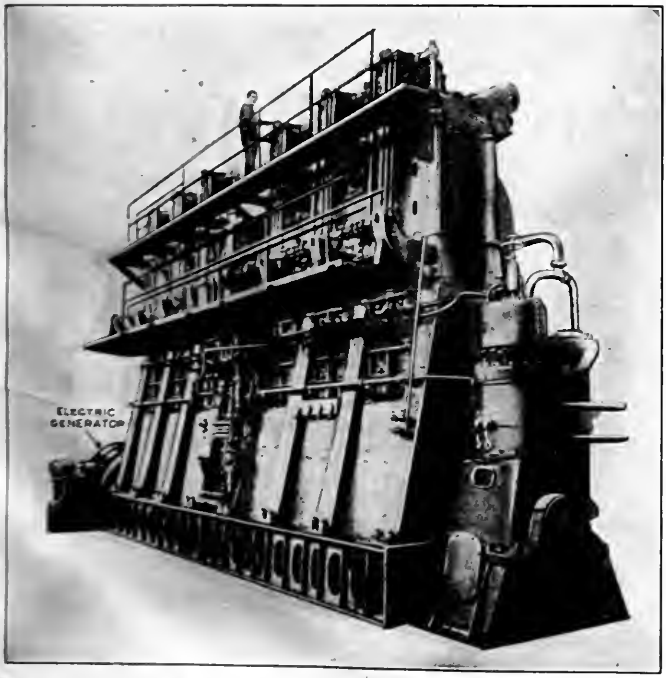


Fig. 10 Standard Marine-Type Diesel Engine

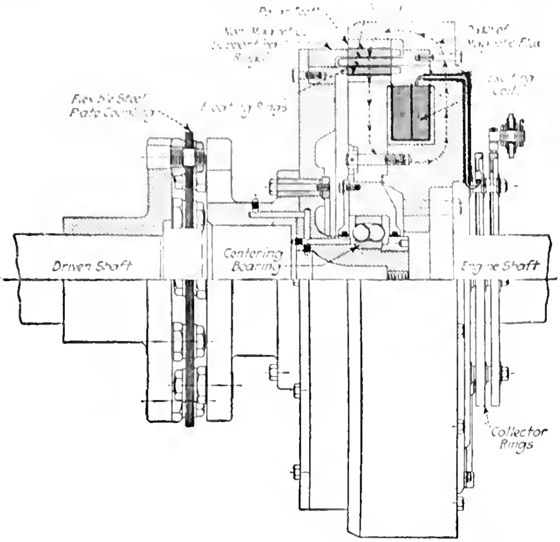


Fig. 11 Air-Gap Type of Electromagnetic Clutch

Field of Usefulness of the New Prime Mover

To engineers versed in the problems of selecting and designing prime movers, the advantages of the compound combustion engine are readily apparent. Its light weight for a given power with resulting low first cost and capital charge, the low costs for foundations, the high speeds with consequent low costs for connected generators, the small space required and the simplicity and economy of operation are important reasons for suggesting new fields for this prime mover, which has been proven of practical value in a long series of tests under working conditions. The compound engine is especially adapted for use for auxiliary or stand-by service in water-power stations or for carrying the peak loads in central stations where installations as large as 21,000 kva. have been contemplated. The important considerations are quick starting, non-deterioration of fuel reserve and flexibility of required fuel, amounting to almost complete independence of fuel quality. Other uses for the compound which readily suggest themselves are city water works and irrigation projects, either directly or by electrical distribution.

The possibilities of the compound-Diesel-electric locomotive should not be overlooked, as it presents all the well-recognized advantages of electric traction. At the same time it represents a component part of the central power station, with the advantage over the latter that it operates at the highest thermal efficiencies known—nearly three times the efficiency of even a very large power plant, i.e., three times the tractive effort is delivered to the rail from every pound of fuel burned. Also the capital charges for main feeders, substations, bonded rails and shunted switches and frogs, and the third rail or elaborate overhead construction are eliminated. The tracks are used exactly as they now stand.

Application to Ship Propulsion

We now come to the greatest present employment of oil engines, namely, their substitution for steam in ship propulsion. The advantages of motorships are rapidly being recognized, and they are now being built in practically every maritime country more rapidly than ever before. There were building last year 454,502 tons of Diesel-driven ships, or over 7 per cent of the world's total under construction. In the light of the past ten years' experience the Diesel engine has proved an efficient, reliable and thoroughly seaworthy prime mover, suitable for a large proportion of the total sea-borne tonnage.

Novel Electromagnetic Clutch Affords Elastic Drive

In connection with the development of the compound engine for marine purposes, and in order to provide any Diesel type of engine with speed flexibility equaling the reciprocating steam engine, there has been developed an electromagnetic clutch operating on an entirely new prnicple.

This new type of clutch transmits power entirely through air

gaps and has no mechanical contact whatever between the driver and driven, eliminating wear and deterioration. It is capable of remote control and can be operated at any speed from zero to full engine speed: the torque may be varied at will from maximum to minimum. The power required to operate the clutch at full load is but a small fraction of one per cent of the power transmitted. In one instance 525 hp. required 256 watts, or 0.065 per cent of the power transmitted. An outstanding feature of this clutch is that on direct drive or full speed it is magnetically locked, which insures perfect synchronism and no slip with an extreme increase in pull-out torque. At this and all times, in fact, the transmission has the "velvet touch" of an air drive and insures complete torquewise isolation of the mass moments lying on the two sides of the clutch. As seen in Fig. 11 the clutch forms a part of even a small-sized flywheel of either a Diesel or compound with little, if any, alteration of its mass moment.

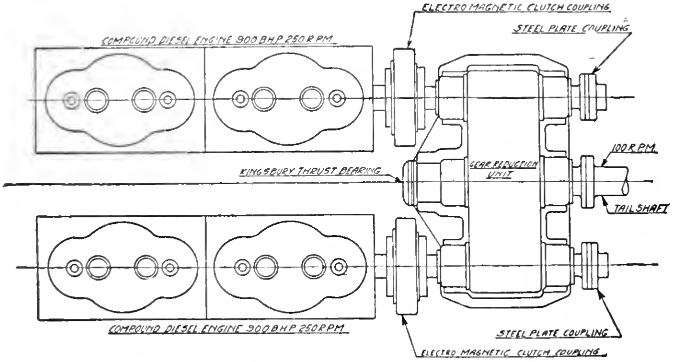


Fig. 12 Plan of Proposed Installation of Propelling Machinery

The clutch is characterized by two kinds of torque operating by opposite phenomena; the greater the differential or relative velocity between the driver and driven parts, the greater the torque available for starting and for bringing up to synchronism. This phenomenon also provides for slipping and continuous operation at all fractional speeds by means of the loaded secondary effect acting as an induction motor.

The air-gap clutch drives through magnetic flux comprising four ring elements, two of which are driving and two of which are driven. The flywheel proper accommodates an exciting coil producing the magnetic flux. At all fractional speeds or while this clutch is slipping, this magneto induction generates large currents in the driven elements which are now acting as short-circuited secondaries, producing heavy drag torques under perfect control by varying the amount of coil excitation. However, when the speed comes up in the vicinity of synchronism, locking occurs.

Proposed Installation of Propelling Machinery

Fig. 12 shows in plan view a proposed installation of the propelling machinery, securing the advantage to both engine and tail shaft of entire freedom of each to run at its own best speed. A propeller for a given ship has a speed at which it gives its most efficient performance; likewise a combustion engine can be built most economically and to give its best performance for a given size if the designer is given entire freedom to choose the best engine speed, a condition which is extremely desirable.

With this clutch and the engine combination shown in Fig. 1 several very important advantages are secured:

a There are available on a single propeller all the advantages and flexibility of a multiple engine equipment, where one engine may be shut down and completely disconnected for inspection, valve grinding, etc., and yet the ship be going forward at three-quarters its normal speed.

b Complete flexibility of the electric drive without the expense, weight and space of the electric generators and motors and the cumbersome electric control equipment for handling the heavy currents in maneuvering, and the double losses of generators and motors which are of substantial amount and a constant drag on plant and fuel economy.

c The simplest form of gear drive may be employed because the magnetic clutch allows the pinion to be a complete "floater." The pinion may thus accommodate itself to any want of precision and all sorts of idiosyncrasies of the main gear and teeth without shock. Any irregularities existing have to deal only with the small masses of the pinion itself and its stub shaft, being completely isolated from the large mass moments of the engine.

d The well-known irregularities in torque of any reciprocating engine and circumferential oscillation are entirely smoothed out by the air gap in the clutch and are not permitted to reach the pinion; its specific tooth operation is thus completely safeguarded. The crash and general irregularities of the engine torques thus never reach the pinion and therefore can have no effect on the complete smoothness of its performance.

e The torque, being under complete control, can be lowered so as to safeguard the equipment against overloading, especially when sailing in obstructed harbors, near derelicts, and where floating obstacles are likely to be encountered by the propeller blades, thus providing an important emergency disconnecting gear breaking away from the large engine masses and allowing the propeller to "stop in its tracks" through the self-interruptibility of the magnetic clutch when reduced to fractional underload condition. In this way many disasters to the propelling machinery and interruptions to the service may be avoided.

f Nearly all revolving machinery is subject to periods, sometimes running into severe "criticals." These criticals always develop from the irregularities in torque of the mass moments within the engine pitted against outside mass moments aft. This can occur only when these are solidly coupled with each other, but if instead they are isolated, as by the cushion or air gap of a magnetic clutch of proper design, these troublesome criticals with their excessive stresses are completely suppressed and can never develop.

g The combustion engine is reversible and runs equally well in either direction. The magnetic clutch solves completely all maneuvering problems, and in this way stands out in bold contrast to the difficult maneuvering and reversing conditions introduced by the non-reversible turbine.

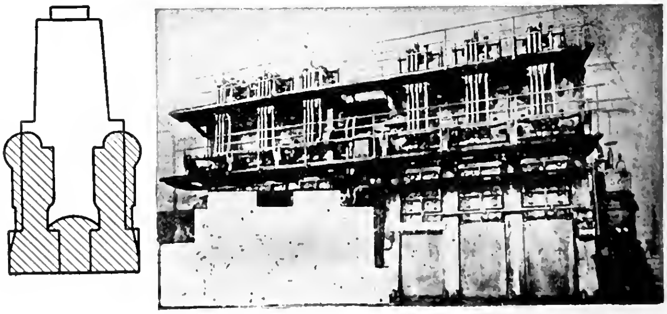


Fig. 13 Comparison between Compound Divided-Unit Geared Drive and Standard Diesel Engine Delivering to Tail Shaft the Same Power and Speed

As seen in Fig. 12, a Kingsbury or equivalent thrust bearing may be located forward of the main gear. The pinions flanking the gear on either side are not necessarily diametrically disposed. This gives an excellent distribution of the machinery, compact engine-room arrangement, and ample space for the small oil-engine generating sets for the ship, which incidentally also supply the clutches with the very trifling amount of energy and any other auxiliaries outboard of the engines. The engines are completely reversing and self-air starting, and either engine may be completely isolated at will. When either engine is running, the other may be gradually or quickly started up by means of the clutch instead of by air, if desired. The engines under this arrangement run with extreme smoothness and

(Continued on page 74)

Commercial Operation of Airplanes

By L. B. Lent,[1] New York, N. Y.

In order that those interested in the operation of airplanes for commercial use may have an idea of what may be expected of a properly organized and operated service, the author presents in this paper an analysis of the record of the Air Mail Service of the United States Post Office Department for the year ending Sept. 30, 1921. The operating record, the cost of operation, and the life and maintenance of planes and of engines furnish a basis upon which the author points out possible improvements, the most important in present practice being the use of efficient commercial planes equipped with a thoroughly reliable power plant. In regard to cost of operation, the author states that the total operating cost should not exceed 70 cents per plane-mile for single-engine planes of not over 400 hp.

It is the purpose of the author to present in this paper some information which may be found useful by those interested in the operation of airplanes as vehicles of transportation for profit.

Up to the present time there has been comparatively little such commercial service in this country and consequently there have been very few data developed which might be useful in an investigation and analysis of this important subject.

Commercial flying in Europe is developing very fast, but the conditions under which it is performed make it difficult to apply the information gained to operations in this country. A large part of the foreign service is devoted to carrying passengers and the operations are in many cases partly supported by government subsidies, and nearly all of the elements of cost are such as to make it difficult to apply the results to any proposed operation in the United States.

Fortunately, however, there has been a service in operation in the United States since May 15, 1918, which has rapidly developed into what may be properly characterized as the largest commercial operation of airplanes in the world; namely, the Air Mail Service operated by the Post Office Department of the United States Government.

This service is operated by a purely civilian personnel and is very similar in nearly all respects to that which would be effective in a purely commercial service. Moreover, the records of this service have been carefully kept during its entire existence, and if properly interpreted can be used as a basis for estimating the probable performance and costs of any commercial service of the immediate future.

Organization

The Transcontinental Air Mail Service operates daily in each direction between New York and San Francisco, an air-line distance of 2630 miles and a total daily mileage of 5260 miles. The various flying fields and the principal buildings located on each are as follows:

New York (Hazelhurst).	1 Hangar 1 Storage hangar 1 Office building
Bellefonte, Pa.	1 Hangar
Cleveland, Ohio	1 Hangar 1 Workshop 1 Office
Bryan, Ohio	1 Hangar
Chicago, Ill.	1 Large repair hangar 1 Storage hangar 1 Operating hangar 1 Office 1 Stock house 1 Test house with stands 1 Oil house
Iowa City, Ia.	1 Office; stock room and repair building 1 Tent hangar
Omaha, Neb.	1 Hangar
North Platte, Neb.	1 Hangar
Cheyenne, Wyo.	1 Hangar
Rock Springs, Wyo.	1 Tent hangar
Salt Lake City, Utah.	1 Hangar
Elko, Nev.	1 Tent hangar
Reno, Nev.	1 Hangar
San Francisco, Cal.	1 Hangar 1 Office

The airplane equipment now used in this service has been standardized and all machines are the De Haviland planes equipped with Liberty 12 engines turned over to the Mail Service by the War and Navy Departments. These machines are rebuilt to accommodate the mail load in the cockpit in front of the pilot and strengthened to meet the hard service required. A considerable amount of this equipment was turned over as indicated, and is stored in two buildings in Newark, N. J. This constitutes the major source of supplies for the entire service.

The total investment of the Air Mail Service is about $800,000, of which $133,000 is for buildings, trucks, tools, etc., the remainder being for airplanes and engines.

Equipment

It is obvious that the actual number of planes in serviceable condition and under repair may vary from day to day, but the following is a fair average figure for the year: In serviceable condition, 50; under repair, 18; awaiting repair, 30. During the year, 27 planes were damaged beyond repair and salvaged, while 48 new planes were placed in service and about 20 experimental types retired.

Engine equipment has always been in excess of actual need, because of the large number of Liberty engines turned over by the Army. The total number of Liberty 12A (Army high-compression) and Liberty 12N (Navy low-compression), developing about 400 and 350 hp., respectively, in use is about as follows: Engines in serviceable condition, in planes and as spares, 150; engines under and awaiting repair, 350. The foregoing figures do not represent the engine requirements for such a service.

An accurate estimate of the total engine requirements for this service can be based on the following: 22 engines are required for the 22 planes in daily service; at least 1 spare engine should be at each major station, making a total of 14; another supply of approximately 30 engines is necessary for those constantly in transit between the various fields and the overhaul stations, including the period of overhaul, making a total of 66 engines. If this service is properly organized a total of 75 engines is ample for successful operation of such a service.

Operating Record

The operating record for the past year is shown in Table 1. For a thorough understanding of these figures it is thought well to briefly outline the conditions under which the service was rendered.

The transcontinental course is divided into 13 legs of approximately 200 miles each with stations as given above. The route is divided into three major divisions—the eastern, extending from New York to Chicago, the central, from Chicago to Rock Springs, Wyo., and the western, from Rock Springs to San Francisco, Cal. It has been found that in the western trip the flight is hampered by prevailing westerly head winds, whereas the eastern trip is, of course, assisted by such conditions. Inasmuch as the supply of gas for each ship is approximately only four hours at cruising speed, it becomes necessary in many flights to stop at intermediate stations for service. Many times coming east, planes fly a major leg of approximately 400 miles. The number of such trips per month is somewhat varied, depending upon conditions.

While the available space in each plane accommodates 400 lb. of mail, the average amount carried per trip for the entire year was less than 150 lb. per plane per trip. These planes carry a pilot only, who flies a leg in one direction each day, returning to his home station the next day and laying off the third day. This schedule is, of course, subject to change, which occasionally results in a pilot doing more mileage than indicated.

The total flying time per day varies with the weather conditions, but the average speed for the entire year was 86.3 miles per hour; for the last 6 months (during better weather conditions) the average speed was 87.88 miles per hour. Up to the present time all flights have been made during the day. An indication of what is possible in a continuous trip, is the record established on Feb. 22 and 23, when the mail was carried from San Francisco to New York in elapsed time of 33 hr. 20 min., or a total flying time of 26 hr. 50 min. The fastest scheduled train time between these two

---

[1] Chief, Engineering and Survey Division, Aerial Transport Corp., Mem. Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

points is 92 hr. The eastbound trip from Chicago to New York has been made in 5 hr. 30 min. The flight from Salt Lake City to San Francisco was made on Oct. 14, 1921, in 6 hr. 1 min. elapsed time, or a total flying time of 5 hr. 32 min. over a distance of 624 miles. The fastest train between these two points is scheduled for 24 hr. 15 min. It follows that, for the transcontinental distance, daylight flying only will cut train time about in half, and with night flying, the time is cut to about one third.

The operation record discloses one feature of special merit given under "Per Cent of Performance." It will be noted that the percentage of performance for the year was 88.33 per cent. For the last 6 months this average was 98 per cent, of which 96 per cent was actually completed on scheduled time. In view of the fact that the Pennsylvania Railroad in their printed timetables boasts of a train performance of 95.6 per cent on time, the foregoing record for the last 6 months is truly remarkable.

As to the effect of weather on the service, it will be noted that defaulted trips and the number of forced landings show a decided increase during the winter months. An interesting fact is that the number of forced landings from mechanical trouble also shows an increase, which would indicate the effect of cold weather on the quality of work done by mechanics.

During the year ten pilots and one mechanic were killed—four of the former during the last six months. This is equivalent to one pilot killed for each 169,756 miles flown.

TABLE 1 OPERATING RECORD OF THE U. S. AIR MAIL SERVICE. OCT., 1920—SEPT., 1921

Month	Trips Possible (Scheduled)	Trips Attempted	Trips Defaulted	Trips Uncompleted	Weather Encountered		Mileage Possible	Miles Traveled	Per Cent of Performance[1]	Mail Carried, Lb.	Forced Landings Due to	
					Trips in fog	Trips clear					Mech.	Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1920												
October	750	593	157	57	190	143	154,700	123,274	79.68	89,541½	54	59
November	758	575	183	77	230	345	156,076	114,750	73.50	87,302	85	69
December	884	662	222	105	347	315	178,776	127,306	71.21	89,942	89	138
1921												
January	850	697	153	87	253	444	171,900	132,679	77.18	84,435	117	131
February	782	660	122	71	310	350	159,238	130,431	81.90	88,135	82	122
March	918	871	47	59	351	520	185,652	171,593	92.42	110,117	64	123
April	884	837	47	36	370	467	178,776	171,156	95.73	117,778	79	107
May [2]	850	833	17	20	320	513	171,900	168,397	97.96	115,073	72	81
June [3]	832	829	3	10	268	561	168,636	166,956	99.00	105,838	57	51
July	624	623	1	6	65	558	131,450	130,555	99.31	77,276	34	29
August	693	689	4	13	129	560	136,974	134,549	98.22	81,680	32	30
September	657	651	6	8	180	471	127,706	125,914	98.59	88,401	13	26
Total	9482	8520	962	549	3013	5247	1,921,784	1,697,560	88.33	1,138,518	778	966

[1] For last 6 months, 98 per cent.

[2] May 31 — Last day's service on New York-Washington Route.

[3] June 30 — Last day's service on St. Louis-Twin Cities Division.

During the year 27 planes were so badly wrecked that they were salvaged instead of repaired, and there were 145 forced landings which resulted in damage to planes necessitating repair work; of these about 100 required major repairs. Obviously some were damaged more than once during the year. A further analysis of this as affecting the cost of operation is given later.

The large number of actual forced landings from mechanical trouble and other causes will no doubt attract attention as being excessive, and it should be noted that of the total number of forced landings only 172 resulted in damage to the planes. This is one plane damaged for every 10 forced landings.

It should, in fairness, be pointed out that all landings other than those regularly scheduled, even though made on an intermediate Air Mail field, are counted as forced landings.

Cost of Operation

The consolidated costs of operating this service for the yearly period chosen are shown in Table 2. It will be noted that there is no charge for interest on investment. This is of course a proper charge in any commercial service and should be added in any estimated costs. By making such a charge and adding it to the total costs shown in the table, it is thought that the figures resulting are safe and conservative for estimating the operating costs for any similar commercial line. In fact, the figures shown can be very much bettered if advantage is taken of the experience gained in the Mail Service.

An analysis and consolidation of the figures given in this table are shown in Table 3, which give the service and unit costs and the costs per mile for the year. In this table the total costs are divided into three general headings, namely, Overhead, Flying and Maintenance. Under the head of Overhead is included departmental overhead, office force and watchmen, motorcycles and trucks, rent, light, fuel, power, telephone, water and radio. Maintenance consists of miscellaneous, mechanics, helpers, repairs and accessories, and warehouse charges. Flying consists of gasoline, grease and oil, and pilots.

It will be noted that the mileages as shown in column 9, Table 1 and in column 3, Table 3, do not agree. The former figure is miles traveled in regular mail trips and the latter is "total miles" flown, which includes ferry trips, test flights and retrieving planes. The "total miles" is the proper basis for estimating costs per mile.

An examination of Table 2 will show that the largest items of cost are gasoline (15.0 per cent of the total), repairs and accessories (18.6 per cent), pilots (12.8 per cent) and mechanics and helpers (14.5 per cent). Considering these separately, it is seen that the gasoline cost cannot be materially reduced by the use of more economical engines, for even if engine economy is increased, say, 10 per cent (which is difficult), the total reduction would only be one tenth of 15 per cent, or 1.5 per cent of the total.

The largest item, repairs and accessories (column 4), is susceptible of considerable reduction. The elimination of forced landings and the damage resulting therefrom would largely reduce this charge. Fair wear and tear on places is relatively very small.

The basis on which pilots are paid, namely $2000 per annum, plus 5, 6, and 7 cents per mile flown, has proved to be very satisfactory, and more so than any other basis tried by the Mail Service. In all cases it supplies the men with a living wage and develops efficient service, which is rewarded by increased pay.

The pay for chief mechanics in the Mail Service averages $2000 per annum; other mechanics from $1400 to $1800 per annum; helpers from $1100 to $1400 per annum; and watchman and helpers from $900 to $1200 per annum.

An explanation of column 7 is essential. In most of the major fields the Mail Service was supplied with flying field, and in some cases with hangar facilities, by the cities in which they are located, without charge therefor. Rent for field and hangar facilities is paid at New York, Bellefonte, Pa., Cleveland, Ohio, Bryan, Ohio, Chicago, Illinois, and College Park, Maryland (training station). At all other cities west of Chicago no rent is paid.

This item of cost is therefore comparatively low and should be modified if used for estimating similar costs of a commercial line, unless similar arrangements could be made with various municipalities for use of municipal airdromes. If commercial companies have to purchase flying fields, as well as field equipment, it would of course, add largely to the capital costs, as well as the operating charges. It is believed, however, that very favorable arrangements can be made with most of the large cities in the United States for proper landing-field facilities.

The analysis shows that the average yearly operating cost per flying mile was 80.86 cents and for the last six months of the year, 71.83 cents.

As mentioned herein, if the cost is reduced to a ton-mile basis, the figures resulting will be unreliable; a fair basis of comparison is on a plane-mile basis, for it costs but little more to fly a plane loaded to its capacity than it does to fly it empty. It is a safe statement that under the conditions prevailing in the Mail Service, the cost per plane-mile will soon be reduced to the neighborhood of 60 cents.

With proper equipment and organization, a commercial service, using single-engine planes of not over 400 hp. each and flying only one round trip per day over a distance equivalent to that of the transcontinental service, can be accomplished for a total cost not exceeding 50 cents per flying mile. This is especially true if more than one round trip per day is flown.

TABLE 2 CONSOLIDATED COSTS OF OPERATING U. S. AIR MAIL SERVICE FOR YEAR ENDING OCT. 1, 1921

Month	Gasoline	Grease and oil	Repairs and accessories	Miscellaneous	Motorcycles and trucks	Rent, light, fuel, power, telephone and water	Office force and watchmen	Warehouse	Pilots	Mechanics and helpers	Radio	Departmental overhead charge	Total
October, 1920	$20,959.94	$3,840.85	$22,571.32	$16,264.81	$5,827.95	$1,813.91	$8,501.34	....	$10,989.85	$21,204.47	.....	$5,448.06	$117,422.50
November	17,635.97	3,920.24	18,626.50	16,511.32	5,197.57	2,511.17	9,081.01	....	16,460.01	19,510.24	....	6,289.69	115,743.72
December	17,783.40	3,814.04	21,072.46	21,529.14	5,199.62	2,954.73	12,310.29	....	15,816.07	20,561.00	....	4,031.01	125,094.76
January, 1921	18,558.44	4,303.29	28,006.76	18,790.86	6,010.07	3,405.32	12,136.21	....	15,432.13	19,583.76	....	3,880.59	130,107.43
February	18,823.70	3,824.18	17,689.41	20,461.60	6,581.91	3,904.82	12,025.41	....	16,246.74	18,388.37	4,744.81	3,775.30	126,469.25
March	22,896.17	4,970.33	33,531.52	17,827.86	6,832.30	3,792.54	11,270.34	....	17,851.24	19,912.92	4,583.10	3,725.75	147,194.07
April	22,956.61	5,554.75	31,321.32	12,829.73	6,457.85	2,559.12	12,254.29	4,277.72	17,965.49	18,577.71	9,834.41	3,301.64	147,890.64
July	21,752.41	4,870.72	15,217.83	10,551.05	5,666.64	2,277.41	11,868.01	1,484.67	17,708.11	16,595.44	11,184.21	3,578.24	125,754.74
June	19,624.08	4,544.75	27,921.81	8,236.00	3,918.51	1,110.32	9,493.98	4,524.12	18,897.17	17,343.52	8,602.67	3,262.90	127,479.83
July	15,314.14	3,377.71	20,312.72	9,759.07	3,966.08	1,209.05	9,304.52	5,357.08	11,636.14	13,912.18	9,629.07	3,021.35	109,799.11
August	14,711.17	3,513.35	20,948.14	9,011.39	4,215.42	1,205.92	8,323.45	5,571.94	14,764.20	15,008.99	5,571.22	2,882.58	106,986.98
September	13,530.82	3,232.78	18,742.45	8,690.28	3,941.77	1,725.59	9,280.02	5,415.87	14,329.58	14,773.75	5,772.40	2,799.83	102,998.45
Totals	$224,546.85	$49,766.99	$275,962.24	$170,469.11	$63,815.69	$28,469.90	$125,848.87	$29,631.40	$191,096.73	$215,375.35	$59,921.89	$45,996.94	$1,482,921.48
Per Cent of Total Cost	15.0	3.35	18.6	11.5	4.3	1.91	8.5	2.0	12.8	14.5	4.01	3.1	

LIFE AND MAINTENANCE OF PLANES

It may be noticed that in the foregoing no account is made of depreciation. In the present service no plane has remained intact long enough to wear out and so determine even approximately a rate of depreciation. Before a plane wears out most or all of the parts are replaced and charged up under that heading, or else it is so completely destroyed as to be retired from service, charged off entirely, with credit for such material as can be salvaged for use in repairing other planes. A fairly accurate idea of the rate of this destruction may be had from the following data:

During the year 27 planes were so badly damaged that repairs were not undertaken, these planes being salvaged. Of the many forced landings, 145 resulted in "crashes" necessitating repairs, of which about 100 necessitated major repair work. The number of "crashes" is thus about 10 per cent of the total number of forced landings. The average for the year is one "crash" for each 17,560 miles flown with mail; and for the last six months, 31,211 miles.

The number of planes required as original equipment to operate such a service as the Mail Service and the rate and cost of replacement may be estimated as follows:

1 plane for each of the 22 daily flights	22
1 spare plane for each daily flight, to be used in case of "last-minute" trouble with scheduled plane	22
1 spare plane at each of the 14 fields which may be in transit to and from repair shops and under repair........................	14
Total..	58

Mail-Service experience shows that after a plane has had about 450 hours in the air it is necessary to lay it up for a thorough inspection and reconditioning. This operation involves some labor and material (usually new wing covers, etc.) and costs an average of $600 per plane. The total time required for such an operation at present is about two months. Since the flying hours per year are 21,952, the total number of such overhauls is 21,952 ÷ 450 or 49. The record also shows that about 100 planes were so damaged as to require repairs. The average cost of these repairs was about $1000 each and the average time about two months per plane. The present rate of repair and overhaul for the entire Mail Service is about 11 to 12 planes per month.

It is thus seen that about 14 to 15 planes (about one for each 14 fields) must be constantly traveling to and from the repair shops and undergoing repairs. It should be stated that some plane repairs are made at many fields as well as at the main repair shop in Chicago.

An analysis of the above shows that:

- *a* The initial plane equipment is about one (1) plane for each 82 miles of scheduled flight
- *b* One (1) plane repair for each 16,975 scheduled miles flown
- *c* One (1) plane reconditioned for each 34,000 scheduled miles flown
- *d* One (1) complete "washout" for each 62,000 scheduled miles flown
- *e* The cost of conditioning 49 planes at $600 each = 1.8 cents per mile
- *f* The cost of repairing 100 planes at $1000 each = 6.0 cents per mile
- *g* The cost of "washouts" for 27 planes at $4000 each = 6.5 cents per mile
- *h* Total cost for repairs and replacements = 14.3 cents per mile.

This amounts to a total estimated cost of $238,000. Deducting this amount from the total in column 4 ($275,962), leaves $37,962, which it is fair to assume is the cost of engine overhauls and repairs, or about 2.25 cents per mile.

LIFE AND MAINTENANCE OF ENGINES

The record of engines actually replaced, repaired, salvaged, etc., is so involved in the records that it is difficult to discover the exact data. However, methods of maintenance, inspection and overhaul have been so developed and improved that it is more accurate to base an estimate on the present rate than to use total figures for the year.

Present methods of conditioning and caring for engines have resulted in an almost uniform service of 100 hours of running between each overhaul, unless an engine is damaged in some "crash." Since a total daily mileage with mail is about 5300 miles and the average speed is 86.3 miles per hour, the daily flying time is about 62 hours per day. To this must be added the time consumed in warming up engines (6 hours) and the time of engines on various test stands, so that the total daily time for the service is 80 engine-hours. This is equivalent to 0.8 engine replaced per day. Crashes, mechanical troubles and causes other than plain wear bring up the rate to just about 1.0 engine per flying day. While this may seem high, considering that only twenty-two planes fly regularly each day, it is not, for 100 flying hours per

engine between overhauls is a very high figure and can only be attained by the most efficient and systematic conditioning and repair methods in force in the Mail Service. While about 300 engines were used, the whole 300 were not actually overhauled, as many new engines were placed in service during this period. The yearly demand is, however, at about a rate of 300 engines per year.

This running time of 100 hours between overhauls is true even after the second and sometimes the third overhaul, the necessary replacements being made at each overhaul.

The average cost of an engine overhaul is as follows:

One mechanic and one helper, 10 days, 8 hours each	80 hours
Washing and valve grinding by other men	8 hours
Carburetor work, cleaning and adjusting	4 hours
Ignition work	4 hours
Block testing	6 hours
Total	102 hours

This total time may vary 50 per cent each way, but it is a fair average. The average labor cost is about $75 per engine. The average cost of the necessary material replacements, based on Government war prices, is $150. The average total cost is therefore $225 per engine. This cost may seem excessive, but is justified by the amount of careful and accurate work done, which is the real reason for 100 hours of further satisfactory service.

TABLE 3 ANALYSIS AND CONSOLIDATION OF FIGURES GIVEN IN TABLE 4 FOR PERIOD OCT. 1, 1920–SEPT. 30, 1921

	Service and Unit Cost					Cost Per Mile, Cents		
	Gasoline gal. (1)	Total Time, hr.-min. (2)	Total miles (3)	Cost per hour (4)	Cost per mile (5)	Overhead (6)	Flying (7)	Maintenance (8)
1920								
October	60,010	1,852-56	154,486	$66.71	$0.80	$0.18	$0.23	$0.39
November	50,573	1,651-20	139,759	73.57	0.87	0.21	0.27	0 39
December	49,841	1,569-28	131,040	83.60	1 00	0.23	0.29	0.48
1921								
January	51,427	1,668-51	139,609	81.78	0.98	0.23	0.27	0 48
February	68,698	1,733-01	153,655	76.08	0.92	0.25	0.27	0.40
March	66,929	2,103-36	186,625	73 18	0.82	0.19	0.25	0.38
April	66,854	2,175-04	186,950	67 98	0.79	0.18	0 25	0 36
May	64,322	2,041-29	181,216	61.08	0.69	0.19	0 24	0 26
June	57,873	2,118-27	185,091	59.33	0.69	0.15	0.23	0 31
July	48,625	1,644-26	118,684	66.76	0.73	0 18	0.22	0 33
August	47,818	1,696-30	149,432	63 06	0.71	0 16	0.22	0.33
September	43,953	1,667-07	148,099	61.72	0.70	0 17	0 21	0.32
Total	676,926	21,952-18	1,891,646	$69.57	$0 808			
				Avge.	for year	$0 1933	$0.246	$0 368

Total average for year . 80 66 cents per mile

Avge. for last 6 months....$0.1716 $0.2282 $0 3182

Total Average for last 6 months 71 83 cents per mile

Average speed for the year $\frac{\text{Col. 3}}{\text{Col. 2}} = 86.3$ miles per hour

Average speed for the last 6 months = 87.88 miles per hour

Right here may be a proper place to point out the economy resulting from such methods. More frequent overhauls and a less satisfactory service record are a sure sequel to a lack of attention to the power plant, which is *the* important element. To illustrate, consider briefly the procedure employed in the Air Mail Service. Even a new engine is not assumed to be in proper condition. Nothing is "taken for granted." The method of conditioning of such an engine, and in general all engines after repair, may be briefly described as follows:

Even new motors are at least partly torn down to inspect the condition and fit of cylinders, pistons, piston rings, crankshaft and pin bearings, gears, etc. Crankshafts are especially checked for alignment, end play and proper condition of thrust bearings. Carburetors are carefully inspected and calibrated for both mechanical perfection and proper functioning, as are also generators, distributors, and other parts. The usual procedure is to put on every engine a set of carburetors, distributors, etc., which have already been inspected and calibrated in workrooms devoted to this special work. Such similar parts removed are turned into these departments for conditioning. All gaskets, especially those at carburetor and intake-manifold connections, are replaced with those whose condition is known to be good, thus preventing possible air leaks and improper carburation. Rubber-hose connections on gas, oil and water pipes are all replaced when necessary and it is usually necessary.

By using a timing disk, the correct timing of camshafts, valves and distributors is checked and the distributors for each bank of cylinders are synchronized both mechanically and electrically to within a quarter of a degree.

After a complete inspection and conditioning, the engine is run for about two hours at speeds varying from 300 to 1400 r.p.m. and also with wide-open throttle. After test, the engine is washed with kerosene and again inspected externally, and any faults which may have developed are corrected. All nuts are tightened, if necessary, all cotter pins are placed and securely fastened and the general condition made up to a *standard* and passed by the chief mechanic.

The foregoing constitutes a presentation of the mail record for the year, together with its analysis and certain deductions from this record, based on the author's experience in and knowledge of the Air Mail Service. It is assumed that some of the lessons learned in this service, and perhaps some of the opinions as to what improvements are possible, will be interesting, and they are accordingly set forth in the following paragraphs.

Improvements Possible

First and foremost, it must be apparent that the actual pay load (or mail load) carried is very small for planes powered with 400 hp., and if the cost of operation be reduced to a ton-mile basis, the results are not encouraging. However, it must also be evident that the costs really apply to a specific number of plane-miles, and not ton-miles, for it costs almost exactly as much to fly a plane empty as it does loaded. The mail planes carried an average load throughout the year of only about 133 lb. per trip attempted. As previously mentioned, the maximum mail load possible to put into the space available in the fuselage of these converted war machines was about 400 lb. These machines are now being remodeled to carry 850 lb. of mail. The important point, however, is that in a plane designed for commercial service, using the same Liberty 12, 400-hp. engine, and *costing no more to operate*, the *pay load should be all of 2000 lb.*

Another important point to bear in mind is that the mail planes make *one* trip each way per day. A commercial service operating several trips per day could do so without greatly increased overhead costs and at a considerably reduced unit cost of service. Just what the reduction would be, would depend, of course, on the number of trips made. Hence it may be fairly said that a most apparent improvement is a use of planes designed for commercial service, those which will carry a maximum load economically over a reasonable distance at high speed.

The cruising speed of such a plane should not be much, if any, less than 100 miles per hour. Head winds of 30 to 40 miles per hour are sometimes encountered, which slow down the actual ground speed by exactly that much, which means that the 100-miles-per-hour plane is traveling at (100–40) 60 miles, whereas a plane having an air speed of 130 miles per hour, or 30 per cent more, is doing (130–40) 90 miles per hour over the ground, or 50 per cent more than the 100-mile plane. Some carrying capacity should be sacrificed to speed in order to enable a plane to make time under adverse weather conditions. High speed also decreases the time required to fly a given distance and also decreases the total gas consumption, an important consideration, as will be seen.

Inasmuch as the fuel load is one of the factors in determining the size and weight of the plane, it is important that the fuel be used as efficiently as possible. The actual cost of the fuel burned is not so important as the reduction in the total fuel weight for a given flight, for this saving in weight may be put into added cargo; or, more important, it can be put into added power-plant weight, which will, in large measure, prevent forced landings. Overall

efficiency involves (*a*) reducing plane resistance, (*b*) increasing the loading per unit of wing area, (*c*) using a propeller of the highest possible efficiency, (*d*) running the engine, or engines, at nearly full power and (*e*) using engines of high specific economy. The effect of a proper combination of the above elements is to reduce first cost by using relatively small machines to do the work of large ones, which in turn decreases capital costs and further reduces the operating expense.

The question of reducing plane resistance, that is, increasing the ratio of the lift to drag (L/D), seems to have been given serious attention only in military or racing machines and has been ignored on commercial machines, especially of the multi-engined type. As the gross load which can be carried is equal to the thrust of the propeller multiplied by the ratio of the lift to drag (L/D) at a given speed, and as a low-resistance plane does not need to weigh more than one of higher resistance, it follows that the "usefulness" will be increased by increasing the lift-drag ratio, but in much greater proportion. For example, in an airplane making 100 miles per hour with a propeller efficiency of 80 per cent, the net available thrust is 3 lb. per engine hp. If the L/D ratio of such a plane is 6 at this speed, the total weight-carrying ability is 18 lb. per hp. If the weight empty is 10 lb. per hp., the net weight of the useful load is 8 lb. per hp. By increasing the lift-drag ratio to 9 instead of 6, the total weight-carrying ability will be 27 lb. per hp., and the net useful load 17 lb. per hp. instead of 8 lb. In other words, an increase of 50 per cent in the L/D ratio increases the useful load capacity 112 per cent, a gain by no means negligible and, in fact, not difficult to obtain.

Real airplane engine efficiency is not in fuel economy alone, although a low specific fuel consumption is essential. Contrary to more or less popular ideas, reliability is not a direct function of weight per horsepower only, for the mere addition of weight does not necessarily add reliability. As a matter of fact, the designers of recognized ability agree that airplane engines should be as light as possible. Lightness is an inherent quality of airplane-engine design and does not necessarily mean decreasing the factor of safety of important members below a safe figure. Making valves (for instance) much heavier would seriously interfere with their proper functioning as valves.

The best engines have a combined fuel and oil consumption of seldom less than 0.5 lb. per hp-hr. at full load, so that fuel and oil for a 5-hour flight is 2.5 lb. per hp., or more than the weight of a modern engine. It is therefore important that the fuel be consumed efficiently.

If the desire to "take off" quickly and climb rapidly is met, there must be much more power available than is required for economical cruising, and since all present types of engines have a higher *specific* fuel consumption when throttled, it follows that best results are to be obtained by some method which permits engine speed reduction with a nearly wide-open throttle. The variable-pitch propeller for single-engine machines is one solution of the problem.

Another solution is the multiple-unit power plant; that is, two or more power units driving a single propeller.

This brings us to a most important consideration in commercial operation, viz., the prevention of forced landings. Their elimination will practically insure 100 per cent service all of the time and materially reduce the amount of the largest single item of cost, viz., that of repairs of planes and engines. Until we can fly planes from one airdrome to another with certainty, even at reduced speed, we cannot obtain the best service records nor the lowest operating costs.

The author ventures to predict that the next most successful departure from a single-engine machine will be the multiple-unit plant using a single propeller. And further, that such a power plant will not consist of separate complete engines geared to one "stick," but perhaps of two, three, or even more, banks of cylinders on a common crankcase, which will also house the necessary shafts, gears and clutches in this rigid structure. All the units of such a power plant could be used in "taking off" and climbing to a safe altitude, after which one or more could be shut down and held in reserve to be put into service if required. Engine and propeller speeds in such a unit could be made such as to give maximum combined efficiency under normal operating conditions. The weight of fuel saved in such an efficient combination, over a reasonable length of flight, will compensate for the added weight of the "relay" units of such a power plant.

The experience of the Mail Service, as well as that of others, is that a landing chassis of ample strength saves many a "crash" in a forced landing, as well as in a hard landing on the flying field. If the landing gear stays together, much damage is averted, which otherwise might be serious. Large wheels and large tires have proved to be most useful, especially in rough and soft ground. In fact, the Mail Service uses Handley-Page bomber wheels on the DH4 machines as standard equipment and has operated them on soft fields, which would have been impossible with standard DH4 wheels and tires. Nor did these larger tires and wheels slow down speed to any noticeable extent. There seems to be almost no reasonable limit to the size of wheels which may advantageously be used.

In a large number of forced landings, where damage results, the front end of the machine only suffers, such as the propeller and the radiator and possibly the front end of the fuselage when the plane "noses over." This necessitates laying up the whole plane during the repair operation. To obviate this, some designers are using a separate quick-detachable nose, which carries the engine. The advantages of such construction are too obvious to warrant discussion.

It will no doubt be found desirable in commercial machines to use unit construction as much as possible, so that replacements may be quickly made and the damaged unit repaired at leisure.

Intelligent engineering attention to the many details of airplane design will be well repaid in more efficient operation and decreased cost. We do not need to seek for new or radical types with which to run a commercial service. The present types, properly engined, will deliver a most satisfactory service if handled by a properly organized and operated personnel.

Some idea of what a commercial plane, using a 400-hp. engine, can do, is given in the following data, which are based on accurate knowledge of proved performance. Such a plane having a lift-drift radio of 9, will not weigh over 5 lb. per sq. ft. of wing area. Besides fuel and oil for a 4-hour flight, together with a pilot and other accessories, such a plane will carry an actual pay load of 3000 lb. at a cruising speed of 100 miles per hour with the engine throttled down so as to be developing only two-thirds of its maximum 400 hp. Such a plane will cost no more to operate than the mail planes discussed herein.

CONCLUSIONS

While both the design and operating methods are susceptible of improvement, it is believed that the following are warranted from our present knowledge and experience:

- *a* The number of planes required for a given service is about one (1) for each 100 miles of scheduled flight
- *b* The number of spare engines required is about 50 per cent of the total number of planes
- *c* The total operating cost should not exceed 70 cents per plane-mile for single-engine planes of not over 400 hp.
- *d* Scheduled flights over reasonably long distances can be at least twice as fast as the fastest scheduled trains, flying in daylight only, and at least three times as fast if night flying is done
- *e* Night flying can be successfully accomplished with reliable power plants and a proper equipment of airdrome beacons and landing flares
- *f* The most important and desirable improvement in present practice are: the use of efficient commercial planes equipped with a thoroughly reliable power plant
- *g* The United States is admirably adapted to commercial airplane service because: (1) the large area permits long flying distances; (2) large centers of population well distributed over this area should supply ample business, and, (3) fast transportation of both goods and passengers is more in demand than in any other country in the world
- *h* The development of a large commercial service will furnish a reserve of planes, pilots, mechanics and other highly skilled men which would undoubtedly be the most valuable and effective part of our national defense.

Process Charts and Their Place in Management

By FRANK B. GILBRETH[1] and L. M. GILBRETH, MONTCLAIR, N. J.

The process chart is a device for visualizing a process as a means of improving it. Every detail of a process is more or less affected by every other detail; therefore the entire process must be presented in such form that it can be visualized all at once before any changes are made in any of its subdivisions. In any subdivision of the process under examination, any changes made without due consideration of all the decisions and all the motions that precede and follow that subdivision will often be found unsuited to the ultimate plan of operation.

In this paper the authors point out the place of the process chart in management and present established working data used successfully in numerous working installations for many years. They also point out its simplicity, field of application, its relation to standardization, etc., etc.

While the process-chart methods will be found helpful in any kind of work and under all forms of management, the best results can come, the authors state, only where there is a mechanism of management that will enforce and make repetitive the conditions of the standards.

The Process Chart is a device for visualizing a process as a means of improving it. Every detail of a process is more or less affected by every other detail; therefore the entire process must be presented in such form that it can be visualized all at once before any changes are made in any of its subdivisions. In any subdivision of the process under examination, any changes made without due consideration of *all* the decisions and all the motions that precede and follow that subdivision will often be found unsuited to the ultimate plan of operation.

The process chart is a record of present conditions. It presents, in simple, easily understood, compact form, data which must be collected and examined before any improvement in existing conditions and methods is undertaken. Even if existing conditions are apparently satisfactory, the chart is useful as presenting much information in condensed form.

The process chart serves as an indicator of profitable changes. It assists in preventing "inventing downward," and stimulates invention that is cumulative and of permanent value. It is not only the first step in visualizing the *one best way to do work*, but is useful in every stage of deriving it.

This paper presents established working data used successfully in numerous installations for many years.

Field of Application of the Process Chart

The process chart lends itself equally well to the routine of production, selling, accounting and finance. It presents both simple and complicated problems easily and successfully; it provides records that are comparable; it assists in solving problems of notification and interdepartmental discrepancies, and it makes possible the more efficient utilization of similarities in different kinds of work and in the transfer of skill.

During the stress of unexpected rush in production, it is often considered advisable to continue existing practice in present processes, even though inefficient. On the other hand, when production is normal or slow, it is more generally conceded that processes can profitably be bettered.

The use of this process-chart procedure permits recording the existing and proposed methods and changes without the slightest fear of disturbing or disrupting the actual work itself, and also regardless of whether business conditions are usual or unusual.

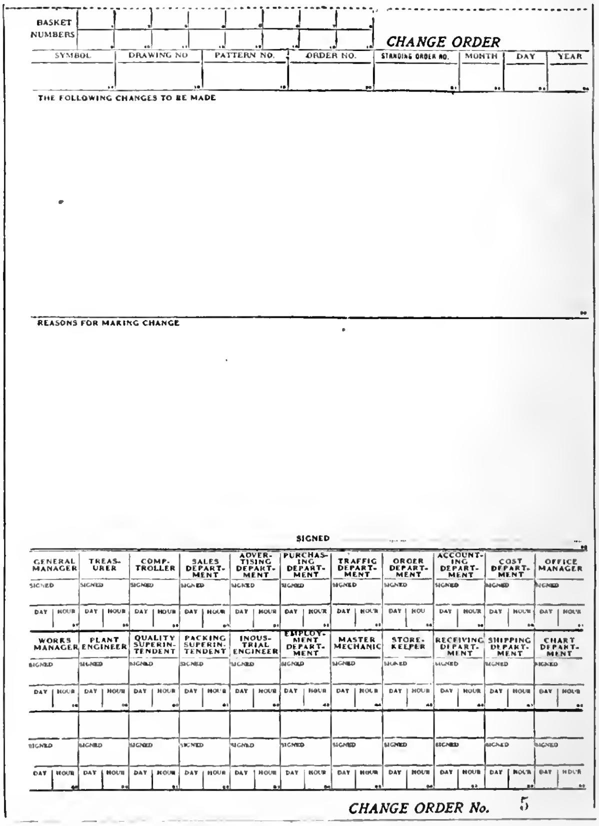
Those who are interested in improving their process of production should utilize times of industrial depression for that purpose. Many concerns are now taking such action; many more could undoubtedly enter upon such procedure of scrutinizing all their processes with the idea of putting them in the best possible condition, if they knew a simple procedure of such analysis.

Simplicity of the Process Chart

The aim of the process chart is to present information regarding existing and proposed processes in such simple form that such information can become available to and usable by the greatest possible number of people in an organization before any changes whatever are actually made, so that the special knowledge and suggestions of those in positions of minor importance can be fully utilized.

The time has passed—if it ever existed—when the engineer prided himself upon the abstruse material that he studied and presented. Today engineering ranks with the other sciences in conveying ideas in a form that is immediately usable. We avoid "translating," interpreting and adapting, thus eliminating waste.

The process chart has met the tests of a satisfactory teaching device from the psychological standpoint, as well as of a satisfactory working device from the engineering standpoint. It shows the planned process as well as the present process, and therefore gains the coöperation of those affected. In many instances recording industrial processes in process-chart form has resulted in astonishing improvements.



BASKET NUMBERS

CHANGE ORDER

SYMBOL	DRAWING NO	PATTERN NO.	ORDER NO.	STANDING ORDER NO.	MONTH	DAY	YEAR

THE FOLLOWING CHANGES TO BE MADE

REASONS FOR MAKING CHANGE

SIGNED

GENERAL MANAGER	TREASURER	COMPTROLLER	SALES DEPARTMENT	ADVERTISING DEPARTMENT	PURCHASING DEPARTMENT	TRAFFIC DEPARTMENT	ORDER DEPARTMENT	ACCOUNTING DEPARTMENT	COST DEPARTMENT	OFFICE MANAGER
SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED
DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOU	DAY | HOUR	DAY | HOUR	DAY | HOUR
WORKS MANAGER	PLANT ENGINEER	QUALITY SUPERINTENDENT	PACKING SUPERINTENDENT	INDUSTRIAL ENGINEER	EMPLOYMENT DEPARTMENT	MASTER MECHANIC	STOREKEEPER	RECEIVING DEPARTMENT	SHIPPING DEPARTMENT	CHART DEPARTMENT
SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED
DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR
SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED
DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR	DAY | HOUR

CHANGE ORDER No. 5

Fig. 1 Standard Change-Order Blank

Note that all blank forms should be thus numbered in each blank space to be filled out for describing clearly the One Best Way to Learn Work

Collecting the Information

Process-chart notes and information should be collected and set down in sketch form by a highly intelligent man, preferably with an engineering training and experience, but who need not necessarily have been previously familiar with the actual details of the processes. In fact, the unbiased eye of an intelligent and experienced process-chart maker usually brings better results than does the study of a less keen man with more special information regarding present practices of the processes. The mere act of investigating sufficiently to make the notes in good enough condition for the draftsman to copy invariably results in many ideas and suggestions for improvement, and all of these suggestions, good and bad, should be retained and filed together with the description of the process chart. These suggestions and proposed

---

[1] President, Frank B. Gilbreth, Inc., Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

improvements must be later explained to others, such as boards of directors, managers and foremen, and for best results also to certain workmen and clerks who have special craft or process knowledge. To overcome the obstacles due to habit, worship of tradition and prejudice, the more intelligence shown by the process-chart recorder, the sooner hearty coöperation of all concerned will be secured. Any one can make this form of process chart with no previous experience in making such charts, but the more experience one has in making them, the more certain standard combinations of operations, inspection and transporting can be transferred bodily to advantage to the charts of proposed processes.

Utilizing Suggestions

A new viewpoint concerning old conditions invariably comes to those members of the organization who have become so accustomed to the traditional method that they cannot easily visualize a new method without prejudice until they actually see it in a new graphical form. After the rough notes of the process-chart maker have been redrawn and blueprinted, they are later exhibited in the executives' theater.

If discussions arise as to the correctness of the presentation of the existing facts, or as to further details of the operations being studied, as shown by the simple symbols of the process chart, the room can be darkened and inexpensive glass diapositives projected on the wall. In addition, those present may be supplied with a special pocket folding sterescope for use with the same glass diapositives.

As soon as the old or existing process is understood, a process chart of a better sequence and kind of operations which compose it is made. The procedure for this is the same for all cases as far as they are carried for the time being, but of course those processes which warrant the most study should be carried farthest in the process-chart procedure. The more people who see the process chart and the greater detail into which the regular process charts are divided, the more suggestions for improvement will come in.

Relation to Standardization

There is no process that warrants a process chart that does not warrant a "write-up" or "written system." The more care taken in making the written system, the more will develop the need for and appreciation of the value of clearly defined written standards. The better and the more detail in which the written system is developed, the better and easier will the standards and standing orders be developed.

Standards in writing should be made, even if there is not the managerial mechanism necessary to enforce and maintain them. Standards made even with enforcing mechanism absent will hasten the day when the enforcing and maintaining mechanism will be installed and continuously operated. The procedure of making the standards will invariably lead to the simplifying and improving of the various steps as shown on the process chart.

If it is desirable to study, improve and still further identify the subject-matter of each part of the process chart, it should be submitted to the regular routine process of standardization. A standard is a matter of degree. In its best form it is identified and defined with all the care and precision of the best practice for making the standing orders. The range, however, is dependent upon the degree of perfection with which provision has been made for enforcing and maintaining standards.

While on the subject of range, it is well to call attention to the remarkable attempts of Germany and Holland to provide national standards. These standards already cover a very wide field, from the style of the hand lettering and the rulings to be used on the paper on which the standards themselves are printed, to a metal seat for a harvester, tractor or tank. The range, in fact, already covers a surprisingly wide list of things which have not been properly standardized in America, and is intended eventually to cover everything that is manufactured in quantity, or that will for any other reason reduce costs or improve quality. Although there is much to criticise in these foreign standards, they are highly meritorious, worthy of continuous and careful attention, and a great credit to those who have devised them.

It must be remembered that the kind of standard adopted will affect the process almost invariably. Therefore standardization must be considered if the *one best way to do work* is to be derived.

Particular attention should be called to the fact that the creation of national standards of manufacture, even to the smallest components of the arts and trades, means also the stabilization of employment and business in general, because manufacturers without sufficient orders in their regular lines of business to keep going will find it more profitable, in many instances, to manufacture the

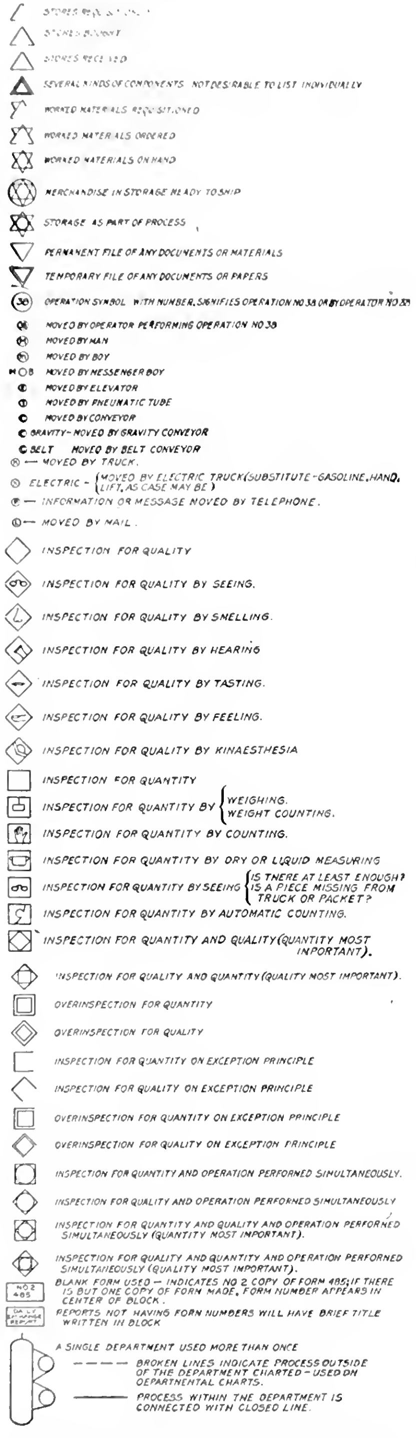


Fig. 2 Standard Symbols for Process Charts

national standards and thus to turn their stores inventories into money immediately, rather than let their specially trained and skilled men leave them, with all the disadvantages of a high labor turnover. Here is an endless spiral of benefit, for the more chances there are for a manufacturer to dispose of his inventory for cash and keep his organization together a little longer, even in times of general timidity, the more he will dare be a purchaser of raw material, for the process for such emergencies can be standardized and ready. The result is standardization, with stabilization of employment, a quick capital turnover and a low labor turnover.

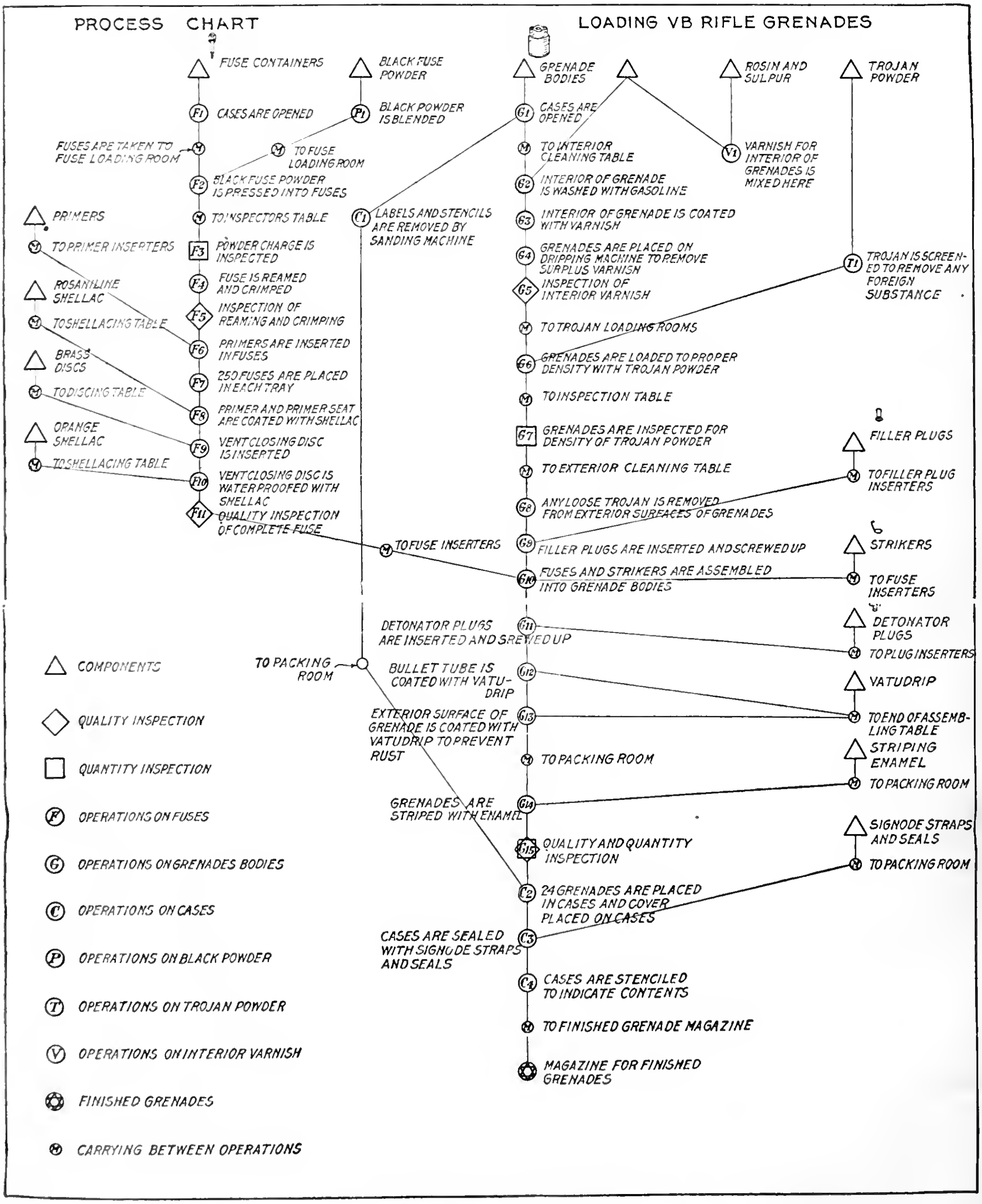


Fig. 3 Process Chart for Loading Rifle Grenades

Many fear standardization of the component elements of a process chart as something from which, once done, it will be difficult to escape. For the purpose of allaying such groundless fears, the standard change order, Fig. 1, has been provided. This, when signed by the authorized party, instantly changes, or for a certain instance, or a certain time, waives the existing standard whether it relates to a thing, a method, a procedure or a process. It will be noted that this change-order blank contains provisions for the notification of, and acknowledgment of receipt of notification of, all persons who are concerned with, or interested in, the change.

Note that in the lower right-hand corners of the various spaces in Fig. 1 there are small consecutive numbers. This is standardized to agree with write-ups and standing orders for using standard blank forms. It not only makes the writing of the standing order more simple, exact and clear, but it also shortens the time of the learning period for using these blank forms. This is a valuable feature at all times, but particularly useful during the transitory period of installing new methods of management.

Experience shows that if process charts are made use of, exceedingly few of the existing blank forms survive in their present form. The savings that can be made in any large organization resulting from submitting them to the test of this process will invariably prove it to be a good investment.

If all departments of the United States Government would adopt two features, namely:

- *a* Put small numbers in each space to be filled out on all of its blank forms, and
- *b* Make write-ups and standing orders of exactly how each blank form is to be filled out

and would then make a survey and criticism in accordance with the known laws of micromotion study, the resulting savings would be astounding.

We believe that, as a result, not one per cent of present blank forms would remain unchanged. All Government blank forms that we have seen violate all laws of motion study and learning methods of least waste.

The standing order is for enforcing standards and other standing orders. This has already been described in a paper before this Society.

The more detail in which the standing order is made, the better. The more the procedure is described by it, the greater will be the improvements and the greater the automaticity resulting.[1]

If any operation of the process shown in the process chart is one that will sufficiently affect similar work, then motion study should be made of each part of the process, and the degree to which the motion study should be carried depends upon the opportunities existing therein for savings.

If the operations are highly repetitive or consist of parts or subdivisions that can be transferred to the study of many other operations, then micromotion studies already made can be referred to; also new and further micromotion studies may be warranted in order that the details of method with the exact times of each of the individual subdivisions of the cycle of motions, or "therbligs," as they are called, that compose the one best way known, may be recorded for constant and cumulative improvement. Such motion study can be best visualized if seen in chart form, and similar process charts can be made of any or all of the large or small circles, squares and diamonds shown on the process charts. These subdivided motion charts can be made of each and all of the cycles in any given operation. Much benefit can often be derived, even if such motion charts are made roughly. For best results, and especially when complete records are required, such, for example, as when the process charts are of work that is highly repetitive, micromotion charts can be made which will give the maximum amount of analysis and visualization of component parts of the existing and proposed processes. These can be still further visualized by the chronocyclegraph process. Both the chronocyclegraph and the micromotion process have been described before the Society, and more recent development in these methods and devices for visualizing existing and proposed processes will be the subject of a later paper.

The records of the micromotion study and the chronocyclegraph methods and devices present permanently all the facts in such form that they can be used at any time. These photographic records can be studied as slowly as desired, regardless of how fast the motions of the process were actually made, and the marvels of the details of superskill, unknown and unrecognized even by those who possess it, can be studied at will, leisurely and intensively, by learners everywhere, far as well as near. If desired, these errorless records may be used only as far as to fill the need of present requirements, or they may be laid away until further needs demand further study, such records being in such perfect detail that they are practically as usable when old as when new. These permanent records of complete sequences of details of complete processes furnish the foundation of the best kind of trade and industrial education, namely, the dissemination of detailed instructions as to the synthesized processes of the best workers obtainable.

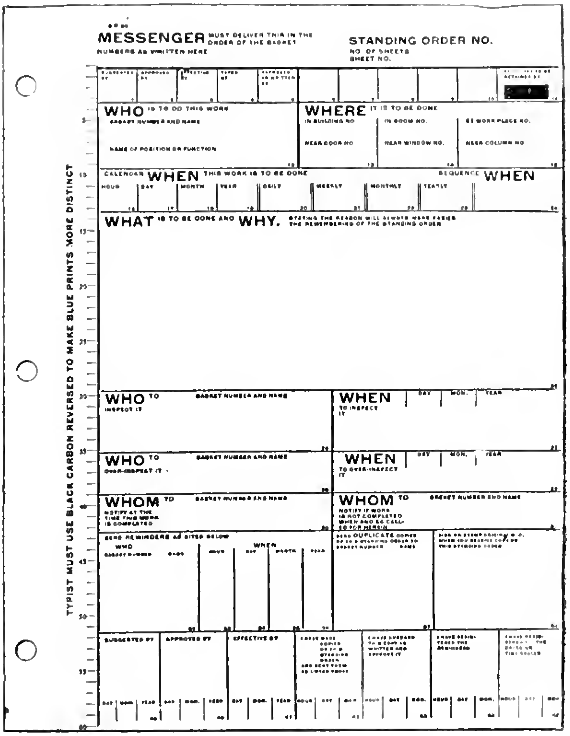
These synthesized records of details of processes in turn may be further combined and large units of standard practice become available for the synthesis of complete operations in process charts.

While the process-chart methods will be helpful in any kind of work and under all forms of management, the best results can come only where there is a mechanism of management that will enforce and make repetitive the conditions of the standards.

Mechanism of Making Process Charts

There are shown herewith:

- *a* The symbols used with their meanings (Fig. 2)
- *b* Completed process chart (Fig. 3)
- *c* Accompanying forms (Fig. 4)
- *d* Illustrations of collecting and using data.



MESSENGER MUST DELIVER THIS IN THE ORDER OF THE BASKET NUMBERS AS WRITTEN HERE

STANDING ORDER NO.
NO. OF SHEETS
SHEET NO.

WHO IS TO DO THIS WORK
BASKET NUMBER AND NAME
NAME OF POSITION OR FUNCTION

WHERE IT IS TO BE DONE
IN BUILDING NO
IN ROOM NO.
AT WORK PLACE NO.
NEAR DOOR NO
NEAR WINDOW NO.
NEAR COLUMN NO

CALENDAR WHEN THIS WORK IS TO BE DONE
HOUR DAY MONTH YEAR
SEQUENCE WHEN
DAILY WEEKLY MONTHLY YEARLY

WHAT IS TO BE DONE AND WHY. STATING THE REASON WILL ALWAYS MAKE EASIER THE REMEMBERING OF THE STANDING ORDER

WHO TO INSPECT IT BASKET NUMBER AND NAME
WHEN TO INSPECT IT DAY MON. YEAR

WHO TO OVER-INSPECT IT BASKET NUMBER AND NAME
WHEN TO OVER-INSPECT IT DAY MON. YEAR

WHOM TO NOTIFY AT THE TIME THIS WORK IS COMPLETED BASKET NUMBER AND NAME
WHOM TO NOTIFY IF WORK IS NOT COMPLETED WHEN AND AS CALLED FOR HEREIN BASKET NUMBER AND NAME

SEND REMINDERS AS DATED BELOW
WHO BASKET NUMBER NAME
WHEN HOUR DAY MONTH YEAR

SEND DUPLICATE COPIES

SUGGESTED BY
APPROVED BY
EFFECTIVE BY

TYPIST MUST USE BLACK CARBON REVERSED TO MAKE BLUE PRINTS MORE DISTINCT

Fig. 4 Standing-Order Blank

Summary

The procedure for making, examining and improving a process is, therefore, preferably as follows:

a Examine process and record with rough notes and stereoscopic diapositives the existing process in detail

b Have draftsman copy rough notes in form for blueprinting, photographic projection and exhibition to executives and others

c Show the diapositives with stereoscope and lantern slides of process charts in executives' theater to executives and workers

d Improve present methods by the use of —

1. Suggestion system
2. Written description of new methods or "write-ups," "manuals," "codes," "written systems," as they are variously called
3. Standards
4. Standing orders

(Continued on page 70)

---

[1] See Psychology of Management; Applied Motion Study; and *Bulletin of the Taylor Society* for June 1921.

DISCUSSION OF ENGINEERING EDUCATION

(Continued from page 7)

problems of the world had been accomplished without laboratories.

E. H. Sniffin[3] had always held the opinion that it might be a good thing if professors were to enter business life and later return to the schools. Probably ninety per cent of those graduated from engineering schools would be judged ten years later upon the basis of their qualities rather than their engineering knowledge.

Joseph W. Roe[4] said that it was utterly impossible for those who were trying to teach the specialist in an undergraduate course in any way to meet the full demands. The best that they could do was to send out men wellgrounded in the fundamentals, and in his opinion, more important than that, with a right attitude toward work and toward investigation.

H. B. Shaw[5] could see no reason why some engineering schools should not develop along the line of requiring the arts degree for entrance, and others develop graduate courses in engineering. There was really no need to have all of the engineering schools teaching engineering in exactly the same way.

K. G. Matheson[6] felt that the so-called collateral studies should more largely predominate as being essential to the highest type of the engineer; but unless something like adequate compensation could be offered so as to attract the very highest type of intellectual ability and training, that the standards of engineering colleges would certainly become more mediocre.

D. C. Jackson[7] wished to emphasize the fact that while Mr. Otterson suggested in his paper that the test in the engineering school seemed to be of a character that solely selected the encyclopedic mind, the truth was that the tests are, as a rule, intended to select men from the standpoint of the powers of analysis and synthesis. These powers were in fact those which led to a final balanced judgment and the accomplishment of the object was one that could not be left solely to the engineering school to bring about the best results. It was necessary to have the advice of the industrialists to arrive at the highest type of professional engineers. Professor Jackson's own definition of it, some years back, was that the highest type of professional engineer is one that can conceive exact ideas in important engineering works or in engineering affairs.

J. P. Jackson[8] defined an engineer as a man who should be in charge of all phases of industry except financial investigation. Most of the men who had discussed the subject spoke of the importance of character and he felt that stressing this before an engineering faculty every few days would do a great deal of good.

C. A. Adams[9] said that he had not heard anything so encouraging from the standpoint of teachers of engineering for many years as the two papers presented by the industrialists. It showed a great advance in the attitude of industry toward engineering education, and the emphasis of the two papers, could be summed up in a very few words, namely, more emphasis on fundamentals, the ability to think rather than a superficial knowledge of the practical side of the subject, the amount of cramming necessary. Our engineering education was for the most part brutally superficial. The men did not get the fundamentals. He would guarantee to take 100 picked graduates of electrical engineering schools of this country and show that 90 per cent of them had no grasp whatever of the fundamentals of maximum and minimum; that is, a sound grasp, a visualizing of phenomena and seeing through the mathematical equation into the physics beyond, so understanding the physics that they could express it directly in mathematical form. That was the difficulty with our engineering education. What was wanted in every engineer and every student was the habit of honest thought, the habit of demanding a sound foundation for his analysis in whatever field he is, and of building soundly on that foundation, and not the habit of thinking he knows something and throwing from his memory the things which he ought to know.

L. W. Wallace[10] said that the world, in general, had come to learn that the engineering type of mind, the engineering type of approach, was the correct type of mind and type of approach to apply to many of the perplexing problems that were confronting society and the world today. It should be instilled into young engineers that they were in not only a learned profession, but in one of great potential possibilities, and that it was not only their duty to do their technical work well but to make their ability and training and analytical minds felt in dealing with the social problems of the day.

W. H. Carrier[11] agreed with Professor Adams in his statement that ninety out of one hundred students did not understand the fundamentals of engineering. In many cases he had personally found it necessary to learn a great many of these fundamentals after he had left college. He was not a particularly backward student, but there were too many things to do, and not enough time in which to emphasize the fundamentals. The tendency of all education had been to place too much emphasis on quantity rather than quality. Students had not been taught to reason. They had been pushed along too fast.

R. L. Sackett[12] said that one thing characteristic of the curriculum of Pennsylvania State College that could not be blamed on the industries, was a lack of elasticity. All students who entered, say, the electrical course was not made in the same mold. They might be of equal mental capacity, they might have good minds, but it was quite impossible at the present time, in the present state of the art that vocationally they should be the same to any extent at the beginning of their college course.

Frank B. Gilbreth[13] said that in training the individual for accomplishment, judgment should not be developed until after all facilities for measurements had been exhausted. He was not prepared, however, to criticise the product of professors who had done such wonderful work for such inadequate rates of compensation. Something would have to be done whereby the graduates from the colleges, when they came to the industries, would be prepared to do something to teach the worker.

Sidney Ash[14] wished to emphasize a point that Mr. Pratt had brought out in his paper, namely, that there had been a considerable improvement in several all-around capacity of the average technical student turned out in recent years. He came in contact with a great many men taken in by his company as college graduates, and thought that this improvement was about 30 per cent in the types that were coming through today.

PREVENTION OF WASTES IN INDUSTRY

(Continued from page 10)

trol of the movement of material through the works from one operation to another and from one department to another; inadequate, or entire absence of provision for teaching or training operators, and minor executives; absence of effective means of recording attainments of workers, foremen, etc., so that their standing does not so much depend on actual performance as upon other things, some of them little if at all related to the work, such as nationality, religion, membership in secret organizations or fraternities, and sometimes plain graft.

When we set out to discuss an acknowledged fault our picture is necessarily rather a dark one. There is, of course, a bright side. We must work to make that bright side still brighter.

The greatest and most effective incentive for the prevention of industrial wastes is disarmament, so to speak; the cultivation of friendly relations between all those concerned in industrial enterprises; and the maintenance of such a system as will enable every man, from the highest to the lowest, to know what he is responsible for, to whom he is responsible, and that he personally will be credited and rewarded in proportion to service rendered.

---

[3] Mgr. Power Dept., Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

[4] Professor Industrial Engineering, New York University, New York, N. Y. Mem.Am.Soc.M.E.

[5] Henry L. Doherty & Co., New York, N. Y.

[6] Georgia Inst. of Technology, Atlanta, Ga.

[7] Professor Electrical Engineering, Massachusetts Institute of Technology. Mem.Am.Soc.M.E.

[8] Assistant to Chairman, Industrial Relations Committee, Philadelphia Chamber of Commerce, Philadelphia, Pa. Mem.Am.Soc.M.E.

[9] Professor, Harvard Engineering School, Cambridge, Mass. Mem.Am.Soc.M.E.

[10] Executive Secretary, American Engineering Council, F.A.E.S., Washington, D. C. Mem.Am.Soc.M.E.

[11] Carrier Engineering Corporation, Newark, N. J. Mem.Am.Soc.M.E.

[12] Dean of Engineering, Pennsylvania State College, State College, Pa. Mem.Am.Soc.M.E.

[13] President, Frank B. Gilbreth, Inc., Montclair, N. J. Mem.Am.Soc.M.E.

[14] Educational Dept., General Electric Co., Pittsfield, Mass.

Radio Ship Control

Details of the Mechanical Changes Made in the U. S. S. "Iowa," by Means of Which the Vessel Was Operated and Maneuvered From a Distant Control Ship

By REAR-ADMIRAL R. S. GRIFFIN,[1] U. S. N., RETIRED

Rear-Admiral R. S. Griffin

THE bombing tests which were carried out last summer against the old battleship *Iowa* (now designated Coast Battleship No. 4), during which that ship was operated and maneuvered under her own power without the presence on board of any of her officers or crew, created so much public interest that it has been suggested that a description of the mechanical changes that were made in her power equipment would be of interest to the members of The American Society of Mechanical Engineers.

The *Iowa* is a ship 360 ft. long on the water line, of 72.2 ft. beam, and at a draft of water of 24 ft. has a displacement of 11,346 tons. She has twin-screw vertical triple-expansion engines of 11,800 indicated horsepower which are capable of giving her a speed of 17-knots. They are, of course, condensing.

The problem presented was so to modify her power plant that the ship would be susceptible of control by radio energy from another ship, both as to speed and direction, without any person being on board; that under this condition she should be capable of steaming for at least two hours at a speed of about 10 knots; and that means should be provided for automatically stopping the engines and shutting off the oil supply to the boilers after fifteen minutes of operation following a failure of the radio control.

The first part of the problem obviously pointed to an oil equipment as the only one that could be considered, and as the *Iowa* was a coal-burning ship it became necessary to transform some of her boilers to oil-burning. The speed requirement of 10 knots necessitated the development of but a small fraction of full power, and therefore it was necessary to convert only one-half her boilers for steaming at a very moderate rate of combustion.

The boilers are of the Scotch or return fire-tube type, and therefore are not so well adapted to oil burning as are water-tube boilers. However, for the power that had to be developed, this presented no difficulty. The lining with firebrick of the combustion chambers and the front end of the furnaces, and the protection of the joint of furnace and combustion-chamber sheet were the only alterations that were necessary to the fire side of the boilers. Alterations to the furnace fronts were, of course, necessary to accommodate the oil burners. All these alterations are indicated in Fig. 1.

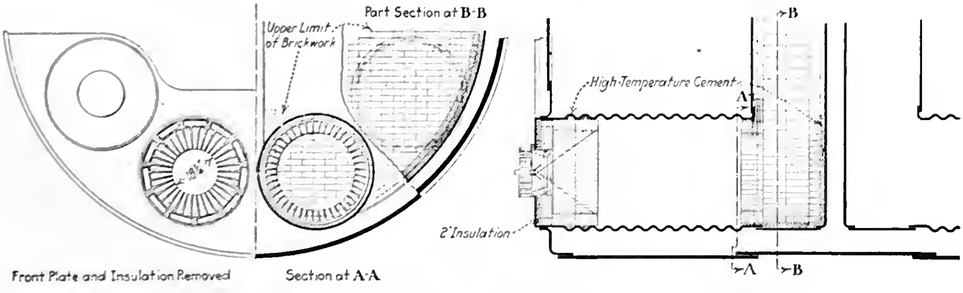


Fig. 1 Alterations in Scotch Marine Boiler to Adapt It to Oil Burning

Fuel-oil pumps were installed and were equipped with stop valves in their steam lines such that these valves could be instantly closed by radio signal if it were desired to stop the engines, or automatically in case of low water in the boilers.

In order to maintain a uniform water level, it was necessary to install feedwater regulators, which controlled the speed of the feed pumps in the usual manner.

The storage of fuel necessary to provide the continuous steaming laid down in the problem was easily effected by utilizing a few of the double-bottom compartments.

The only alterations that were necessary to the engines were certain modifications of the throttles to permit of radio control. The type of engines made it necessary to design for the condition in which the engines would be just turning over before the crew abandoned the ship, the function of the radio control then being to open the throttle to the extent necessary to secure the desired speed—which had been determined by test—and also to stop the engines should it be necessary so to do. The control was so effective that no difficulty whatever was experienced in controlling the speed, slowing down being accomplished in twenty seconds and increase to full speed in three minutes.

Such auxiliaries as air pumps, circulating pumps and bilge pumps, the operation of which at normal speed would have no material influence on either the speed of the engines or the boiler conditions, were unaffected by the conditions of the problem and were untouched after once having been set at the proper speed of operation.

The points that have thus far been mentioned pertain solely to the propulsion of the ship. In order to maneuver her, which was one of the most important considerations in connection with the bombing tests, it was necessary that the steam steering engine be under as complete radio control as the main engines. Ordinarily this is accomplished through wire-rope transmission from the steering wheel on the bridge to the shaft which operates the engine-control valve. For this test a small motor was installed and connected by chain drive to the control-valve shaft. It was provided with an automatic reversing contactor controller which was operated through the radio-control panel or automatically through the gyro clutch. It proved to be an admirable substitute for the hand steering wheel.

Naturally, considerable electric energy would be necessary to operate the various radio circuits and apparatus, but as operation of the ship's electric plant during the test would unnecessarily complicate the problem without supplying any useful information respecting the results which it was desired to accomplish, it was decided to provide storage batteries and control panels for the several circuits.

In preparation for radio control the oil-fuel pumps, the air and circulating pumps, the feed pumps, an air compressor and a bilge pump are put in operation, and the steering engine warmed up and operated by hand control. When normal conditions are

---

[1] Washington, D. C. Hon. Mem.Am.Soc.M.E.

established, the main engines are started and kept running at dead-slow speed, the bridge control of steering engine thrown out, all batteries connected to bus bars, and switches to radio-control instruments and gyro compass, and steering-engine motor thrown in. Everything is now in readiness for radio control and the signal given to "abandon ship." As soon as the boats that take off the crew are clear of the ship, she is immediately put under radio control by the control ship, which in this case was the battleship *Ohio*, which during the past two years has rendered excellent service in radio experimental work under the Bureau of Engineering of the Navy Department.

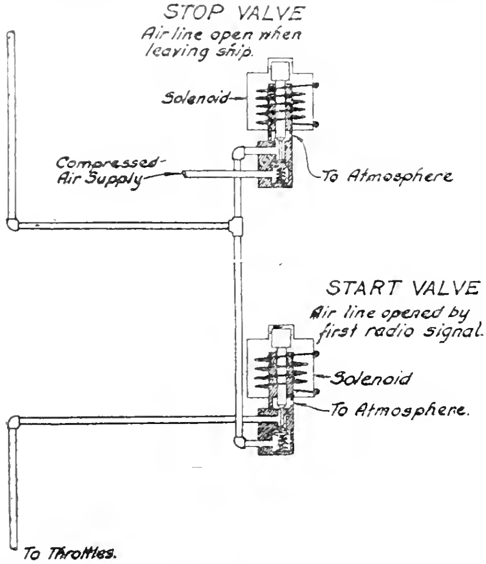


FIG. 2 RADIO-CONTROL VALVES FOR OPENING AND CLOSING THROTTLE-CONTROL VALVE, FIG. 3

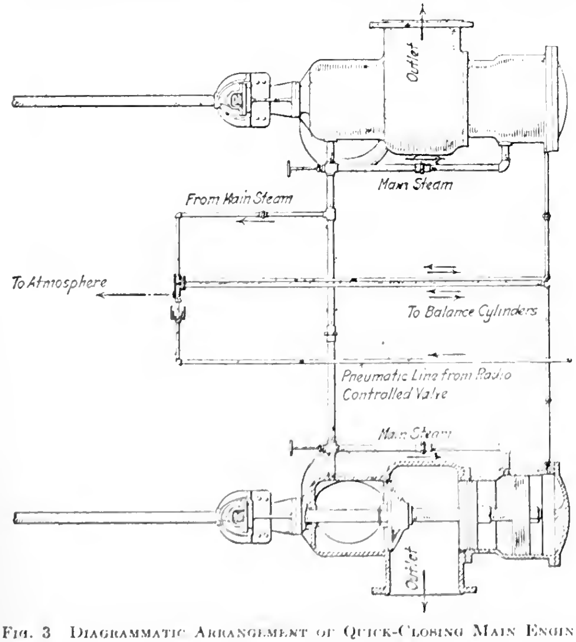


FIG. 3 DIAGRAMMATIC ARRANGEMENT OF QUICK-CLOSING MAIN ENGINE THROTTLE VALVES AND CONTROL VALVE

The method of control will be understood from the following:

When the air compressor is started, pressure is brought up to the "stop valve," Fig. 2, which may be called the master radio-control valve. This valve is then energized from the ship's control room, by which action air is admitted to the balance cylinder of a quick-closing valve in the steam line to the fuel-oil pump and up to the "start valve," as indicated in the sketch. The first signal from the control ship energizes the "start valve," Fig. 2, which admits air to the piston of the throttle-control valve shown in Fig. 3. This throws the piston to the left, shuts off steam from the upper balance pistons, and the throttles open to the extent necessary for the desired speed, the lower balance piston being smaller in diameter than the upper one.

The opening by the control ship of the radio circuit to "start valve" closes the valve to air pressure under the action of the spring, and the pressure in the line to throttle-control valve is released. When this occurs, the piston valve is thrown far enough to the right to uncover the port to the steam pipes leading to the upper chambers of the balance cylinders and the throttles close under the action of the steam pressure.

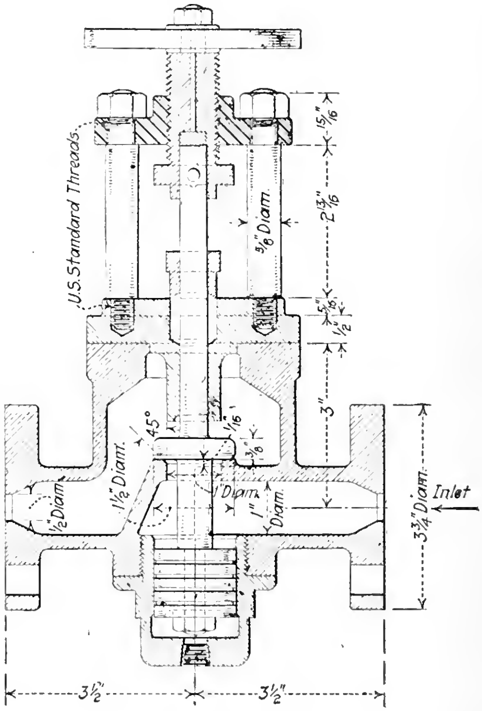


FIG. 4 TYPE OF VALVE USED IN CONTROLLING FUEL-OIL PUMP

Similar action takes place when it is desired to stop the fuel-oil pump. The proper opening of the steam valve to this pump having been previously determined and air pressure being on its balance piston, a radio signal releases the air pressure, whereupon the valve closes automatically under the influence of steam pressure on the other side of the balance piston. The throttles close at the same time. Fig. 4 shows the type of valve used.

The requirement that the engines and the fuel-oil pumps should stop automatically after a certain lapse of time in case radio control failed was accomplished by the introduction of a "time limit clock" in the "stop valve" circuit. After the lapse of time for which it had been set, the clock opened this circuit, and the steam valves to the oil pumps and the engine throttles closed in the manner previously described.

The low-water alarm was of the usual type except that, instead of blowing a whistle, the steam was used to operate a piston that opened the "stop valve" circuit.

The principal radio-control apparatus is covered by patents of John Hays Hammond, Jr., who permitted the free use of it for this test. It was constructed by the General Electric Company under the supervision of Mr. Hammond and the Bureau of Engi-

(*Continued on page 70*)

Code for Displacement Compressors and Blowers

Preliminary Draft of the Fifth in the Series of Nineteen Codes in Course of Preparation by the A.S.M.E. Committee on Power Test Codes

In 1918 the Power Test Committee of the A.S.M.E. was reorganized to revise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, consisting of a Main Committee of 25 under the chairmanship of Fred R. Low, and 19 Individual Committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the fifth of these codes to be completed, namely, the Test Code for Displacement Compressors and Blowers.

The Individual Committee which developed this Code is headed by Mr. Paul Diserens as Chairman, and consists of the following men: Hugh V. Conrad, John F. G. Miller, Snowden B. Redfield,[1] Carl G. Sprado, Charles Prentice Turner, and John T. Wilkin. This Committee will welcome suggestions for corrections or additions to this draft of its Code and especially desires constructive comment on Pars. 10 and 10a. These should be addressed to the Chairman, care of The American Society of Mechanical Engineers.

Introduction

1 The code for displacement compressors and blowers is intended as a guide for testing reciprocating piston compressors and blowers, as well as rotary compressors and blowers of the positive displacement type. The tables for data and results apply to complete units, including compressor element and driving element, but the code itself constitutes a set of rules for the test of the compressor element only. For the driving element the codes for steam engines, steam turbines, internal-combustion engines, water wheels, etc., depending upon the method of drive, should be consulted and followed.

Object

2 In accordance with the "General Instructions," the object of the test should be determined and recorded. If the object relates to the fulfilment of a contract guarantee, an agreement should be made between the interested parties concerning all matters about which dispute may arise, as noted in Par. 2 of the "General Instructions," and the points agreed upon should be stated in the report of the test.

Measurements

3 The measurements to be made in any test of a compressor or blower have for their purpose the determination of the following essential quantities:

(*a*) The quantity of air or gas compressed and delivered expressed in cubic feet in terms of gas or air under intake conditions of temperature and pressure
(*b*) The average intake and discharge pressures
(*c*) The power required to compress and deliver the measured amount of air or gas handled
(*d*) The amount of steam, electrical energy or fuel, depending upon the method of drive, consumed by the driving element during the test.

In order to arrive at these quantities and as a means of interpreting them, the following measurements are necessary:

(*e*) Diameter and stroke of compressor cylinders, or equivalent dimensions for positive rotary blower
(*f*) Diameter of piston rods
(*g*) Number and dimensions of intercoolers and aftercoolers
(*h*) Principal dimensions of driving element (See appropriate code)
(*i*) Speed in r.p.m. and total number of revolutions
(*j*) Indicated horsepower in compressor and driving cylinders (steam engine, internal-combustion engine, etc.)
(*k*) Discharge pressure
(*l*) Intake pressure
(*m*) Intercooler pressure
(*n*) Barometric pressure
(*o*) Temperature of air or gas before and after each stage
(*p*) Temperature of cooling water at inlet and outlet of each jacket and cooler
(*q*) Quantity of jacket and cooling water
(*r*) Temperatures, pressures, etc., steam, gas or oil as applied to driving element (See appropriate code).

Instruments and Apparatus

4 The instruments and apparatus necessary for the measurement of the quantities enumerated in Par. 3 are:

(*a*) Gaging tank and nozzle or orifice for measuring air or gas compressed
(*b*) Tanks and platform scales of suitable capacity for measuring the quantity of condensed steam when a steam engine constitutes the driving element or for measuring fuel oil when an oil engine constitutes the driving element
(*c*) Water meters or calibrated tanks, or tanks and platform scales for measuring jacket and intercooler circulating water
(*d*) Pressure gages, vacuum gages, water and mercury manometers, and thermometers
(*e*) Barometer
(*f*) Steam calorimeter (for steam-engine-driven compressor)
(*g*) Voltmeter, ammeter, wattmeter and power-factor meter for measuring electrical input for motor-driven compressors
(*h*) Revolution counter
(*i*) Indicators
(*j*) A planimeter
(*k*) A deadweight gage tester

Directions for the use and calibration of instruments and apparatus enumerated above are given in Pars. Nos. —— of the code on "Instruments and Apparatus."

4a The measurement of the quantity of air compressed shall be by the following method:

(*a*) In the case of a compressor or blower: Flow into the atmosphere through nozzle or orifice from a gaging tank on the discharge side of the compressor or blower
(*b*) In the case of a vacuum pump: Flow from atmosphere through a nozzle or orifice into a gaging tank on the intake side of the vacuum pump.

4b Where the foregoing prescribed method is impracticable, as for example in the case of a compressor handling inflammable gas or gas which cannot be wasted, one of the following instruments may be used. These alternatives are listed in order of preference.

(*c*) Venturi meter
(*d*) Nozzle or orifice in discharge line
(*e*) Receiver tanks of known capacity into which the discharge from the compressor may be delievered, to be used only for compressors working at a discharge pressure of 1000 lb. per sq. in. or greater.

If method (*c*) or (*d*) is used, the instrument should be applied in a pipe through which the gas is permitted to flow under a pressure considerably less than the compressor discharge pressure. The reduction in pressure can be brought about by throttling and will result in eliminating, or at least minimizing, the pulsations in flow induced by the compressor.

4c The kind and size of gaging tank and nozzle or orifice selected will depend upon the particular method chosen for measuring the quantity of air or gas compressed. Whenever possible a low-pressure nozzle or orifice shall be used. A low-pressure nozzle is one through which the drop in pressure is small, that is, one in which the upstream absolute pressure is less than twice the downstream absolute pressure. Its use for high- or moderate-pressure compressors involves throttling the gas before it is admitted into the gaging tank to such an extent that all, or nearly all, pulsation is eliminated. If a high-pressure nozzle is selected, that is, one through which the drop in pressure is relatively large ($P_1 > 2P_2$), care should be exercised to select an orifice of a size sufficient to insure as much throttling between the discharge receiver and the gaging tank as possible.

4d The measurement of the intake and discharge pressures shall be by gage attached at the desired point, the fluctuations of which are reduced as far as may be by choking the gage cock. When extreme accuracy is desired or when the fluctuations are large, the average pressure may be found by working up pipe diagrams taken at or near the same point, thereby determining the mean pressure for the entire stroke.

---

[1] Mr. Redfield approves the draft of the Code as here printed with the exception of Par. 10a. *He* believes that the amount of moisture removed in the separator should be weighed and that this weight should enter into the calculations.

PREPARATION

5 Before proceeding with a test of a compressor or blower, Pars. 4 to 8 of the "General Instructions" should be carefully read. The dimensions and physical conditions not only of the compressor but of all the associated parts of the plant essential to the object of the tests should be determined and carefully recorded.

5a *Dimensions.* The dimensions of the compressor cylinders should be determined by actually measuring the machine itself without reference to the drawings. If the cylinders are much worn the average diameter should be taken, but proper record of the fact should be noted.

5b The method for measuring clearance will depend upon the particular design of the compressor in question. In a reciprocating displacement compressor with valves of the automatic type, the most satisfactory method will be to calculate the clearance from the measured dimensions of the cylinder, its several ports, and passages. If detailed drawings are available it will be found convenient to check each dimension of the parts involved by actual measurement and from this information compute the clearance volume. If mechanically operated valves are used, or if the construction of the valves of the automatic type is such as to permit blocking them in their closed position, the clearance may be obtained by the water-measurement method. This should only be attempted, however, when extreme accuracy is necessary or desirable. To carry out this method, refer to Par. 5a of the Code for Steam Engines.

5c The area of the compressor cylinder-jacket surface is that part of the cylinder wall or cylinder-head wall in contact with the water circulation and should be measured on the dry side of the metal.

5d The intercooler and aftercooler surface should be measured on the dry side of the cooling surface. Surface in contact with the air to be cooled on the one side and atmospheric air on the other side should not be included as cooling surface. If a record of its amount is made it should be listed as a separate item.

OPERATING CONDITIONS

6 As pointed out in the "General Instructions," Par. 19, in all tests in which the object is to determine the performance under conditions of maximum efficiency, or where it is desired to ascertain the effect of predetermined conditions of operation, all such conditions which have an appreciable effect upon the efficiency should be maintained as nearly uniform during the trial as the limitations of practical work will permit.

Tests to determine the performance under working conditions in which no attempt at uniformity is made are not advised, since the only available method of air measurement involves the determination of the rate of flow and total quantities of gas or air must be computed from the observed rate. Unless all conditions of operation are kept uniform or nearly uniform, the results obtained will not be of any value.

STARTING AND STOPPING

7 The compressor should be operated under test conditions for a considerable period before a record of its performance is made. This period should be of a duration sufficient to bring about a steady condition of pressure, temperature and speed. In this connection Pars. 16 and 18 of the "General Instructions" should be carefully noted

DURATION

8 The duration of compressor tests will generally be governed by the requirements in so far as the driving element is concerned, and for direction as to the necessary period reference to the appropriate code governing the driving element should be made. In the case of a motor-driven unit accurate results can be obtained from very short tests, the controlling factor being the time required to record enough sets of observations to demonstrate the uniformity of running conditions during the test.

RECORD

9 The general data should be recorded as pointed out in Pars. 20 to 30 of the "General Instructions." Instruments should be read and indicator cards taken from each end of each cylinder at least quarter-hourly when the conditions are uniform, and oftener when there is much variation. For short tests referred to in Par. 8, readings and cards should be taken much more often. If there are wide fluctuations in readings they should be shown by recording instruments. Each indicator card should be marked with the number, date, time, scale of spring, and end of cylinder, and on one card of each set the readings of the pressure gages should be recorded. The log should contain the record of the readings of discharge, intercooler and intake gages, thermometers, revolution counter, speed indicator, gaging-tank pressures and temperatures, and all other instruments, and these readings should be obtained at practically the same time the indicator cards are taken. The areas, lengths, and mean effective pressures shown by the indicator cards should also be entered in the log. If complete test data are required, representative pipe diagrams should be taken with an indicator applied near the cylinder port and operated by connection to a reducing motion driven from the engine or compressor crosshead.

9a A set of specimen indicator diagrams should be carefully selected from the whole number taken, and these should be embodied in the record. The specimen cards selected should be such as to show the average conditions of pressure. If pipe or port diagrams are obtained, specimens of these should also be placed in the record.

CALCULATION OF RESULTS

10 *Volume of Air or Gas Compressed.* The measurement of the amount of air or gas through a nozzle, orifice, or venturi tube results in a determination expressed in pounds per unit of time. (See Code for Instruments and Apparatus, Par. —.) The results obtained must therefore be reduced to terms of volume at the temperature and pressure obtaining at the compressor or blower intake. For this purpose the required specific weight at intake conditions may be calculated from the following formula:

$$\text{Specific weight} = \frac{P \times 144}{RT} \text{ in lb. per cu. ft.}$$

where P = absolute intake pressure, lb. per sq. in.
T = absolute intake temperature, deg. fahr.
R = constant (=53.3 for air).

This assumes that the fluid compressed is ideal gas, an assumption quite satisfactory for air. The weight of air or gas per minute as shown by nozzle measurement divided by the specific weight at intake conditions is equal to the volume of free gas or air compressed per minute.

When natural gas is compressed the value for R is not nearly enough constant under all conditions to satisfy engineering requirements and a correction must be made, depending in amount on the ratio of compression and the nature of the gas. (See Code for Instruments and Apparatus, Par. —.)

10a[1] *Correction for Moisture.* In the case of a compressor handling moist air, if some of the moisture is condensed during the process of intercooling and aftercooling, the air under discharge pressure will be saturated. In order to correct the rate of flow as shown by the orifice results it will only be necessary to figure the capacity of the compressor in terms of a total pressure equal to the sum of the partial pressure of air under intake conditions plus the partial pressure of the moisture in moist air having a relative humidity less than that observed in the intake by an amount representing the moisture removed in the cylinders, intercoolers, and aftercoolers. To determine this equivalent pressure to be used in calculating the specific volume, the following formula may be used:

$$P = P_d + P_m$$

where P_d = partial pressure for air in intake
P_m = partial pressure of moisture corrected for water of condensation removed from compressor and coolers.

To arrive at the value for P_m, proceed as follows: In the steam tables find the density of steam corresponding to the observed temperature in the discharge receiver. Multiply this first by the ratio of the observed absolute intake pressure to the observed absolute discharge pressure and then by the ratio of the absolute temperature in the discharge receiver to the absolute temperature

---

[1] See footnote on preceding page.

in the intake. The value thus obtained will be a hypothetical density, opposite which in the pressure column of the steam table will be found the desired partial pressure P_w.

It should be noted that the correction for moisture may be properly made only if moisture in the form of condensate is actually removed from the coolers. Care should be taken to make sure that the discharge temperature and pressure used is taken at or near the outlet of the cooler. If no aftercooler is installed the discharge temperature and pressure at or near the outlet of the intercooler should be used in the calculation outlined above.

11 *Indicated Horsepower.* The indicated horsepower for each end of the cylinder is found by using the formula:

$$\text{I.hp.} = \frac{PLAN}{33,000}$$

where P represents the mean effective pressure in pounds per square inch, L the length of the stroke in feet, A the area in square inches of the piston less the area of the piston rod, if any, and N the number of revolutions per minute. The total horsepower of the cylinder is the sum of the horsepower developed in the two ends.

11a *The Mean Effective Pressure* should be found by dividing the area of the indicator diagram in square inches as determined with a planimeter by the length of the diagram in inches, and multiplying the quotient by the average scale of the indicator spring. If a planimeter is not available, the approximate mean effective pressure may be determined by finding the average height of the diagram in inches as obtained by averaging a suitable number or ordinates, at least twenty, measured between the lines of the forward and return strokes, and then multiplying this average by the scale of the spring. The length of the indicator diagram is the measured distance along the atmospheric-pressure line between ordinates erected perpendicular to it and passing through the ends of the indicator diagram.

12 *The horsepower required to compress isothermally* the measured quantity of air at average speed of the compressor is found by multiplying the volume compressed per minute in cubic feet corrected to intake pressure and temperature by the absolute intake pressure in pounds per square foot and by the hyperbolic logarithm of the ratio of the absolute discharge pressure to the absolute intake pressure and dividing the product by 33,000.

13 *The Gross Horsepower* is the indicated horsepower in the steam or power cylinders in the case of a steam or internal-combustion-engine-driven compressor; the electrical horsepower multiplied by the motor efficiency in the case of a motor-driven compressor; and the brake horsepower delivered to the compressor shaft in the case of a belt-driven compressor. In the case of a compressor driven through belt, gear, etc., the power absorbed by the belt, gear, etc., must be taken into account.

14 *Electrical Horsepower.* The electrical horsepower of a motor is found by dividing the input at the terminals expressed in kilowatts by the constant 0.746. In the case of an alternating-current motor, the input determined, whether expressed in electrical horsepower or kilowatts, should be the total input. When the power for excitation or ventilation is taken directly from the compressor shaft, the total input is that indicated at the a.c. motor terminals; but if the motor efficiency as given does not account for the exciter input and exciter loss, the total electrical horsepower used in calculating the gross horsepower (Par. 13) is that indicated at the motor terminals less an equivalent current required to run the exciter.

15 *Volumetric Efficiency.* The volumetric efficiency is the ratio of the capacity of the compressor to displacement. The capacity is the actual amount of air or gas compressed and delivered, expressed in cubic feet per minute at intake temperature and pressure.

16 *Mechanical Efficiency.* The mechanical efficiency is the ratio of the air indicated horsepower to the indicated horsepower in the power cylinders in the case of a steam-driven or internal-combustion-engine-driven compressor, and to the brake horsepower delivered to the shaft in the case of a power-driven machine.

17 *Compression Efficiency.* The compression efficiency is the ratio of the work required to compress isothermally all the air or gas delivered by the compressor to the work done within the compressor cylinder, as shown by the indicator cards. The two factors involved in this ratio are defined in Pars. 12 and 11, respectively.

18 *Overall Efficiency.* The overall efficiency is the product of the compression efficiency and the mechanical efficiency.

THE DATA AND RESULTS

19 The data and results should be reported in accordance with the tables given herewith, adding lines for data not provided for or omitting those not required, as may conform to the purposes of the test. Unless otherwise indicated, the items should be the averages of all observations.

Table 1 constitutes the data and results applying to the compressing element and Tables 2, 3 and 4 the data and results applying to the driving element for motor, steam-engine and internal-combustion-engine drive, respectively. In reporting a test Table 1 should be combined with its appropriate driving-element table, the two being thrown together to form one complete table. The items of Tables 1, 2, 3 and 4 are so numbered as to indicate how this may be done most conveniently.

TABLE 1 DATA AND RESULTS OF TEST ON POWER-DRIVEN DISPLACEMENT AIR COMPRESSOR

COMPRESSING ELEMENT

(*A.S.M.E. Code of 1923*)

GENERAL INFORMATION

(1) Date of test..

(2) Location..

(3) Owner..

(4) Builder..

(5) Test conducted by..

(6) Object of test..

DESCRIPTION, DIMENSIONS, ETC., OF COMPRESSOR

(7) Type of compressor (single or multiple stage, and kind of gas)........

(8) Type of compressor valves..

(9) Method of driving compressor..

(10) Method of volume control..

(11) Rated discharge pressure..........................lb. per sq. in

(12) Rated speed..r.p.m.

(13) Rated displacement..............................cu. ft. per min.

(14) Rated output expressed in volume (air or gas at intake pressure and temperature).................................cu. ft. per min.

(15) Type of intercoolers and aftercooler..................................

		1st inter-cooler	2nd inter-cooler	3rd inter-cooler
(16)	Area of water-cooled surface, sq. ft...... See Par. 5	......	......	......
		1st stage	2nd stage	3rd stage
(17)	Diameter of compressor cylinders, in..	......	......	......
(18)	Stroke of pistons, ft..................	......	......	......
(19)	Diameter of piston rods or tail rods, in...	......	......	......
(20)	Clearance in terms of piston displacement, per cent...........	1st stage	2nd stage	3rd stage
	(a) Clearance, head end.......	....	....	....
	(b) Clearance, crank end......	....	....	....
	(c) Clearance, average........	....	....	....
(21)	Air cylinder ratio based on piston displacement:			
	(a) 1st stage to 2nd stage......	....	....	....
	(b) 2nd stage to 3rd stage......	....	....	....
	(c) Total (1st stage to final stage)....................	....	....	....
(22)	Horsepower constant, air cylinder:	1st stage	2nd stage	3rd stage
	(a) Head end (stroke × net piston area ÷ 33,000)........	....	....	....
	(b) Crank end (stroke × net piston area ÷ 33,000)........	....	....	....
(23)	Area of compressor cylinder jacketed surface..................	1st stage sq. ft.	2nd stage sq. ft.	3rd stage sq. ft.
(24)	Length and cross-sectional area, intake pipe..................	ft.	ft.	ft.
(25)	Diameter of final discharge pipe ..	in.	in.	in.

DESCRIPTION, DIMENSIONS, ETC., OF COMPRESSOR DRIVING ELEMENT

(See Tables 2, 3 or 4)

TEST DATA AND RESULTS

(40) Duration of test..hr.

Average Pressures

(41) Barometric pressure................................in. of mercury

(a) Corresponding absolute pressure...............lb. per sq. in.

(42) Pressure by gage at intake near cylinder..............lb. per sq. in.

(a) Corresponding absolute pressure...............lb. per sq. in.

(b) Maximum pressure above or below atmosphere by intake-pipe diagram .... lb. per sq. in.
(c) Minimum pressure above or below atmosphere by intake-pipe diagram near cylinders. (See Par. 4d) .... lb. per sq. in.

(43) Pressure above atmosphere in discharge pipe near high-pressure cylinder by gage .... lb. per sq. in.
(a) Corresponding absolute pressure .... lb. per sq. in.
(b) Maximum pressure above atmosphere, discharge pipe diagram near high-pressure cylinder .... lb. per sq. in.
(c) Minimum pressure above atmosphere, discharge pipe diagram near high-pressure cylinder. (See Par. 4d .... lb. per sq. in.

(44) Pressure in 1st intercooler by gage .... lb. per sq. in. (See Par. 4d)

(45) Pressure in 2nd intercooler by gage .... lb. per sq. in. (See Par. 4d)

Average Temperatures

(50) Engine-room temperature .... deg. fahr.
(51) Temperature of air or gas near intake, dry-bulb .... deg. fahr.
(52) Temperature of air or gas near intake, wet-bulb .... deg. fahr.

		1st cyl.	2d cyl.	3d cyl.
(53)	Temperature of air or gas in suction port, deg. fahr.	....	....	....
(54)	Temperature of air or gas in discharge port, deg. fahr.	....	....	....
(55)	Temperature of jacket cooling-water inlet, deg. fahr.	....	....	....
(56)	Temperature of jacket cooling-water outlet, deg. fahr.	....	....	....

		1st cooler	2d cooler	inter-cooler
(57)	Temperature of cooler circulating water inlet, deg. fahr.	....	....	....
(58)	Temperature of cooler circulating water outlet, deg. fahr.	....	....	....

(59) Temperature of air or gas in gaging tank at upstream side of orifice .... deg. fahr.

Total Quantities

(65) Relative humidity of air or gas at intake of compressor (use Smithsonian Tables) .... per cent.
(66) Air compressed and delivered to line .... lb. (See Pars. 4a and 4b)
(67) Air or gas compressed and delivered to line expressed in cu. ft. at intake pressure and temperature .... cu. ft. (See Pars. 10 and 10a)

		1st cyl.	2d cyl.	3d cyl.
(68)	Cooling water supplied jackets, lb.	....	....	....

		1st stage	2d stage	after cooler
(69)	Cooling water supplied coolers, lb.	....	....	....

Unit Quantities

(76) Volume of air or gas at intake pressure and temperature compressed and delivered per minute [Item 67 ÷ (60 × Item 40)] .... cu. ft.

		1st cyl.	2d cyl.	3d cyl.
(77)	Cooling water supplied jackets, lb. or gal. per min. [Item 68 ÷ (60 × Item 40)]	....	....	....

		1st stage	2d stage	after coolor
(78)	Cooling water supplied intercoolers, lb. or gal. per min. [Item 69 ÷ (60 × Item 40)]	....	....	....

Speed

(82) Total number of revolutions as shown by compressor counter ....
(83) Revolutions per minute [Item 82 ÷ (60 × Item 40)] .... r.p.m.
(84) Average piston speed .... ft. per min.

Power

(85) Indicated horsepower of compressor cylinders, whole compressor .... i.hp.
(86) Low-pressure compressor cylinder, horsepower:
Crank end .... i.hp.
Head end .... i.hp.
(87) Intermediate-pressure compressor cylinder horsepower:
Crank end .... i.hp.
Head end .... i.hp.
(88) High-pressure compressor cylinder horsepower:
Crank end .... i.hp.
Head end .... i.hp.
(89) Friction horsepower [Item 101 (Table 2) or 90 (Table 3)—Item 85] .... i.hp.

Power Input

(See Tables 2, 3 or 4)

Economy Results

(102) Gross horsepower per cu. ft. of air or gas delivered per min. at intake pressure and temperature (See Par. 13) .... hp.
(103) Electrical horsepower per cu. ft. of air of gas delivered per min. at intake pressure and temperature (See Par. 14) .... hp.
(104) Indicated horsepower in compressor cylinder per cu. ft. of air or gas delivered per min. at intake pressure and temperature (Item 85 ÷ Item 76) .... hp.

Efficiency Results

(109) Horsepower required to compress isothermally measured quantity of air or gas at average speed of compressor during test (See Par. 12) .... hp.
(110) Volumetric efficiency (See Par. 15) .... per cent
(111) Compression efficiency (See Par. 17) .... per cent
(112) Mechanical efficiency (See Par. 16) .... per cent
(113) Overall efficiency (See Par. 18) .... per cent

TABLE 2 ADDITIONAL ITEMS APPLYING ONLY WHEN THE DRIVING ELEMENT IS AN ELECTRIC MOTOR

Description, Dimensions, etc., of Compressor Drive

(26) Type of motor ....
(27) Rated power of motor ....
(28) Volts ....
(29) Amperes ....
(30) Phase ....
(31) Cycles ....
(32) Revolutions per minute ....
(33) Type and rating of exciter ....
(a) Volts ....
(b) Amperes ....

Power Input

(90) Volts ....
(91) Amperes per phase ....
(92) Power factor (from meter) ....
(93) Exciter:
(a) Volts ....
(b) Amperes ....
(94) Efficiency of exciter (from builder's test) .... per cent
(95) Horsepower input to motor (calculated from voltmeter, ammeter and power-factor meter) .... hp.
(96) Horsepower input to motor by wattmeter .... hp.
(97) Efficiency of motor (from builder's test) .... hp.
(98) Net motor horsepower .... hp.
(99) Horsepower output for exciter .... hp.
(100) Net horsepower to drive exciter .... hp.
(101) Horsepower to drive compressor or blower .... hp

TABLE 3 ADDITIONAL ITEMS APPLYING ONLY WHEN THE DRIVING ELEMENT IS A STEAM ENGINE

Description, Dimensions, etc., of Compressor Drive

(26) Type of engine (simple or multiple expansion) ....
(27) Type of steam valves ....
(28) Auxiliaries (steam or electric drive) ....
(29) Type and make of condenser equipment ....
(30) Rated capacity of condenser equipment ....
(31) Type of air pump, jacket pump, and reheater pump (direct or independently driven) ....
(32) Type of governing apparatus ....

		1st cyl.	2nd cyl.	3rd cyl.
(33)	Diameter of steam cylinders, in.	....	....	......
(34)	Stroke of pistons, ft.	....	....	......
(35)	Clearance in terms of piston displacement, per cent:			
	(c) Clearance, crank end	....	....	......
	(d) Clearance, head end	....	....	......
(36)	Horsepower constant, steam cylinder:			
	(a) Head end	....	....	......
	(b) Crank end	....	....	......
(37)	Area of steam-cyl. jacketed surface, sq. ft.	....	....	......
(38)	Area of interior surface, sq. ft.	....	....	......

(39) Steam cylinder ratio (overall):
(a) 1st cylinder to 2nd cylinder ....
(b) 2nd cylinder to 3rd cylinder ....

Average Pressures

(46) Pressure above atmosphere in steam pipe near throttle, by gage .... lb. per sq. in.
(a) Corresponding absolute pressure .... lb. per sq. in.
(b) Maximum pressure above atmosphere, steam-pipe diagram near throttle .... lb. per sq. in.
(c) Minimum pressure above atmosphere, steam-pipe diagram near throttle .... lb. per sq. in.

		1st cyl.	2d cyl.	3d cyl.
(47)	Pressure in steam receiver by gage, lb. per sq. in.	....	....	....

(48) Pressure in exhaust pipe near engine by mercury column .... in. of mercury
(a) Corresponding absolute pressure .... lb. per sq. in.
(49) Pressure in jackets and reheater .... lb. per sq. in.

Average Temperatures

(60) Temperature of steam near throttle .... deg. fahr.
(61) Temperature of saturated steam near throttle .... deg. fahr.

(Continued on page 70)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Experiences on Evaporators with Heat Pumps

By E. Wirth

THE theoretical bases of evaporation with the heat pump are now fairly well known, but the process itself is still in the early stages of development, notwithstanding the fact that a good many plants have been in operation for a number of years. Up to quite recently data were available only on installations handling liquids with a low boiling point, but today we have other data on the heavier liquids.

The power consumption in the vapor-compression process is determined by the pressure ratio between the vapor-compression chamber and the heating chamber of the evaporator. A part of this pressure difference is consumed by what might be called "dead" temperature head, determined by the rise of the boiling point of the liquid because of the presence of dissolved matter therein. This has been pointed out already by Josse, Fluegel and Schreber.

Schreber considers it sufficiently precise to calculate the rise of the boiling point from the content of dissolved matter in the liquid. The writer, however, holds experimental determination to be more reliable, especially as once in his own practice he was unable to obtain proper performance in an evaporator which he built, because the liquid, with constant specific gravity, showed a variation in boiling point as high as 2 deg. cent. This has been confirmed by tests extending over a considerable period of time and without apparent errors in measurement.

The data obtained by direct measurement (Fig. 1) do not show any irregular variations, but produce, in accordance with the specific gravity of the solutions, points lying along two parallel lines, which would indicate the upper and lower limits of boiling. In the case of the glycerine solution, the greatest variation of the boiling point is 2 deg. cent., equivalent to 40 per cent with a total temperature head of 5 deg. cent. This is sufficient to cut in half the performance of the evaporator and shift the compressor into the unstable region of "pumping."

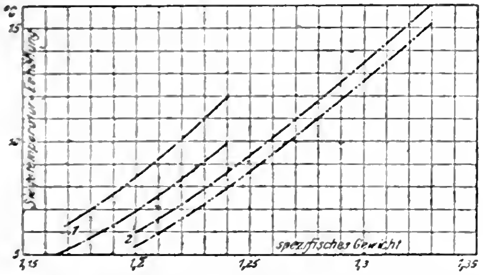


FIG. 1 BOILING-POINT CURVES OF VARIOUS LYES

(*Siedetemperatur-Erhoehung* = rise of boiling point; *Spezifisches Gewicht* = specific gravity.)

Fig. 1 shows not only the variability of the boiling point but also its location as compared with that of pure water. As shown by the curves, the mother liquids can have boiling points 10 deg. cent. (18 deg. fahr.) or more in excess of water, which may make entirely impossible the application of the process. This also shows that evaporator performances of 40 to 85 kg. (88 to 187 lb.) per hp-hr. which have been attained occasionally can be secured only under exceptionally favorable conditions and must not be considered as being possible in general practice.

Useful Temperature Head

In order to show more clearly the movement of the heat the author recommends replacing in the equation for the coefficient of heat transmission $\frac{1}{k} = \frac{1}{\alpha_1} + \frac{1}{\alpha_2} + \frac{\delta}{\lambda}$ the coefficients of heat flow and heat transfer by their reciprocal resistances—

$\frac{1}{k}$ = w = resistance of 1 sq. m. of area of heating element per deg. cent. difference of temperature per hour

$\frac{1}{\alpha_1}$ = w_1 = partial resistance on the condensation side

$\frac{1}{\alpha_2}$ = w_2 = partial resistance on the evaporator side

$\frac{\delta}{\lambda}$ = w_3 = partial resistance of the heater wall.

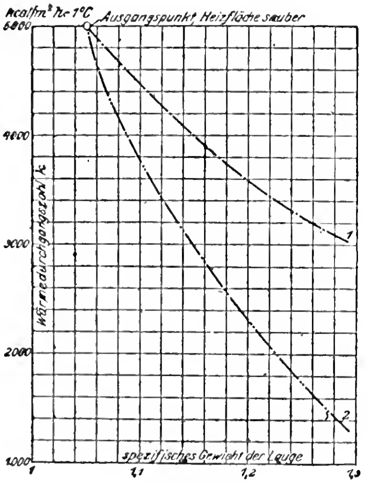


FIG. 2 SULPHITE LYE

(*Ausgangspunkt, Heizflaeche sauber* = starting point, surface of heating elements clean; *Waermedurchgangszahl* = coefficient of heat transmission; *spezifisches Gewicht der Lauge* = specific gravity of the salt solution.)

With this done the total resistance is $w = w_1 + w_2 + w_3$, and the total heat flow is expressed by the equation $Q = \Delta t/w$, similar to the formula for current, $i = e/w$, in electrical engineering.

The partial resistance on the evaporator side may be materially increased by the formation of solid deposits separating out of the mother liquid.

In a certain test there were used in an evaporator first chemically pure non-corrosive sulphite lye and then unpurified lye of similar material, with specific gravities up to 1.3. The heat-transfer values are shown in Fig. 2. From this it would appear that with increasing concentration the heat transfer in the case of pure salt lye decreases, but that the difference in heat transfer is very much greater with unpurified lyes because of an increasing formation of a crust over the heating elements. Notwithstanding the fact that the sediment formation at the end of a 10-hr. run appeared

still to be comparatively light and attacked only a part of the heating element. At the end of the test the coefficient of heat transmission was 3000 for the pure salt solution and 1250 for the impure lye. That the formation of deposits produces unfavorable results in so far as the effectiveness of evaporators is concerned, has been, of course, known for a long time, but it is always assumed that this would apply to very long periods of operation and that cleaning of the tubes would afford a relief for a considerable length of time. The present tests would indicate that this is not always so.

In addition to the maintenance of the walls of the evaporator in a clean condition, the lively movement of liquid in the proximity of the heater walls has also a great influence on partial resistance to heat flow.

The partial resistance on the side where condensation takes place is materially dependent on the presence of non-condensable gases in the steam. For example, the author found by measurement on a vacuum evaporator which was not quite tight that even 3.5 parts per thousand by weight of air in the steam on the condenser outlet side reduces the coefficients of heat transfer from 2140 to 1410. Josse found in the case of a surface condenser that $^1/_2$ of one per cent by weight of air in steam cut the heat transfer as compared with air-free steam in half. It is therefore important to keep the heating chambers as free from air as possible. In the vapor-compressor even a small admixture of air reduces evaporation very rapidly. That not only air but also other gases can affect the heat transfer materially is shown by Fig. 3. The vapor compressor there is operating with the liquid which gives up particles which are, however, soluble in water. Notwithstanding a uniform concentration, uniformly clean surfaces of the heating elements and absence of air, the performance varies to an extraordinary extent, which indicates an unstable condition on the condensation side. Apparently the gas produces an insulating layer on the walls of the heating elements on the condensation side, and this insulating layer upsets all calculations as regards performance.

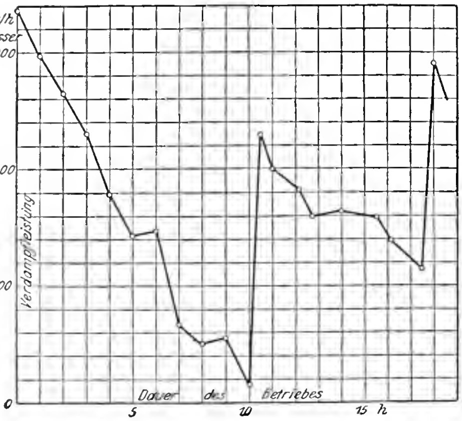


Fig. 3 Curves Showing the Irregularity of Operation of an Evaporator Due to Disturbance
(Other than the presence of air arising on the condensation side)
(*Wasser* = water; *Verdampfleistung* = evaporation output; *Dauer des Betriebes* = duration of run.)

The partial resistance of the metal walls is the element which admits of the most reliable calculation. It is of importance only in cast-iron evaporators or in evaporators where the resistances w_1 and w_2 are very small. Where chemical influences do not make the employment of other materials imperative, iron is usually suitable for heating elements. If, however, the resistances w_1 and w_2 can be maintained very small, it is of benefit to employ a metal wall of good heat conductivity.

In general, in computing the temperature fall across the heater element, it is better not to assume rigid coefficients of heat transmission, but to consider the character of heat flow in each case and the previous experience available in this connection.

Superheating of Heating Steam

This has acquired a considerable importance since the employment of compressors which produce superheated steam without any extra cooling. The first experience with compressors proved to be quite difficult, because of the presence of steam superheating, which was generally considered as being harmful to proper heat transfer. On the other hand, however, Classen has pointed out that the heat transfer in an evaporator with superheated steam is, all other conditions being equal, greater than with saturated steam. The experience of the writer would indicate that this is entirely possible, and, on the whole, the influence of superheating of steam need not be always quite as unfavorable as would seem to be indicated by some previous experiments (Ombeck).

Foaming of the liquid, which increases with rise of temperature, may cause trouble, and such means of combating foaming as are known are apt to cause increased pressure losses in the suction piping.

Since a high level of liquid over the heating surface is undesirable from the point of view of evaporating output because it increases the boiling temperature, attempts have been frequently made to combat its influences by the employment of spray devices. This cannot, however, be applied when the liquid is of such character as to form solid deposits. The Piccard process, in which the heating and evaporation are carried out separately and which has been applied as early as 1878 in Switzerland, is fundamentally simple and good, but increases the pressure conditions in the compressor.

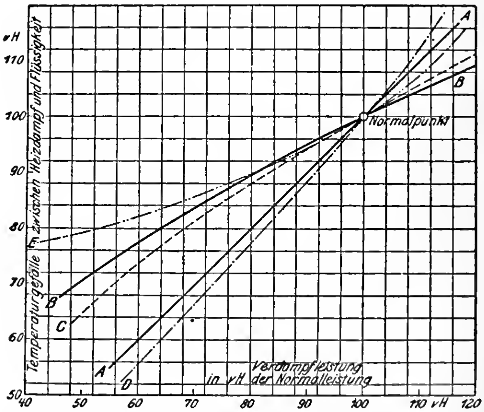


Fig. 4 Characteristic Curves of Various Evaporators
(Ordinates: Temperature head between heating steam and liquid; *vH* = per cent; Abscissae: Evaporation output in per cent of normal output; *Normalpunkt* = point of normal performance.)

The Characteristic Curve of the Evaporator

Even with clean surfaces the heat transfer in an evaporator is not of constant magnitude but depends on the type of evaporator, pressure conditions, character of the liquid, and other influences. In the design of the apparatus it is therefore a good plan to plot first the characteristic curve for the evaporator by plotting the evaporator output against the corresponding temperature differences. In order to obtain a general basis for purposes of comparison, there have been used in the curves of Fig. 4 not the actual values but comparative values based on an output of 100 per cent at a temperature difference of 100 per cent.

For purposes of comparison two theoretical characteristic curves have been plotted: *A*, with an entirely uniform rate of heat transfer under which condition the output varies according to a straight-line law with the temperature differences; and *B*, with a rate of transfer which varies in proportion to the temperature fall under which condition the characteristic curve appears as a parabola. Curves *C*, *D* and *E* have been derived from tests on large evaporators and the curve *C* was taken from an evaporator of conventional design with vertical tubes in the heat chamber. It approaches a parabola and the rate of heat transfer appears,

therefore, to be approximately proportional to the temperature fall. Curve *D* is taken from tests by Professor Stodola on a Kummler and Matter compressor, and curve *E* on an evaporator operating with after-evaporation, and therefore one in which the output depends very strongly on the temperature head.

The Compressor

For larger outputs on one hand and for higher vacua on the other, only centrifugal compressors can be commercially used owing to the large amounts of steam that have to be handled. Such compressors have a lower efficiency than reciprocating compressors, but they have smaller dimensions and the further advantage that they give oil-free condensate and have and can be coupled to the driving machinery more conveniently.

The centrifugal compressor has a characteristic curve showing that with decrease of volume of steam handled the rise of pressure increases until it reaches a maximum, and then, if the volume of steam continues to decrease, begins to fall off, the compressor gradually passing into the unstable region of "pumping." The compressor operation can be expressed in a percentage curve similar to that used in the case of the evaporator, in which case instead of rise of pressure may be used rise of temperature referred to saturated steam. Fig. 5 gives such a characteristic curve for constant speed in revolutions and constant pressure in the case of a standard Zoelly centrifugal steam condenser having an output of about 1700 cu. m. (60,000 cu. ft.) per hr. and a pressure rise from 1 to 1.7 atmos, abs. The curve *v1* is the characteristic curve obtained without cooling by water injection and curve *v2* with cooling in stages by water injection. Although with cooling by water injection the saturated-steam temperature was about 10 per cent higher, in this particular case cooling did not lead to higher output but only to greater power consumption. Curves *v3* and *v4* give the steam in kilograms per kilowatt-hour of the energy supplied to the driving motor. With decrease of output the evaporation per kilowatt-hour falls off materially, and should this fall below the critical volume it would become necessary to resort to throttling, which would make the efficiency still lower. It would appear, therefore, that for vapor compressors the problem is to arrange matters so as to work always with the compressor at its normal output. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 46, Nov. 12, 1921, pp. 1183-1186, *pe*)

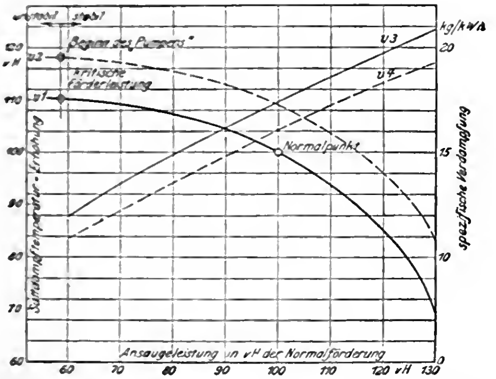


FIG. 5 CHARACTERISTIC CURVES FOR A CENTRIFUGAL COMPRESSOR

(*unstabil-stabil* = unstable-stable; *Beginn des Pumpens* = beginning of "pumping;" *vH* = per cent; *Kritische Foerderleistung* = critical output; *Normalpunkt* = point of normal performance; *spezifische Verdampfung* = specific evaporation; *Ansaugeleistung in vH der Normalfoerderung* = suction output in per cent of normal.)

The following emergency methods for obtaining extra cooling on aeroplane engines are recommended by the Air Board, Ottawa, Canada (Technical Memorandum, No. 12): (1) Addition of a lip to the front of radiator (applicable only to some machines, particularly tractor type); (2) Spiral air deflectors in the open end of the tube (not to be used except for emergency purposes); (3) Removal of cowling (reduces efficiency of engine).

Short Abstracts of the Month

AERONAUTICS

Dornier Dragon Fly Flying Boat. Description of a new machine built at Rorschach on the Swiss side of Lake Constance by the Dornier Co., a subsidiary of the German Zeppelin Works.

Under the characteristic features may be mentioned the air-flow floats projecting from the sides of the hull, which take the place of the wing-tip floats and have the advantage of contributing to the lift instead of adding to the resistance of the machine.

The machine is built almost entirely of duralumin, which is employed also for the wings and wing coverings. The wings, it may be stated, are of the semi-cantilever type without dihedral or sweepback. They are built up in three sections and are made to fold back, and it is stated that with the wings folded the machine maneuvers on the water as easily as a motor boat.

The outer wing sections are braced to the hull by a pair of streamline struts on each side. When the wings are folded back the front struts are disconnected at the attachment to the hull and are secured to a lug in the lower extremities of the rear struts.

The floating operation can be accomplished in about $1\frac{1}{2}$ min. and it takes only about 1 min. longer to extend the wings. Both operations can be carried out while the boat is on the water and it is claimed that once erected the wings do not require any truing up.

With a 50- to 60-hp. five-cylinder radial air-cooled engine, three passengers on board and fuel for one hour's flight, the machine lifts from the water in about 30 sec. (*Flight*, vol. 13, no. 42/669, Oct. 20, 1921, pp. 685-686, 7 figs., *d*)

AIR MACHINERY (See also Testing and Measurements)

Propeller Blowers

Propeller Blowers for Forced-Draft Furnaces, Werner Mueller. General discussion on the subject of propeller-type blowers as distinguished from centrifugal blowers, and description of some of the German types.

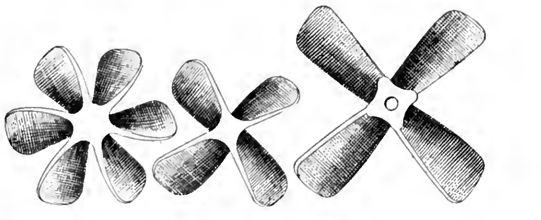


Fig. 1 Aluminum-Alloy Propeller for Use in Blowers

The design of propeller blowers has been materially affected by information gained from tests on aircraft propellers, as the same aerodynamic laws apply to both, even though the purpose of the two is different.

The essential characteristic of the propeller is the profile with a large cross-section of blade, thick rounded-off entrance edge and smoothly-drawn-out exit edge. The pressure side of the blade is concave and the suction side convex, with the constant curvature so designed as to attain a flow of stream lines as far as possible free of turbulence. Figs. 2 and 3 show the difference in the appearance of the air flow between the correctly selected turbulence-free propeller blade and the common, more or less bent, thin sheet-iron blade. Attention is called in this latter type to the turbulent formations on the suction side, which act as a brake on the wheel and thus create a parasite power consumption. With a blade of proper shape these back eddies do not seem to occur.

In addition to the shape of the blade, the design of the blower housing materially affects its efficiency. The propeller screw acts on the surrounding medium by forcing it ahead acceleratingly, and only to a very small extent does a direct transformation into pressure

take place. Because of this, the velocity to the rear of the propeller wheel is greater than that ahead of it, and in order to secure a flow free from turbulence through the housing this latter must have a smaller cross-section to the rear of the propeller than it does in front of it. (Compare Figs. 4 and 5.) Bendemann shows that theoretically the smallest cross-section should be equal to one-half of the propeller-circle area. With such an arrangement there occurs a clearly defined tightening of the flow lines which decreases in increase in counter pressure but never disappears entirely. The remaining excess in flow velocity can be converted into pressure only by the employment of a conical intermediary piece known as a "diffuser." The diffuser therefore plays the same part in a propeller blower as the spiral casing in a centrifugal blower. The relation between the theoretically smallest aerial flow corresponding to the "equivalent nozzle" and the area of the propeller circle gives a valuable basis for the calculation of blowers for given outputs.

Fig. 2

Fig. 3

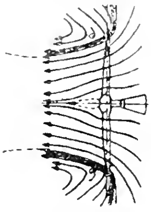


Fig. 4

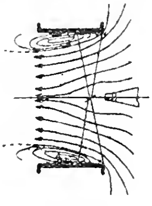


Fig. 5

Fig. 2 Correct Blade Section, Giving a Turbulence-Free Flow
Fig. 3 Incorrect Blade Section, Giving Turbulence in the Rear
Fig. 4 Correct Propeller Housing, Giving Turbulence-Free Flow
Fig. 5 Incorrect Propeller Housing, Creating Considerable Turbulence in the Rear

As regards the most advantageous speed in revolutions, it is stated that for small blowers 2800 and for larger blowers up to 1450 r.p.m. are best, particularly as they correspond to the usual speeds of polyphase motors, thus permitting direct coupling. Such blowers as the Foege are therefore always built for direct coupling and not for belt drive, as the latter at these high speeds of revolution is not sufficiently reliable. Direct drive through steam or air turbines could also be used.

The propeller proper (Fig. 1) is a high-grade aluminum alloy casting with a tensile strength of 18 to 20 kg. per sq. mm. (26,000 to 28,500 lb. per. sq. in.) and is cast from patterns reproducing carefully-tested-out wooden propellers. It is claimed that these propellers require only a very small amount of machinery, and, in particular, that they do not have to be tested for strength under speeds in excess of operating, as the dimensions are so generously proportioned that there is no danger of their bursting under the action of centrifugal stresses. On the other hand, they must be very carefully balanced, as otherwise heating will develop. Also the boring for the shaft should be done very carefully in order that every blade will travel in the exact path of the preceding blade. Ball bearings exclusively are used, and in addition to a double-row shaft ball bearing a thrust ball bearing is employed.

The article describes in considerable detail some of the features of design and installation of the blowers and also gives data on propeller-blower operation.

As to the latter, Fig. 6, in particular, shows that the power consumption of a propeller blower is very nearly the same over the entire cross-section of the piping and that it proportionately falls off as the volume of air increases. It is also practically independent of the resistances which may be created in the piping by the use of throttling valves or similar devices. On the other hand, in centrifugal blowers the power consumption is very materially affected by the presence of resistances, and becomes a maximum with an entirely open pipe cross-section. This means that the motor driving a centrifugal blower has to be made of very generous proportions in order not to be overloaded when all the resistances in the pipe are eliminated; it also means that with certain types of drive, as, for example, the steam turbine, there is a danger that with the passage entirely closed the unit might run away, and special means have to be taken to prevent this dangerous possibility. All these difficulties are eliminated in the propeller blower as the driving motor has to deliver only the predetermined amount of power suitable for continuous operation.

As regards pressure as a function of the pipe cross-section, Fig. 7 gives a straight line, which shows a practically proportional variation. Maximum pressure is obtained with the damper fully closed, while with the damper fully open the entire pressure appears as velocity. Such a mode of variation is particularly acceptable for use with piping, as the pressure produced by the blower increases with the increase of resistances. Contrariwise, in centrifugal blowers the pressure falls off with increase of resistance, which is much less desirable from a practical point of view.

Fig. 8 gives efficiency curves of the two types of blowers, showing that the peak values are about the same in both cases, but the general character of the curves is materially different. In centrifugal blowers the curve of efficiency reaches a clearly pronounced peak value and then rapidly falls off on both sides, which means that it is rather difficult to design a centrifugal blower which will efficiently take care of the variable local conditions of operation. This is much easier with the propeller blower as its curve is considerably flatter.

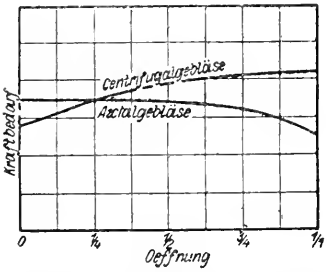


Fig. 6 Power-Consumption Curves for Centrifugal and Propeller Blowers
(*Kraftbedarf* = power consumption; *Oeffnung* = free pipe cross-section.)

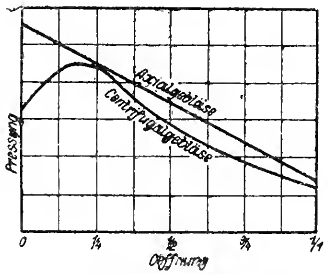


Fig. 7 Pressure Curves for Centrifugal and Propeller Blowers
(*Pressung* = pressure.)

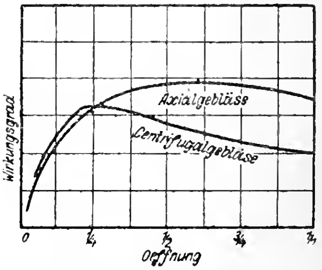


Fig. 8 Efficiency Curves for Centrifugal and Propeller Blowers
(*Wirkungsgrad* = efficiency.)

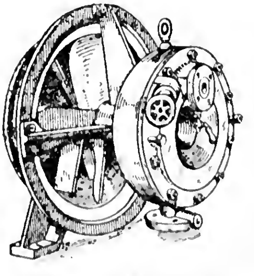


Fig. 9 Foege Blowers
(Translations for all figures: *Oeffnung* = free pipe cross-section; *Centrifugalgeblaese* = centrifugal blowers; *Axialgeblaese* = propeller blowers.)

Fig. 9 shows, in general outline, a Foege propeller blower. (*Zeitschrift für Dampfkessel und Maschinenbetrieb*, vol. 44, no. 36, Sept. 9, 1921, pp. 281–284, 12 figs., *dec*)

ENGINEERING MATERIALS

Stainless Steel for Turbine Blades

Some Engineering Uses of Stainless Steel. Stainless steel is an alloy steel containing from 12 to 14 per cent of chromium and about 0.5 to 0.6 per cent carbon. The present paper describes some experiments made with stainless steel in turbine blades, in particular experiments made in a turbine at the power station of one of the makers of this steel.

The machine selected for the test was a British Westinghouse impulse turbine rated at 2000 kw. and running at 3000 r.p.m.

The experimental blades were fitted to two of the wheels some time about June, 1920, and the wheels chosen were, respectively, the velocity wheel which constitutes the first stage of the turbine and is operated with steam at a high temperature, and wheel No. 8, which constitutes the last stage of the turbine and is fed with wet steam. Twelve of the existing blades were removed from wheel No. 8. Three were replaced by highly polished blades of stainless steel having beside them three blades of the same material in the unpolished condition, while on the opposite side of the wheel another triplet of unpolished stainless steel blades were inserted alongside of three new 5 per cent nickel-steel blades obtained from the builders of the turbine. In the velocity wheel 24 blades were replaced by 21 blades of stainless steel, three of them polished, and by three new blades of the 5 per cent nickel steel.

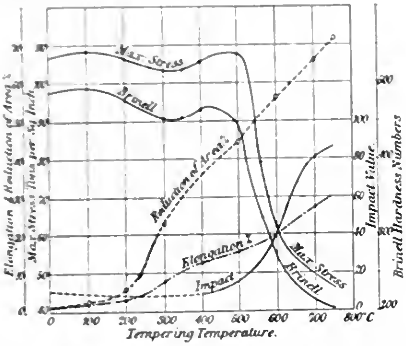


Fig. 10 Curves Showing Physical Properties of Stainless Steel after Heat Treatment

The turbines were opened up after having been in operation with the new blades for 3471 hr. It is claimed that the stainless-steel blade appeared to be totally unaffected by the work done and did not show either corrosion or appreciable erosion, while the nickel-steel blades inserted at the same time showed both, in particular along the inlet edges. The article refers also to the application of stainless steel to the rams of hydraulic pumps.

In a three-throw hydraulic pump built in Sheffield, rams of stainless steel and phosphor bronze were tried. It is said that the stainless-steel ram has maintained its original polish better and suffered less wear than the phosphor-bronze ram.

Stainless steel can be hardened and tempered similarly to carbon steel, but it is important to note that its change point is much higher, namely, at about 950 deg. cent.

Fig. 10 shows the variation in the properties of stainless steel as tempered at the various temperatures represented by the curves. For forging the temperature should be between 1150 and 900 deg. cent., though it is not impossible to work it below the latter limit. It can be electrically welded, but not with a smith's fire, as layers of chromium oxide form and prevent the union of the surfaces. (*Engineering*, vol. 2913, Oct. 28, 1921, pp. 592–594, 7 figs., *ec*)

Strength of Manila Rope, Ambrose H. Stang and Lory R. Strickenberg. Data of tensile tests of 368 specimens of manila rope. All the rope tested was three-strand, regular-lay type having diameters varying from $^1/_2$ in. to $4^1/_2$ in. An interesting feature of the test is the great consistency in results. The ropes showed, however, a continued varying modulus of elasticity and no well-defined proportional limit.

The following is given as a summary of the results obtained:

1 The average breaking load was found to be approximately a quadratic function of the diameter of the rope. It is expressed quite closely by the equation:

$$L = cd\ (d + 1)$$

in which L is the load in pounds, c is a constant equal to 5000, and d is the diameter of the rope in inches.

2 The ropes showed a continually varying modulus of elasticity and no well-defined proportional limit.

3 The number of yarns composing a rope may be expressed approximately by the equation:

$$N = kd\ (d + 0.4)$$

where N is the number of yarns, k is a constant equal to 50, and d is the diameter of the rope in inches.

4 The test results cover sufficient range and show such consistency that it is believed that the formulas deduced may be used safely for three-strand, regular-lay manila rope for sizes of rope between $^1/_2$ and $4^1/_2$ in. in diameter. (*Technologic Paper of the Bureau of Standards*, no. 198, Sept. 15, 1921, pp. 3–11, 5 figs., *e*)

INTERNAL-COMBUSTION ENGINEERING

An American Solid-Injection Diesel Engine

Worthington Airless-Injection Oil Engine. The writer uses the expression "airless injection" to indicate its difference from the air-blast injection of the Diesel engine, although the expressions "solid injection" and "mechanical injection" have hitherto been more common.

In the new Worthington engine fuel oil is delivered to the engine by a service pump operated by an eccentric on the crankshaft.

The engine is of the valveless two-cycle crosshead type with a separate compartment between the cylinder and the crankcase for scavenging air.

One of the distinguishing characteristics of this engine is the use of a divided, or two-part, combustion chamber. The function of this divided combustion chamber is to reduce explosive pressures and to create a condition of air turbulence in the main combustion chamber during the combustion period. Shortly before top dead center, fuel is injected through the spray valve in an atomized condition directly into the smaller of the two compartments, known as the "injection chamber," this being located above and directly in communication with the main combustion chamber or cylinder clearance space. Ignition of the fuel is from the heat of compression and the period of injection is so timed that the partial burning of the fuel charge in the injection chamber produces sufficient pressure to start the flow of the main part of the fuel charge down into the cylinder until the jet of gaseous oil and air from the injection chamber attains considerable velocity, producing a turbulent condition in the cylinder just as the piston starts on its downward stroke. This is accelerated by the downward motion of the piston.

Combustion then takes place in the lower chamber or cylinder, under conditions closely approximating the air-injection Diesel engine, the resultant expansion of gases driving the piston down on its power stroke, after which the cycle described above is again repeated. The pressure from the fuel pump is high, but lasts only during injection about 15 deg. of crank angle. It will be noted that the time and rate of combustion are independent of time and rate of pump injection.

One of the refinements of the Worthington engine consists in providing a scavenging-air connection on the base of the engine which may be piped to the outside of the engine room. By this means a supply of pure, fresh air may be had for scavenging purposes in places where the air of the engine room is charged with dust or explosive vapors.

The fuel-injection pump is of the unpacked type, and as will be seen from Fig. 11, is driven by an eccentric (17) mounted on the crankshaft. Each cylinder has a separate and independent pump, complete in all its details. By avoiding the use of packing from the pump plunger, danger of the plunger sticking is eliminated, and at the same time leakage past the plunger is considerably less than in the usual type of packed pump. The pump body (24) is made from a solid block of steel, designed and constructed with great care, and the plungers and valves are assembled in this body of a unit.

Actuation of the pump plunger is by the eccentric (17), the crosshead (19) engaging the tappet (21), which in turn pushes the plunger upward on its injection stroke, the plunger being returned to its at rest position by the spring as the eccentric passes its top position. The actual instant at which the pump plunger begins to move upward determines the instant of injection of oil into the injection chamber.

For control, a centrifugal governor is fitted, acting through a series of rods and levers to rock the control shaft (10). This shaft is turned eccentric at a point in line with each fuel-pump plunger, and a so-called "by-pass lever" (9), actuated at one end by the pump plunger, rests at the other end on the eccentric part of the control shaft through the medium of an adjustable set screw. As the end of the by-pass lever moves upward with the pump plunger the by-pass tappet (9) and the plunger (7), resting on the lever, will move upward also, closing the gap between its upper end and the suction or by-pass valve (2). When contact is established at this point the continued upward movement of the plunger will open the valve, permitting the oil to by-pass back to the fuel reservoir instead of being forced through the spray valve, and thus ending the injection or effective pump stroke. It will be seen that by rocking the control shaft (10) one way or the other from its normal running position, the instant of opening of the suction valve by the by-pass plunger may be retarded or advanced, thus increasing or decreasing the effective pump stroke and feeding more or less oil into the cylinder, according to the load requirements. Also, by regulation of the set screw in the end of the lever (9), the instant of by-pass opening for each cylinder may be individually adjusted for purposes of initial setting and load balancing. (*Motorship*, vol. 6, no. 11, pp. 872–875, 10 figs., *d*)

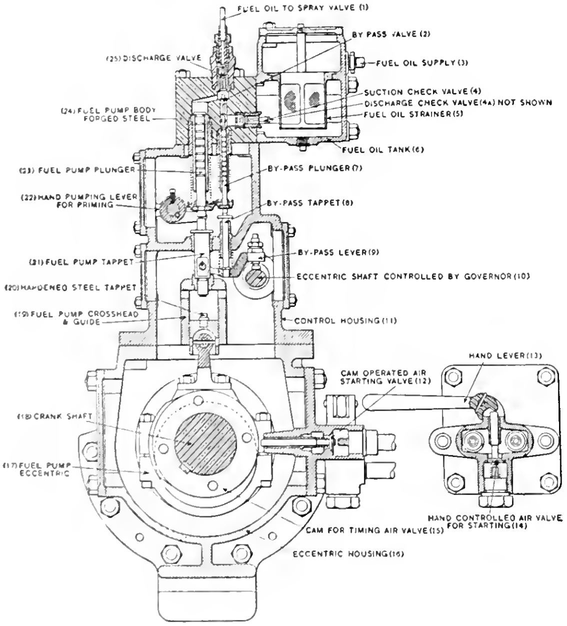


Fig. 11 Section of Worthington Engine Fuel Pump

Cooling-Water Systems for Stationary Internal-Combustion Engines, Edgar J. Kates, Mem.Am.Soc.M.E. Description of the various systems, beginning with the simple cooling tank and proceeding by gradual stages to the cooling towers of various types, overhead supply tanks, and finally the enclosed cooling system, which is the most modern development.

The principal feature of this latter is that the jacket water is recooled in pipe coils over which other water is showered or flowing. The only place where the engine water is exposed is at the visible outlet. Because of this the loss is negligible, practically no makeup water is required, and clean water may be used for jacket circulation while an inferior type is doing the actual cooling work.

Where there is a scarcity even of inferior water for cooling the pipe coils, an arrangement illustrated in the original article may be used. In this the raw water itself is in a basin below the pipes and pumped by a second pump over an open screen-type cooling tower, where it is recooled and ready to be used again over the pipe coils.

The system just described may seem elaborate and complicated, but it is not so in reality. Where the water available is of inferior character and scarce, as in the mining regions of western Texas, such systems afford the only satisfactory method known of cooling internal-combustion engines. It is said that one oil-pipe-line company has equipped all its plants with similar systems.

Reciprocating pumps are said to be preferable to centrifugal pumps for water-circulating systems, because of their greater reliability and uniformity of operation. (*Power*, vol. 54, no. 19, Nov. 8, 1921, pp. 710–713, 4 figs., *cd*)

LOCOMOTIVE ENGINEERING (See Power-Plant Engineering)

MACHINE DESIGN

The Control of Machines by Perforated Records, Emanuel Scheyer. General discussion of the process as applied to textile machinery, piano players, automatic typewriters, etc.

Perforated-paper-record control has been applied also to metal-working machinery, as, for example, in the automatic multiple-punching machines of Wm. Sellers & Co., described in some detail in the article.

The author proposes to apply a modified form of the Jacquard method of perforated-paper-record control to machine tools of the turret type. He states that a lathe equipped with this kind of control cannot compete with the ordinary cam-controlled automatic lathe within the proper field of work of the latter, but may be applied for handling work which is larger or more complicated than can be handled by cam-controlled machinery. The description of a proposed lathe with such a type of control is given in the original article. (*American Machinist*, vol. 55, no. 19, Nov. 10, 1921, pp. 743–747, 8 figs., *dA*)

MACHINE PARTS (See Machine Tools)

MACHINE TOOLS

Gray Co. Planer with Helical Gear Table Drive. Description of a new planer, one of the characteristic features of which is the use of involute helical gearing for driving the table.

Planers have heretofore been built with herringbone or helical gears for the first reduction, but the new Gray planer has helical gears throughout. The Gray company states that a train of planer gears having one or more pairs of spur gears cannot give the results which are obtained by the use of properly proportioned helical gears throughout, that is, from pulley-shaft pinion to table rack.

Helical gears produce end thrusts. Advantage is taken of this fact to cause the end thrust of the bull gear and its pinion to counteract the side thrust of the tools when cutting. Moreover, the diameters and helical angles of the remaining gears of the train are so proportioned that their end thrusts very largely balance one another. Bronze thrust collars, provided with forced lubrication, take the slight residual end thrusts. Particular attention is called to the helical table rack which is of unusual width of face, giving great strength. The helical rack is arranged so that the end thrust of the bull pinion, which amounts to about one-tenth of the driving force, opposes and compensates for the side thrust of the cutting tools when they are being fed away from the operating side of the machine, a condition which obtains at least 90 per cent of the time. As the tool pressure increases, the power required to drive the table and the resultant balancing thrust of the bull pinion also increase proportionately. This, it is said, equalizes the pressure and wear on the two sides of the V's, whereas with a rack of the spur form the pressure and wear are greater on one side of the V's than on the other, due to the side thrust

of the cutting tools. It also overcomes the tendency of the tools to push the table up the side of the V's.

To provide correct tool action, teeth of true involute form, cut by a generating process, are employed. In order to avoid interference and imperfect tooth forms, and to obtain great smoothness of action and stronger teeth, the pinion teeth are so cut that the greater part of the tooth face lies outside the pitch circle. The teeth have a low pressure angle, are cut full depth, and have a short arc of approach and long arc of recess, giving high efficiency, and greatly increasing the number of teeth in contact and the smoothness of action. The action of a tooth having a long arc of recess compared to one with a long arc of approach is analogous to the action of dragging the end of a pole behind you compared to pushing it ahead of you.

This design, it is said, also has the advantage of permitting the use of pinions of larger diameters and stronger tooth form without the disadvantage which attend the use of stubbed teeth, high pressure angles and low gear ratios. (*The Iron Age*, vol. 108, no. 22, Dec. 1, 1921, pp. 1417–1419, 4 figs., *d*)

MECHANICS

Stress Coefficient for Large Horizontal Pipes, Jas. M. Paris. A new method of calculating stresses wherein a general case of the pipe is analyzed by breaking it up into a number of fixed elementary cases, and elastic analysis for each of these is worked out, the results being then combined by simple addition in proportion as the several elementary loadings are contained in the actual loading of any given particular case.

Essentially, for general loads on a large circular pipe, it is assumed that the deflection along the vertical diameter takes place at one end. Considering the half-pipe to one side of this diameter, its one end is assumed fixed and the half-pipe treated as a cantilever beam; the very end is imagined to deflect under the applied external loads and then brought back to its original direction by a moment applied through M_T, and back to its original position by a horizontal force H_T.

From the elastic-arch theory, using Maxwell's theory of reciprocal deflections, equations are deduced for the unknown reactions M and H. These reactions contain m, which is the general expression for the cantilever moment of the external forces on either half of the pipe, and by substituting for m in the equations its actual value for any loading, values of M_T, H_T, etc., are found for that loading. When this has been done for various simple and elementary loadings, any number of them may be combined, and by addition of the separate values the resultant value of H_T or M_T may be found.

Several interesting examples of the application of the method are given in the original article. (*Engineering News-Record*, vol. 87, no. 19, Nov. 10, 1921, pp. 768–771, 3 figs., *tA*)

The Whirling Speeds of a Loaded Shaft Supported in Three Bearings, Prof. H. H. Jeffcott. An extensive paper dealing analytically with the first and higher whirling speeds of a shaft supported in three bearings loaded in any manner and of sections varying from place to place along the length of the shaft. In the general case the shaft is supposed to change in diameter at various sections along its length and to be of uniform size between such sections. Other assumptions are made, in particular, that the shaft is assumed to carry at various places along it a series of loads each of which is balanced. The bearings are assumed to act as free supports and not to fix the direction of the shaft any extent for the small deflections contemplated.

In solving the general problem of a number of loads on the shaft, the author resorts to the use of a principle originally enunciated by Bresse, which may be stated as follows: The displacement of any point by reason of the deflection of the shaft is the resultant of the displacements which would be produced if one supposes all the external known forces to act separately, and one after the other. Thus, the shaft may be considered as supported at each end under the action of the given load acting downward, and also under the action of the supporting force at the intermediate bearing acting upward. The result of the action of these two systems of forces is to make the deflection zero at the intermediate bearing.

From this the author derives a number of equations for the deflections and slopes at any given point of each span due to the system of loads and for the total deflection and slope due to all the loads acting simultaneously. A numerical example to illustrate this principle is given, as well as equations determining deflections and slope under the centrifugal loading considered.

One simple case of oscillatory vibration for a three-bearing shaft is considered and the speed of a simple oscillatory vibration determined, likewise the ratio of oscillatory speed to normal whirl speed. (*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, vol. 42, no. 251, Nov. 1921, pp. 635–668, 5 figs., *tm*A)

MEASUREMENTS AND TESTS (See Engineering Materials)

MILITARY ENGINEERING (See also Aeronautics)

Aircraft versus Dreadnaughts, Hon. Frederick C. Hicks. General discussion of the part of aircraft-bombing tests of seacraft which closed with the sinking of the *Ostfriesland*, presented in a speech in the House of Rrepresentatives, of which the author is a member.

The author tries to present both sides of the question and points out that as long as gravity is the force utilized to carry the bomb to the target, an aeroplane will always have to be within a certain fairly limited zone over the ship which it is attacking.

On the other hand, however, the torpedo-carrying plane may be expected in the near future to become part of the aircraft outfit, and the torpedo bids fair to be the most deadly weapon carried by aircraft.

As regards the effectiveness of bombs which would simply hit the superstructure, it is admitted that they smash things badly, but it is believed that their destructive effect is largely local. In fact, what happened on the destroyer *Manly* in 1918 when a number of depth charges exploded on her afterdeck, it would appear that bombing on decks would not materially affect the men below, though of course it is always possible that a bomb might jam the rudder, derange the alignment of the shafts, or cause other damage that would affect the steaming or maneuvering capacity of the ship.

Of the lessons taught by the demonstration the following might be cited.

1 Aircraft is a weapon of such great value as to warrant the immediate expansion of the service; among other things, by the construction of aeroplane-carrier vessels of large size and great speed. No need in the United States Army is said to equal today that for ships of this type, of which there is none either built, building or authorized.

2 For coast defense, aeroplanes are indispensable and are weapons of the first magnitude.

3 Heavy bombs should be employed from the very outset of the attack, except in special cases.

4 Close-by, under-water hits are more deadly than direct hits on the decks or hits on the surface of the water. Under-water explosions can be obtained by delayed fuse action, and, as a matter of fact, the heavy bombs had a delayed action of $1^{1}/_{5}$ sec.

5 There must be a change in the design of surface craft with increased watertight integrity, and war vessels must be provided with better means of protection from both explosive and gas bombs.

At the same time the speaker pointed out that aviation is in its infancy, while battleship construction represents the advanced thought and skill of a century. The margin of development undoubtedly lies with a new service. (*Journal of the United States Artillery*, vol. 55, no. 5/183, Nov. 1921, pp. 390–399, *g*)

MOTOR-CAR ENGINEERING

British 200-Mile Rate and Its Lessons, "A Competitor." One of the striking features of the British 200-mile race limited to cars of 1500 cu. cm. was the high crankshaft speed employed and the reliability of the multi-valve head. Speeds were as high as 4000 r.p.m. (*The Autocar*, vol. 47, no. 1359, Nov. 5, 1921, pp. 864–865, *g*)

Progress in Light Cars, "Runabout." The success of some small cars in the Scottish six-day trial and their ability to handle all requirements of general travel have led to what appears to be

a stampede to produce cheaper and lighter cars, and a good many of them appear to be quite satisfactory.

Some of these cars like the 8-hp. air-cooled Rover have given apparently excellent satisfaction. It is, however, stated that air cooling is still in its infancy and, for example, the Rover has to be decarbonized about every 800 miles. Also the twin-cylinder engine is apt to be somewhat noisy. Improvement is, however, being rapidly made in both directions.

As regards performance, it is stated, for example, that a speed Hillman does 45 m.p.h. uphill on middle gear and is very economical both in oil and fuel consumption.

An important feature in this connection is that not only the smaller firms but also some of the leading concerns are becoming effectively interested in the production of small cars.

As regards the economy of the small cars, it is stated that 35 miles per gallon is common and as high as 50 miles has been attained, together with 1500 miles per gallon of oil. At the same time, however, it should be remembered that the cost of running a small car is very much higher in England than it is in America. In the first place, a car of the Hillman type costs somewhere around £400, or roughly $1500, although 8-hp. models are available in the market at prices as low for British conditions as £250 ($950). (*The Autocar*, vol. 47, no. 1359, Nov. 5, 1921, pp. 879–882, 6 figs., *g*)

General Survey of the Mechanical Features of British Automobiles for 1922. An article based on the features shown at the Annual Automobile Exhibition in London. In the broadest sense, the typical car of 1922 as exemplified by the show meets the following specifications: Four-cylinder water-cooled block engine with side valves; magneto ignition; cone clutch; four-speed side-chain gear box; spiral bevel final drive; semi-elliptic springs; wire wheels.

There is, however, a strong tendency toward the use of overhead valves, detachable cylinder head, single-plate clutch, disk wheels and possibly four-wheel brakes.

The four-cylinder engines still hold the leading position; detachable cylinder heads are becoming common practice, and the joints are being so arranged that the gasket has to be compression type only, while separate joints, sometimes in the exterior of the engine, attend to the necessary water circulation between cylinder jacket and head jacket.

Water cooling remains standard for the engines of larger cars, but air cooling for smaller vehicles is used and a new system of air cooling has made its appearance. As regards air-cooled engines, it has been found that the cylinders become rapidly carbonized with burned oil. Also an excess of oil in the combustion chamber is a prolific source of spark-plug troubles.

In one car this year there is used an engine which is oil-cooled, the method being to increase to about double the quantity of oil carried and to give it a free circulation over the outside of the cylinder walls, the outside of the valve seats, the valve stems and springs, the inside walls of the cylinders and the interior surfaces of the pistons. Preliminary tests have been satisfactory.

Cast iron appears still to be the favorite material for pistons. Of late there has been a tendency to decrease the thickness of piston rings and it is becoming common to use for narrow rings fitted to each piston, three compression rings at the top and a scraper ring at the bottom of the skirt.

As regards valves, the use of multiple valves has not made much progress in touring-car engines. Overhead valves are, however, steadily gaining in popularity, especially on engines of small cubical capacity.

Skew gears and spiral bevel gears are used, but the production of a gearing sufficiently quiet and inexpensive is a matter which taxes the ingenuity of engineers. The regular practice is to use an overhead valve gear operated by push rods from a camshaft containing in the crankcase, which is easier to manufacture commercially.

In regard to lubrication and carburation, the situation in England appears to be essentially the same as in America.

The outstanding feature in brake design is the introduction of front-wheel and four-wheel systems. It is only questions of expense that retard the adoption of front-wheel brakes for the less expensive cars, but much experimenting is in progress. In most cars where the open propeller shaft is used, the transmission brake is employed; also opinion is veering round to the idea that a compensating device is not necessary for rear-wheel brakes, but that some form of linkage which allows a slight spring is effective and less liable to get out of order.

Disk wheels are making steady progress, owing to the fact that they can be produced cheaply and are very easy to keep clean. Most of the small cars are now fitted with disk wheels, the sole objection being their liability to exaggerate any noise emitted by the back axle. (*The Autocar*, vol. 47, no. 1360, Nov. 12, 1921, pp. 945–953, illustrated, *g*)

PIPE (See Mechanics)

POWER-PLANT ENGINEERING (See also Air Machinery)

Preheating Air to Furnace by Flue Gases, E. R. Welles, Mem. Am.Soc.M.E., and C. T. Mitchell. The problem as to whether air delivered to furnaces can or cannot be preheated by flue gases is more an economic than a mechanical one, the chief concern being to find how large an apparatus can be built and still obtain a reasonable return on the investment.

Economy from preheating air would manifest itself in reducing coal consumption per unit of power output, as such coal would be needed to preheat the air in the furnace. In other words, the beginning of the heat cycle would be moved up a notch.

In regard to the furnace control with hot air, there is the choice of two courses. The quantity of air can be reduced in proportion to the reduction of coal, thus raising the furnace temperatures and probably lowering the stack temperatures. All conditions can be maintained as they were with cold air, using enough warm air to keep the furnace temperatures, and hence also the stack temperatures, unchanged.

From such evidence as the authors have we should expect no trouble regarding furnace control, but a greater tendency to burn out the grates and tuyeres, increasing with the temperature of the air.

Preheating would be particularly helpful with powdered coal and would immediately widen its field of application.

In order to determine the economical size of a preheater, the writers attempt to develop an expression for the efficiency of such a unit for varying capacity of heating surface. To do this they assume that the heat-transfer apparatus consists of a sheet-metal condenser filled with steel tubes. The flue gas travels through the tubes and the cold air around the tubes, or vice versa, the flow being countercurrent in order to keep the temperature difference nearly constant. The weight of the flue gas per hour is taken the same as the weight of air and the velocity of the two and specific heat are the same, the latter being 0.25. The final formula for the efficiency of the heater under these assumptions is—

$$\frac{1}{\frac{W}{2AK}+1}$$

where W = lb. of air per hr.; A = heating surface of the preheater in sq. ft.; and K = heat-transfer rate in B.t.u. per sq. ft. per hr. per degree temperature difference between the surface of the tube and the adjacent air. (This quantity must also take care of any mechanical or structural limitations in the heater.) The proper value for K here is of determining influence and yet it is still quite uncertain, and all things considered the writers expect the value of K in a properly designed heating unit to be not less than 4 and possibly as high as 10. From this point of view the diagrams in Fig. 12 become of interest. Each curve has a point of greatest curvature and it is to be anticipated by the correct size of the heater for any given set of conditions will lie approximately under that point. If we know the cost of heaters per square foot and also the true value of K, it becomes a simple matter to determine the size of heater giving the greatest net return on the investment.

A numerical example is given in the original article. The entire matter seems to be yet in the initial stages of development, and as an editorial in the same issue of *Power* (p. 84) points out, the commercial success of an air preheater is still uncertain. (*Power*, vol. 54, no. 22, Nov. 29, 1921, pp. 844–846, 1 fig., *dg*)

The Design of an Internally Fired Superheater, Prof. W. R. Woolrich, Mem.Am.Soc.M.E. Some dats of work done along these lines at the University of Tennessee. Experiments were tried as early as 1910 at the University of Tennessee to superheat steam by the combustion of gas, the burner operating within the steam main against the steam-main pressure. In 1916–17 a design was assembled by the author. Fundamentally, the apparatus consisted of a commercial air-atomizing oil burner designed for high pressures with its tip projecting into the steam pipe. In actual tests with a burner ignited and the steam line closed, it was found that no adjustment would give a suitable flame at the burner tip and as soon as the outside supply of air was shut off the flame would go out. This was because the commercial oil burner is designed to secure only a part of its air supply from the inside, replying on the surrounding air to make up the deficiency.

In 1919 H. E. Ayres took up the problem as an undergraduate thesis. In this case a new burner was made up representing a combination of two standard oxy-acetylene welding torches with several added features.

This work was continued by O. A. Kraehenbuehk, but the results at first were very unsatisfactory. No difficulty was experienced operating the burner in the closed main without steam, but when the steam was turned on at any working pressure the flame would be extinguished.

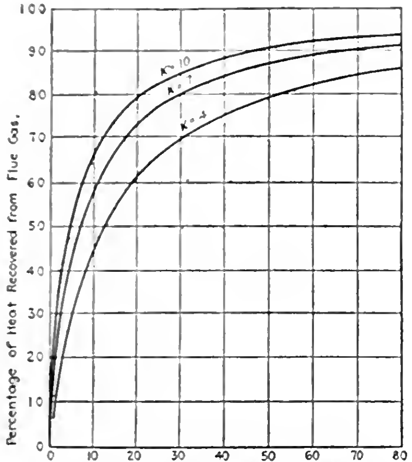


Fig. 12 Curves Showing Relation Between Size of Air Preheater and Recovery of Heat in Flue Gas (*K*-Heat-Transfer Rate)

After a series of adjustments operation was secured but of a very erratic character, the burner at times working steadily for periods as long as an hour. On the whole it has been proved that gas can be burned in the presence of high-pressure steam, but the influence of non-condensable by-products supplied to the steam by these means on condensation has not been determined.

The method may be applicable, however, to superheating of exhaust steam to be used in dye tubs, laundries, and, generally, processes where steam temperatures over 212 deg. fahr. are required. (*Power*, vol. 54, no. 19, Nov. 8, 1921, pp. 717–718, 2 figs., *d*)

Waste-Steam Turbine at Coal Mine

Mixed-Pressure Turbine Installation with a Regenerator at a Coal Mine, C. W. Smith. Description of the power plant recently installed at the Nokomis Mine in Illinois.

Prior to the installation of the plant all electric power used was purchased from outside, while the hoist, fan engine and several pumps were supplied by steam from six horizontal return-tubular boilers. This system resulted in very high operating costs for power, especially during periods of slack work. The costs have increased still more in the last two years when the power companies' rates were almost doubled. Another objection to this system of operation was the numerous and expensive shutdowns caused by frequent failures of the utility plant to deliver current.

Because of this it was decided to install a power plant sufficient to take care of all requirements. In order to conserve steam it was decided to electrify all machinery on the surface with the exception of three car-puller engines. This not only decreased steam consumption generally but reduced condensation in the various steam lines.

In order to utilize the waste steam from the hoist engine a mixed-pressure turbine was selected for the main unit of 1000 kw. capacity, in addition to which a 300-kw. high-pressure turbine was installed to handle the night load.

The system is as follows: The exhaust steam as it comes from the hoist engine passes through an 18-in. header to the Rateau regenerator. This is 9 ft. in diameter and 25 ft. long and is equipped with back-pressure valves set at 3 lb., which is the maximum back pressure on the hoist engine. From the regenerator the exhaust steam passes through an oil separator to the low-pressure side of the turbine. When the pressure in the regenerator falls to about 1.5 lb. per sq. in. below the atmospheric pressure, the governor on the mixed-pressure turbine automatically admits enough live steam to carry the load until the pressure in the regenerator is again sufficient to carry the load alone. The 300-kw. high-pressure turbine is equipped with a jet condenser. The circulating water from this condenser is not passed through the spray nozzles handling the cooling water on the main condenser, as this would require an additional circulating pump. This cooling water is allowed to circulate from the discharge near one end of the pond to the suction line on the opposite end. During the normal operation for which this unit was intended this arrangement is entirely satisfactory. Even in the summer months the temperature of the pond rises only a few degrees. When this unit has to be operated for more than 16 hr. a day, as sometimes happens when the mine is not working, the circulating pump on the large condenser is operated once or twice a day for a period of approximately an hour in order to cool down the temperature of the pond. This has proved a highly satisfactory manner of eliminating an additional circulating pump and of saving the power required for its operation.

It is stated that no trouble has been encountered as regards the performance of the mixed-pressure turbine in shifting from high-pressure to low-pressure steam under variable loads. It has also been found that the regenerator instead of increasing the back pressure on the hoisting engine has caused it to be reduced. However, the original exhaust lines were too small. Under conditions existing at the Nokomis Mine only two men have had to be added to the power-plant force since this plant was put into operation.

The installation is of considerable interest to deep-shaft mine engineers. The steam hoist has been considered rather wasteful to operate, and if this wastefulness can be overcome by the installation of a mixed-pressure power plant, this would tend to increase materially the field of usefulness of this latter. (*Coal Age*, vol. 20, no. 19, Nov. 10, 1921, pp. 753–757, 7 figs., *d*)

PUMPS

Centrifugal Pumps in Sugar Refineries

Centrifugal Pumps in Sugar Refinery, Claude C. Brown, Mem.Am.Soc.M.E. For various reasons motor-driven centrifugal pumps are rapidly growing in favor in sugar-refining work, but the type of pump used has some special features developed to meet sugar needs and conditions.

In Western sugar-refining plants where great quantities of salt water are used for condensing purposes in connection with the boiling of sugar in vacuum pans, the pumps are situated on the ground floor of the plant where they have a suction lift from the bay of from 12 to 15 ft. according to the tide and a lift of approximately 150 ft. to the pan condensers. When first installed trouble developed. Thus, it was difficult to hold the suction at low tide, as air was finding its way into the pump suction. The introduction of this air was eliminated by tightening all leaks in the suction line, smoothing it out and eliminating air pockets and sharp turns. Furthermore, it was found that at the points in the casing casting adjacent to the runner hub there were shoulders which still continued to act as air pockets. These shoulders were vented to the outer casing with a 1/4-in. line which effectually destroyed any detrimental effect they might have had.

The method of priming these pumps is of interest. A small vacuum pump was installed near the battery of pumps and a $^1/_2$-in. line run to each pump. When it is desired to start one of the centrifugal pumps, the small vacuum pump is started first and any number of salt-water pumps can be primed immediately.

As first installed the salt-water pumps consisted of cast-iron casings with bronze and cast-iron runners and shafts made of Cumberland steel. Before very long powerful corrosion set in, affecting both casing and runner. The cast-iron casing was then replaced by a bronze casing, and the Cumberland steel shafts by shafts of 3 per cent rolled nickel steel. Further, bronze sleeves were shrunk on over the portions of the shaft that were inside the pump, after which all trouble from corrosion disappeared.

For the pumping of liquors, syrups, etc., other questions of corrosion and erosion came up. Here again the most successful results were obtained with combinations of bronze casing, bronze runner, and steel shaft with bronze bushing. This withstood corrosion but not erosion, and where this latter was especially noticeable, cast-iron casing, chrome-vanadium steel runner and monel-metal shaft were used which gave good satisfaction.

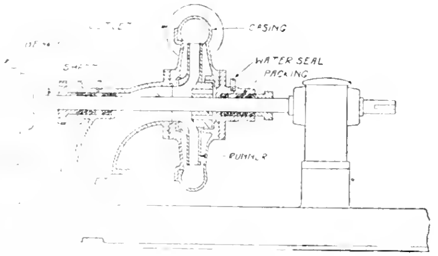


Fig. 13 Centrifugal Pump with Water-Sealed Packing for Pumping Sugar Solution

In the pumping of sugar solution it is absolutely necessary that this latter shall not come in contact with the pump packing. Because of this water-sealed packing (Fig. 13) is used. A $^1/_4$-in. line of fresh water is connected within each packing gland and just enough water allowed to enter the gland to seal it and prevent the sugar from coming out.

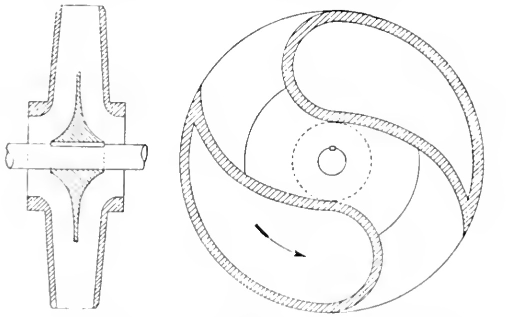


Fig. 14 Sewage-Type Runner with Double Suction

As regards the question of type of pump runner, it has been found in sugar plants that the most successful type for general all-round requirements is the sewage-type runner (Fig. 14). The open-type runner, which resembles an open star, has also proved successful, particularly for pumping liquids which have matter in suspension. (*Power Plant Engineering*, vol. 25, no. 22, Nov. 15, 1921, pp. 1087–1088, 4 figs., *d*)

SPECIAL MACHINERY

Bar Mills Adapted to Handle Alloy Steel, J. D. Knox. Description of a new unit built by the Central Steel Company, Massillon, Ohio, the characteristic feature of which is that care has been taken to adapt the mill to peculiarities of alloy steel. Only some of the features can be noted here. Thus, the motors driving the 16- and 12-in. roll trains are cooled by air washed in a Carrier-type washer.

The 18-in. finishing mill is driven by a 2200-hp. variable-speed motor designed to operate from 303 to 505 r.p.m. The gear set with a ratio of 115 to 34 provides various roll speeds ranging from 90 to 150 r.p.m. (*Iron Trade Review*, vol. 69, no. 20, Nov. 17, 1921, pp. 1275–1281, 11 figs., *d*)

SPECIAL PROCESSES

Bending Lock-Seam Tubing. Lock-seam tubing is made with the folded seam. Such tubing can be used for automotive exhaust manifolds providing it can be bent to the forms required for this purpose without opening the seams. The method of making the bends by first filling the tubing with molded lead or rosin was found, however, to be too expensive for commercial production.

In order to meet this problem a special form was made for use on a No. 5 pipe-bending machine by the Wallace Supply Manufacturing Co. of Chicago, Ill. This equipment is so designed that the work is continually supported around the complete circle both inside and outside at the point of bending. The form around which the work is bent is grooved to embrace half the circumference of the pipe and a similar grooved follower embraces the other half of the pipe. There is a mandrel of the same size as the inside diameter of the work to be bent. As the pipe is bent around the form both the follower and mandrel move with it, so that they always support the work at the point of bending and the metal is made to flow. (*Machinery*, vol. 28, no. 4, December 1921, pp. 289, *d*)

STEAM ENGINEERING (See also Engineering Materials)

Investigation of Breakdown of 30,000-Kw. Turbine. Data of an investigation by Prof. H. F. Moore, Mem.Am.Soc.M.E., and Geo. L. Kelley of the accident to the 30,000-kw. turbine of the Philadelphia Electric Co. which occurred on Saturday morning, Sept. 3, 1921.

The machine was being tested for overspeed and was gradually brought to 9 per cent above its normal speed of 1500 r.p.m.; the throttle was then closed by the governor, and the machine began to slow down. A few seconds after the main throttle had closed a loud hissing noise was heard, instantly followed by two heavy crashes and a shower of broken pieces of metal.

The investigation has shown that the low-pressure casing was cracked, the steam passages from the high- to the low-pressure stages were broken, all the shaft bearings were broken and the 20-in. mainshaft likewise.

The following explanation is offered by Professor Moore: Under running conditions the passage from the high-pressure to low-pressure stages is under a bursting pressure considerably greater in magnitude than the collapsing pressure existing when there is a vacuum in the passage, and moreover the casting is designed with stiffening ribs on the outside, so that under bursting pressure the bulging of the passage will tend to cause the ribs to be in tension in their outer fibers and the plates to be in compression. Under vacuum this state of affairs would be reversed. He believes, therefore, that it would seem unlikely that the steam-passage casting would fail when the interior was under vacuum and the fractures are explained as secondary failures.

One of the most striking features of the wreck was the breaking of the mainshaft and the tearing up of the surface of the exciter armature. The character of the metal at the break would lead one to believe that there was dragging of one piece of metal over the other as fracture occurred.

As regards the primary cause of failure, a theory was offered to the effect that a polepiece of the exciter field became loose and was jammed into the armature, causing enough twisting or bending to break off the exciter frame and the main shaft, throwing the remainder of the shaft sufficiently out of line to cause the wreck of the turbine disk and bearing. The state of the armature would appear to support this theory.

From all evidence it would appear that the failure of the main shaft was one of the last events in the wreck.

The fractures in the turbine disk show evidence of a progressive crack ascribed to the existence of lateral vibrations in the disk. This again is explained as follows: The steam jet enters on one side of the buckets and leaves from the opposite side, any frictional lateral drag from the steam being all the time in one direction. As the disk revolves the steam must strike on any given blade with a regular rhythmical variation of force. At certain speeds this rhythmical variation might be so nearly in tune with the natural period of lateral vibration for the disk that severe repeated bending stresses would be set up. Moreover, these lateral vibrations may have been numerous enough to develop such a typical progressive fracture as was found in this case.

In addition, it was found that the turbine disk had only a rough surface finish and carried deep tool marks which might have served to localize the effects due to sidewise vibration. In fact, recent tests at the University of Illinois made in the course of the joint investigation on fatigue of metals have shown that such surface conditions might reduce the ability of the disk to resist lateral vibrations by as much as 20 per cent.

If the primary cause of the wreck were a progressive failure of the disk, it is easy to show that the wreck might be expected to occur at a time when for any reason the speed is particularly high. In this instance, for test purposes the speed was increased to 109 per cent of its normal magnitude which resulted in an increase of centrifugal force to 1.19 times its normal value, which is a very material increase indeed. (*Power*, vol. 54, no. 21, Nov. 22, 1921, pp. 788–793, 13 figs., *dg*)

STEAM TURBINES (See Mechanics)

SUGAR REFINERY (See Pumps)

TESTING AND MEASUREMENTS

Measurement of Air Velocities and the Testing of Anemometers, Jas. Cooper. The two best-known methods of measuring air velocity in mines, namely, by the anemometer and by means of smoke, are both liable to serious error. In particular, as regards anemometers, the friction of the parts has the effect of making anemometer readings correct for only one particular velocity. At other velocities accuracy can be achieved only by corrections for the influence of friction, and at low velocities the corrections may be greater than the speed registered by the instrument.

In view of this, means for testing anemometers have been provided at the Heriot Watt College in Edinburgh. There is already in England an installation for testing anemometers at the National Physical Laboratory, but they are not tested there at velocities lower than 600 ft. per min., while air speeds under that figure are common in mines and the need for calibration is particularly imperative for velocities below 300 ft. per min. The testing table used for calibrating anemometers is described and it is stated that figures obtained from the tests have been compared, first, by observation of smoke velocities, and second, by walking tests with the meters over a measured straight line in a still atmosphere.

The data of tests were charted and it was found that although the charts plotted from the tests were similar in form to those sent out by the makers of the instruments, the figures of correction varied widely. (Paper presented in October, 1921, before the Mining Institute of Scotland, abstracted through *The Iron and Coal Trades Review*, vol. 103, no. 2798, Oct. 14, 1921, p. 540, *ep*)

Friction of Cup-Leather Sleeves

Tests on Cap-Leather Sleeve Friction, Eugen Irlon. In the measurement of power in testing materials with machines operated by means of levers or weights or the like, precision to within 1 per cent is usually obtainable with comparative ease. On the other hand, when the power is applied by hydraulic means, its measurement is complicated by the fact that considerable friction is present at the cup-leather sleeve, depending on the fluid employed as a pressure medium and the material of the packing, and therefore subject to considerable variation. As a matter of fact, unless this friction is measured quite frequently, considerable errors in final results of measurement of power applied may be found. Data of such tests of friction in cup-leather sleeves are presented in this article. All the data in the abstract will be given in the original metric units and the conversion factors to American units appended in a note at the end of the abstract.

This is not the first attempt to measure such friction and an investigation on the same subject has been published by A. Martens in the *Zeitschrift des Vereines deutscher Ingenieure*, 1907, p. 1184.

The present tests were carried out in a 75-ton hydraulic bending machine water-driven by a three-piston electric pump. The pressure cylinder had a useful piston area $F = 380.13$ sq. cm. (58 sq. in.) The dial of the pressure gage was graduated in atmospheres and kilograms.

The division into kilograms was obtained experimentally by using the average friction value obtained by Martens and by adding this value to the pressure in kilograms as obtained from the equation—

$$P = Fp \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where P is the theoretical pressure, F the piston cross-section in square centimeters and p the pressure in the pressure cylinder in kilograms per square centimeter. This gave Equation (1) the form—

$$P_1 = (F\,p + F\,\frac{pR_p}{100}) = Fp\ \left(1 + \frac{R_p}{100}\right) \text{ in kg} \ldots\ldots (2)$$

where P_1 is the actual pressure in kilograms, and R_p the cup-leather sleeve friction in per cent as found by Martens.

The total friction was measured by a special gage having a maximum range of 100 (metric) tons (=110 short tons). Two other pressure gages were used with ranges of 100 tons and 200 tons, respectively, the errors of which were determined by careful calibration. Table 1 gives the friction values found by Martens in 1907 as percentages of the pressure in kilograms per square centimeter. The values in column 2 have been calibrated from Equation (1), and the values in columns 3 and 4 taken directly from the tests of Martens. By adding the values in columns 2 and 4 are obtained the values of column 5 giving a total effective pressure p_1 in the pressure cylinder in kilograms per square centimeter.

The tests have shown, as is evident from Table 2, that the differences between the actual experimental data as shown by the gage and the values in the curve of Martens (curve *A*, Fig. 15) in ordinary cases do not amount to more than 0.5 to 1.1 per cent, and that therefore the data of the two series of tests are in fairly good agreement.

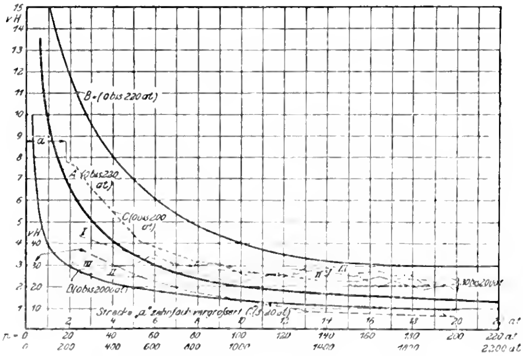


Fig. 15 Curves of Cup-Leather Friction

(Curve *A*, Martens; curve *B*, Puppe; curves I, II, III, author's tests on 300-ton concrete press; curve *C*, author's tests on 75-ton bending machine. (*Bis* = to; *at.* = atmospheres; *vH* = per cent; *Strecke "a" zehnfach vergroessert* = section "a" magnified ten times.))

On the other hand, however, in nearly all cases the sleeve-friction values as obtained by the present author were higher than those obtained in the Martens test, which may be due to the fact that the pressure fluid in the present instance was not entirely free from dust and fine grains of sand, which is also the usual condition in actual operation. It was also found that the first measurements carried on after a period of several hours of rest of the measurement always gave slightly higher friction values than later tests. This was particularly so in early morning tests which followed the idle period of 10 to 15 hr. when the leather cup had a chance to become dry. After the piston has moved up and down for some time the

values come back to within 0.5 to 1.1 per cent of the Martens values. The friction values obtained by Dr. Eng. Puppe in 1910 are given in curve *B* for the sake of comparison. Furthermore, the present author has carried out several comparative tests during the war on a 300-ton concrete press.' The data of these tests are given in curves I, II and III, Fig. 15. All these curves agree fairly well with each other, though the high frictional values of Dr. Puppe would indicate that at high pressures rubber packing rings produce a considerably higher friction than leather cups.

In Fig. 16 is graphically indicated the relation between the load *P* and the friction R_p. From the appearance of the curve of friction it would seem that at a pressure of 10 tons, or roughly 25 atmos., the pressure amounts to only 6.6 per cent, while at 75 tons, or, say, 200 atmos., it is only 2.1 per cent.

The division of the pressure-gage dial into kilograms appears to be a material improvement in testing machines. In the majority of cases one may allow an error of ± 2.5 per cent, although a greater precision can be obtained by the use of a control manometer.

Table 3 gives the cup-leather friction in percentages of *Fp* and *f p*, where *f* = 350 sq. cm. is the sum of all surfaces of the cup leathers in friction. The values in the last column are also of interest as they give the coefficients of friction of cast iron against leather at various pressures per unit of area. [Note: 1 sq. cm. = 0.1550 sq. in.; 1 kg. per sq. cm. = 14.223 lb. per sq. in.; 1 metric ton = 1000 kg. = 2200 lb.] (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 39, Sept. 21, 1921, pp. 1016–1017, 2 figs., *eA*)

TABLE 1 COEFFICIENTS OF FRICTION (MARTENS)

(1) *P* tons = 2200 lb.	(2) *p* Atmospheres	(3) Per cent	(4) Atmospheres	(5) Atmospheres
1	2.63	....	....	......
2	5.27	....	....	......
3	7.9	....	....	......
4	10.54	....	....	......
5	13.17	....	....	......
6	15.8	....	....	......
7	18.43	....	....	......
8	21.1	....	....	......
9	23.7	....	....	......
10	26.3	5.6	1.48	27.78
15	39.5	4.3	1.70	41.2
20	52.7	3.4	1.79	54.49
25	65.8	2.8	1.84	67.64
30	79.0	2.5	1.98	80.94
35	92.3	2.2	2.03	94.33
40	105.4	2.0	2.1	107.5
45	118.5	1.9	2.25	120.75
50	131.7	1.8	2.37	134.07
55	145	1.75	2.54	147.54
60	158	1.65	2.61	160.61
65	171	1.60	2.74	173.74
70	184.3	1.55	2.86	187.16
75	197.1	1.55	3.06	200.16

TABLE 2 DIFFERENCES BETWEEN THE FRICTION VALUES AS FOUND BY MARTENS AND AS INDICATED BY GAGE, IN PER CENT

	Atmospheres								No load
	10	20	30	40	50	60	70	75	
1	1.05	0.45	0.85	0.75	0.27	0.48	0.11	0.40	0.55
2	0.9	0.83	0.33	0.40	0.43	0.48	0.33	0.29	0.33
3	1.1	1.00	0.85	0.75	0.40	0.46	0.39	0.25	0.56
4	0.9	0.90	0.85	0.34	0.94	0.66	0.87	0.66	0.76
5	1.1	0.98	0.63	0.68	0.95	0.71	0.74	0.58	0.48
6	0.99	0.80	0.76	0.65	0.79	0.35	0.91	0.58	0.63
7	0.75	0.95	0.68	0.79	0.82	0.88	0.61	0.66	0.59
8	1.13	0.30	0.55	0.83	0.64	0.73	0.84	0.52	0.48
9	0.88	0.86	0.76	0.53	0.66	0.53	0.69	0.63	0.59
10	0.76	0.90	0.82	0.70	0.49	0.67	0.47	0.82	0.75
Average	0.96	0.80	0.71	0.64	0.64	0.59	0.60	0.54	....

TABLE 3 SLEEVE FRICTION IN PER CENT OF F_p AND f_p AS FOUND EXPERIMENTALLY BY AUTHOR

P = *pF* tons	*p* Atmospheres	*fp* kg.	Friction in Per cent of F_p	Friction in Per cent of f_p
1	2.63	920	37	40.3
2	5.27	1815	25	27.2
3	7.9	2770	17	18.5
4	10.61	3500	12.5	13.6
5	13.17	4600	9.3	10.1
6	15.8	5530	8.9	9.65
7	18.43	6450	8.4	9.1
8	21.1	7400	7.6	8.25
9	23.7	8300	7	7.6
10	26.3	9200	6.56	7.13
15	39.5	13800	5.45	5.93
20	52.7	18150	4.20	4.55
25	65.8	23050	3.75	4.07
30	79.0	27700	3.21	3.49
35	92.3	32350	3.00	3.26
40	105.4	35000	2.64	2.87
45	118.5	41500	2.55	2.77
50	131.7	46000	2.44	2.65
55	115	50700	2.35	2.55
60	158	55300	2.24	2.44
65	171	59800	2.20	2.40
70	184.3	64500	2.15	2.34
75	197.1	69000	2.10	2.28

VARIA

Agitation for Changes in Canadian Patent Law. John Munnock, Division Court Clerk of the Sault Ste. Marie District, in speaking before the Board of Trade of that town, advocated important changes in the practice of the Canadian Patent Act.

Under the law Americans obtaining patents in Canada are required to begin manufacture in Canada within two years, but may obtain an extension for one more year. It is claimed that this provision of the Act is not enforced and that there are 10,000 articles that could have been manufactured in Canada but are instead imported from America.

It is also claimed that even if an American patentee failed to meet the requirements of the Act as regards manufacture in Canada, he can still obtain an injunction against a Canadian manufacturer infringing his patent.

To meet this situation, the speaker proposes a closer check on the compliance of foreign patentees with the requirements of Canadian laws, and it is claimed that he has carried the matter to Premier Meighen, who is said to have expressed regret that action could not have been taken by the government prior to election.

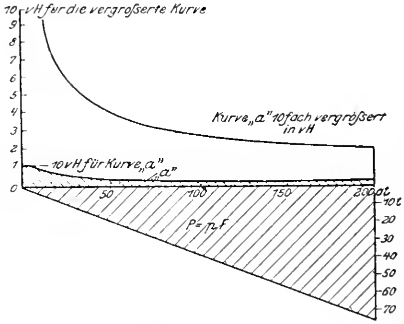


Fig. 16 Relation Between Load *P* and Friction *Rp* for Loads from Zero to 200 Atmos.

(*vH für die vergroesserte Kurve* = per cent for the magnified curve; *Kurve "a" 10fach vergroessert in vH* = curve "a" magnified ten times in per cent.)

The subject was expected to come up for discussion at the Brantford Convention of the Canadian Associated Boards of Trade in November, 1921. This matter affects a large number of American products, among others being American typewriters, cash registers, adding machines, check protectors and machine tools. (*Canadian Machinery and Manufacturing News*, vol. 26, no. 21, Nov. 24, 1921, p. 52, *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Starting Aero Engines at low Temperatures. (Air Board, Ottawa, Canada, Technical Memo No. 15.) From preliminary reports of Experiments carried out last winter by Professor Robb, at Edmonton, it is suggested that the following means of starting Liberty engines at low temperatures may be found to be effective. A complete report will be circulated as soon as received. It is suggested that for the efficient doping of the engines some form of priming pump similar to the Rolls-Royce primer is necessary. At temperatures over 20 deg. fahr., liberal doping with gasoline is sufficient except that the motor will require to be turned over several times after doping to ease it up. At temperatures between 20 deg. fahr. and ten deg. fahr. doping with a mixture of three parts gasoline to one part of ether will be found to be effective. At temperatures around zero, a one to one mixture is satisfactory. At temperatures in the neighborhood of 12 deg. below zero, it will be found that a mixture of two parts ether to one part gasoline is required.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A —RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A1-22. SCALES. Technologic Paper 199 of the Bureau of Standards outlines scientific and systematic procedure for accurate testing of large-capacity compound lever scales by a method developed by the Bureau. Apparatus is described and method of testing is explained. Paper may be obtained at a cost of 5 cents from the Superintendent of Documents, Washington, D. C.

Cement and Other Building Materials A1-22. BRICKS. Sand-Lime and Other Concrete Bricks is the subject of Special Report No. 1 of the Building Research Board of Great Britain. The report is divided into two sections, one on sand-lime bricks, the other on cement-concrete bricks. Each section treats of materials, costs, quality, uses and manufacture. It may be obtained at 4d from Imperial House, Kingsway, London, W. C. 2.

Friction and Allied Subjects A1-22. BALL AND ROLLER BEARINGS. Technologic Paper 201 of the Bureau of Standards describes the tests and gives the conclusions of tests performed on ball bearings and flexible roller bearings under various loads with balls and rollers of different sizes and different hardness with varying radii of races. This report is of great value to any one interested in design of ball and roller bearings. This may be obtained at 10 cents per copy from the Superintendent of Documents, Washington, D. C.

Fuels, Gas, Tar and Coke A1-22. THE COKING OF UTAH COALS. The Coking of Utah Coals is the subject of Report 2278 by Prof. S. W. Parr and T. E. Layng to the Bureau of Mines. Approximate and ultimate analyses were made. The oxygen content was very high. The oxygen-hydrogen ratio was also very high. This indicates a non-coking property. The preliminary tests seem to indicate this but this feature was overcome and a good quality of coke obtained accompanied by a series of by-products of more than usual interest and value. The ammonium sulphate produced was exceedingly constant and averaged 20 lb. per ton. Large-scale operations would probably increase this. The gas yield was low, being 3½ cu. ft. per lb. of coal. The production of gas was very uniform. The heating value of the gas was large. The tar yield averaged 25 to 30 gal. per ton. The coke yield amounted to approximately 60 per cent of the coal employed. It was dense, of good texture and adapted to the usual screen and sizing process. It would probably be suitable for metallurgical purposes. There is considerable volatile matter present in the coke varying from 8 to 12 per cent. The temperature used to carbonize the Utah coals did not exceed 750 or 800 deg. cent. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A2-22. NATURAL GAS-GASOLINE BLENDS. Report 2279 of the Bureau of Mines on Natural Gas-Gasoline Blends, by D. B. Dow, was issued last September. Natural gas-gasoline is obtained by compression and collecting of natural gas. The gasoline dissolves a certain amount of volatile material which evaporates rapidly at atmospheric temperature and pressure. With lean natural gas the gas vapors are absorbed by absorbing oil, after which it is distilled from the saturated oil. This gasoline is of higher gravity and lower vapor pressure than the compression gasoline. To transport the volatile gasoline it must be blended with suitable material such as naphtha or weathered, in which case the volatile portion is allowed to evaporate causing loss. It is difficult to produce blended gasoline which is equal to refinery gasoline. Hence only a small amount of gas-gasoline can be blended with naphtha. Blends are sometimes made with kerosene and subsequently distilled, the kerosene acting as a carrying agent. Most common material is of naphtha range from 50 to 52 Baumé. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A3-22. RECOVERY OF UNBURNED FUEL FROM BOILER FURNACE REFUSE. Report 2281 of the Bureau of Mines on the Recovery of Unburned Fuel from Boiler Furnace Refuse, by Thomas Fraser and H. F. Yancy, has just been issued. The report shows that washing may be used to recover a large portion of the unburned fuel. The results of the test showed that with $^3/_8$-in. screening and $^1/_8$-in. oversize 20 per cent of the refuse was regained as washed fuel. A one-table plant will handle five tons of boiler refuse per hour, producing one ton of fuel. The equipment for such a plant would consist of a roll crusher, a storage hopper, a screw conveyor, washing table and two inclined dewatering drag conveyors. If water is scarce or costly, overflow from sumps may be clarified and returned to the system. The operation would require the part time of one man. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Heat A1-22. HEAT-TRANSFER COEFFICIENT. The heat transfer between hot and cold oil in double-pipe heat interchanger used in distilling gasoline shows an average value of 20.05 B.t.u. per hour per degree per sq. ft. In most cases the mean temperature difference computed by the log formula was about 70. The efficiency of heat transfer in apparatus averaged 78 per cent on account of radiation. Information is from reliable source but name is withheld.

Petroleum, Asphalt and Wood Products A1-22. VISCOSITY OF PETROLEUM OILS. The following notes are obtained from the thesis of Mr. Achille R. Albouze on the Logarithmic Relation between Temperature and Pressure of Petroleum Oils:

The logarithms of temperature and absolute viscosities of the oils were plotted and there was found to be a close adherence to a straight-line law from ordinary room temperature of 70 deg. fahr. to temperatures of 180 to 220 deg. fahr., depending upon the nature of the oils. Around this region of temperatures (180 to 220 deg.) there appears to be a "break" in the straight-line law, but after passing this critical point the oils then invariably follow another straight-line law up to 300 deg. fahr., but at a lesser rate of change of viscosity than at the lower temperatures. In other words, the absolute viscosities of the oils may be represented as two intersecting straight lines as far as 300 deg. fahr.

This critical point where the lines seem to break off is fairly uniform, as was evidenced on plotting gravities, absolute viscosities at 100 deg. fahr. and temperatures at which the breaks in the straight lines occurred. A study of these curves shows:

1 That the greater the density and absolute viscosity of an oil, the higher is the temperature at which the break occurs.

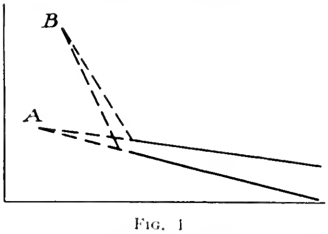


FIG. 1

2 The lines showing relations between viscosity and the "critical breaking temperatures" parallel themselves to a degree of remarkable closeness.

3 Oils of specific gravity below 0.9 show higher "breaking point temperatures" than oils of specific gravity greater than 0.9.

The oils purchased as "paraffin base" oils showed specific gravities at 60 deg. fahr. or less than 0.91 and their rate of change or loss of viscosity per degree of temperature rise was less than the so-called "asphalt and napthene" base oils. Comparing the "paraffin" base with the "napthene" base oils of similar absolute viscosity, it appears that the breaking-point temperature of the "paraffin" oils is generally from 15–20 deg. fahr. higher than the "napthene" base oils. The following table based upon the experimental data obtained in this laboratory (Mechanical Engineering Laboratory, Stanford University) serves to show these points more clearly.

Base of Oil	Sp. Gr. at 60 deg. fahr.	Abs. Visc. at 100 deg. fahr. (poises)	Temperature, deg. fahr., at which lower straight lines break
Napthene	0.92–0.94	0.25–0.75	180–195
Napthene	0.93–0.95	0.75–1.25	190–205
Napthene	0.94–0.95	1.25–2	205–215
Napthene	0.94–0.95	2–4	210–215
Paraffin	0.875–0.90	0.25–0.75	200–220
Paraffin	0.875–0.90	0.75–1.50	210–230
Paraffin	0.875–0.90	1.50–2.25	220–250

An examination of the lines on the logarithmic sheets indicate that the oils tend to converge toward a common point, this being particularly true of oils (or products of oils similarly treated) from the same fields. None of the oils tested showed a continuous straight line from room temperature to 300 deg. fahr., but all can be represented by two straight lines intersecting one another around the region of 200 deg. fahr., as shown in Fig. 1.

If the lines for the lower range of temperatures are prolonged it will be found that they tend to meet at a common point *A* of the diagram. In a similar manner the upper lines through viscosity determinations

from 200 to 300 deg. fahr. indicate a convergency also, but the point of intersection *B* appears to lie at a still further distance away from the point of convergency for the lower temperatures.

No further statements regarding the common points of intersection can be given here, other than to briefly indicate that there are evidences of there being such points, principally because a lack of time has made it impossible to study this particular case thoroughly.

The establishment of the existence of a common point of convergence would be of great practical importance. By this means it would be possible to know the absolute viscosity of any mineral lubricating oil (at any temperature) after one or two viscosity measurements had been made. If the absolute viscosity followed but one straight line over the entire range of temperatures instead of two, it would only be necessary to know the viscosity of an oil at any one temperature—the absolute viscosity of the oil being given by the line connecting the common point of convergence and the viscosity as found by measurement.

Viscosity and density measurements made at lower temperatures after the runs at 300 deg. fahr. had been obtained indicate that the oil underwent no appreciable changes. Most samples showed only a slight increase in viscosity and density due to evaporation. Experiments seemed to show that there were no measurable differences in viscosities regardless whether the values were obtained with increasing or decreasing temperature.

The two Mexican crude oils show also a characteristic straight line law from 150 to 300 deg. fahr. with only a slight tendency to indicate that they are made up of two broken lines. On cooling both samples showed increased viscosities due to the loss of low boiling point components.

Mr. Albouze's thesis includes in addition to the data and results of his own tests, a summary of which is given above, a study of all of the published data on viscosity of oils from various authorities and determined with various types of viscosimeters; a bibliography of physical and chemical tests for internal engine lubricating oils and a section devoted to notes and critical review of bibliography. The bibliography covers 188 publications. Address Prof. W. R. Eckart, Leland Stanford University, Stanford, Cal.

Rubber and Allied Substances A1-22. Tests of Rubber Goods. Circular 38 of the Bureau of Standards has just been issued. The subject of the circular is the test of rubber goods giving the physical and chemical methods used at the Bureau with an introductory portion giving information concerning crude rubber and manufacture of rubber goods. Materials used in compounding rubber are classified and process of manufacture described, with brief summary of the detail of manufacture of tires, tubes, mechanical goods, druggists' sundries, methods of physical tests with data of results as well as methods of chemical analysis are given. Methods of testing fabrics are included. The Appendix contains a list of governmental specifications, a bibliography of papers published by the Bureau and of the more important books and periodicals that deal with rubber. A table of specific gravities of the common compounding ingredients is given. Circular may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. for 20 cents.

Safety Devices A1-22. Head and Eye Safety Code. A second edition of the Head and Eye Safety Code is soon to be published by the Bureau of Standards. This will include specifications for goggles, welding helmets and other protectors. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Steam Power A3-21. Steam Action in Simple Nozzle Forms is the subject of a paper read by A. L. Mellanby and William Kerr before the British Association in August, 1921. A paper on Pressure Flow Experiments on Steam Nozzles was read before the Institute of Engineers and Shipbuilders in Scotland November, 1920, while in February, 1921, a paper on the Losses in Convergent Nozzles was published. This paper was read before the Northeast Coast Institute of Engineers and Shipbuilders. The various papers give pictures of apparatus used, curves showing observed data and theoretical curves discussing the action of steam jets in nozzles. These sets of papers contribute largely to our present knowledge of steam flow.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Apparatus and Instruments B1-22. Acidity and Alkalinity Recorder. An instrument for determining the alkalinity or acidity of boiler feed to automatically control additions of caustic soda to eliminate acid conditions. The principle used is that of measurement of concentration of the hydrogen ions. A hydrogen electrode and calomel electrode are immersed in a by-passed flow of feedwater from the heater tanks. The potential difference measured depends on the H-ion concentration. Results of data so far indicate that method would prove satisfactory. Address E. A. Keeler, Leeds & Northrup, Philadelphia, Pa.

Automotive Vehicles and Equipment B1-22. Experimental Tunnel for Studying Exhaust Gas. See *Internal-Combustion Motors B11-21*.

Boilers and Accessories B1-22. Acidity and Alkalinity Recorder. See *Apparatus and Instruments B1-21.*

Internal-Combustion Motors B1-22. Experimental Tunnel for Studying Exhaust Gas. Report 2288 of the Bureau of Mines on the Bureau of Mines Experimental Tunnel for Studying the Removal of Exhaust Gas, by A. C. Fieldner and J. W. Paul, gives an account of the purposes of the investigation and results found as reported under *Automotive Vehicles and Equipment A5-21*, in Mechanical Engineering for June, 1921. The report gives the following particulars of the construction of this experimental tunnel.

An oval track having an axial length of 400 ft. and having similar construction to that of the ducts proposed in the Hudson River Tunnel, was constructed under ground with a cross-section approximately 9 ft. wide and 8 ft. high. Above the tunnel is an air duct 3 ft. high and below the floor another air duct 3½ ft. high. Either duct may be used for introducing fresh air or for exhausting contaminated air. The tunnel accomodates the smaller types of five-passenger cars. It is completely equipped with sensitive apparatus for measuring temperature, humidity, air pressure and air velocity. Forty-eight air-sampling tubes are installed at eight cross-sections of the tunnel to obtain samples for chemical analysis and to determine diffusion and concentration of exhaust gases. The experimental tunnel tests will include physiological and psychological observations of the effects on the man driving the cars, of temperature, humidity, rate of air flow, smoke and exhaust gases. Ten cars at 40-ft. intervals will be run at the rate of 10 miles per hour and 21,000 cu. ft. of air per minute will be introduced so as to keep the carbon monoxide at 4 parts per 10,000 parts of air. Each driver and observer will be subjected to examination before and after the tests. The tunnel is situated 130 ft. below the surface of the ground and 150 ft. from the pit mouth. The study will include the diffusion of exhaust gases by transverse ventilation, bottom to top and top to bottom, temperature and smoke conditions as effected by operation of motor cars, physiological and psychological effects of temperature, exhaust gases and smoke, final check of previous investigation and practical demonstration of solution of problem.

Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Metallurgy and Metallography B1-22. Deoxidizers. Progress Report to the Division of Engineering of the National Research Council on Substitute Deoxidizers gives some of the work which has been done by the Committee on this subject. The Committee has standardized its work and is now treating standard metal with various deoxidizers in an atmosphere of nitrogen within an induction furnace. The standard metal is commercially pure American ingot iron and iron oxides melted together in an electric furnace in such proportions that the iron thus made give 0.5 to 0.6 per cent oxygen. When this standard metal is melted the deoxidizer is added and allowed to act for 5 or 10 minutes with the heat on the furnace. The melt is then allowed to solidify or is poured into a chill mold. The ingot is then split, examined and photographed. One-half is then forged and the forging properties noted. The forged ingot is then examined microscopically for inclusions and chemically for oxygen and residual amounts of deoxidizing elements.

This work has been repeated in some cases in a 40-lb. experimental electric furnace of the American Rolling Mills Company. Each deoxidizer is to be added in different amounts to determine the proper amount to be used. Certain of the deoxidizers have proven of special value in preventing segregation. Others indicate inability to replace manganese in eliminating sulphur red shortness. Some have shown a refining influence on grain structure and others have shown the possibility of reducing ingot loss from discards due to shrinkage cavities. In the earlier work the Committee has found 73 combinations of elements which promise to be of value as deoxidizers. All contain manganese, but many of them contain less than 2 per cent of this element. As the first steps of deoxidation could be effected by these alloys and the final deoxidization with high-percentage ferromanganese, a great saving can be accomplished.

The functions of the deoxidizer are:

1 To produce the greatest possible yield of sound ingots free from blow holes and with a minimum amount of shrinkage cavities

2 To produce steel possessing satisfactory rolling and forging properties

3 To produce metal free from iron oxide, slag or other solid inclusion, and

4 To produce steel with maximum freedom from dissolved gases.

The report is made by Dr. J. R. Cain, Chairman, Committee on Substitute Deoxidizers. Address Division of Engineering, National Research Council, 29 West 39th St., New York City.

Properties of Engineering Materials B1-22. Corrosion of Pipes. The Bureau of Standards is beginning an investigation of the corrosive action of soil upon iron pipe. Investigations are being made with the coöperation of the Bureau of Soils, Pipe Manufacturers, Public Utility Companies and the Bureau of Standards. Forty locations have been selected representing different kinds of soil found through the United States, and in each locality a number of samples of each kind of iron and steel pipe in commercial use will be buried. One of these pipes will be uncovered from time to time to determine the rate of corrosion. Complete data of the physical and chemical properties of soil and pipes will be obtained. Extensive laboratory experiments will be conducted to determine the effects of variations and characteristics of both soil and pipe materials. Tests will also be made of representative pipe coverings. The investigation will probably take eight to ten years. The progress report will be published from time to time. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Protective Devices B1-22. Corrosion of Pipes. See *Properties of Engineering Materials B4-21.*

Safety Devices B1-22. Safety Code for Logging Operations. A National Safety Code for Logging and Saw Mill Operations is being prepared by the Bureau of Standards with the assistance of a Sectional Committee. This Code is nearing completion. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire cooperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring cooperation or aid will state problems for publication in this section.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Machine Tools F1-22. Torque and Power Required for Tapping and Threading. A bibliography of three items. Search No. 3469. Address A. M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 370 to 374 inclusive, as formulated at the meeting of October 27, 1921, and approved by the Council. In accordance with the Committee's customary practice, the names of inquirers have been omitted.

Case No. 370

Inquiry: Is it permissible, under the rules in the Boiler Code, to construct a boiler drum, 36 in. internal diameter, built with the shell in one sheet, $^{13}/_{16}$ in. thick, with one longitudinal seam having butt straps $^{1}/_{2}$ in. thick on each side? Information is also requested as to the maximum allowable working pressure as determined by the efficiency of the longitudinal seam and the tube-hole ligament.

Reply: It is the opinion of the Committee that a boiler drum constructed as described does not conform to the requirements of Par. 19 of the Code. The Committee is not in a position to determine the maximum allowable working pressure for constructions not permitted by the Code and would recommend that the question be taken up with the state authorities or insurance companies interested.

Case No. 371

Inquiry: Is it permissible to construct vertical fire-tube boilers of either the through-tube or submerged-tube types with the tubes welded in both the upper and lower tube sheets?

Reply: It is the opinion of the Committee that Par. 250 was not intended to forbid rolling and welding at both ends of the tubes of a fire-tube boiler, when desired.

Case No. 372

Inquiry: An opinion is requested as to the actual distance above tubes at which the fusible plug should be inserted in economic-type boilers under the requirement of Par. 430*r*. Is 1 in. above the upper row of tubes sufficient?

Reply: It is the opinion of the Committee that, as this type of boiler is quite similar in construction to an h.r.t. boiler, an elevation of the fusible plug 2 in. above the upper row of tubes will be necessary to meet the requirements of Par. 430*r*.

Case No. 373

Inquiry: Will the rules in the Boiler Code for calculation of the Adamson type of furnace apply to the design of conical furnace shown in Fig. 20, using the mean diameter of the cone as the nominal diameter of the furnace, and is it permissible in such construction to form the two vertical seams therein by autogenous welding?

Reply: It is the opinion of the Committee that Par. 231 covers the construction described. Autogenous welding is not permissible in this type of boiler, except in those portions of the furnace which are to be stayed.

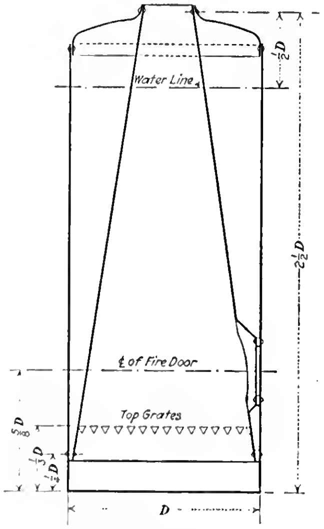


Fig. 20 Design of Vertical Boiler with Continuous Unstayed Conical Furnace

Case No. 374

Inquiry: Does the requirement of Par. 256 of the Code, relative to the term: "machine driven," refer solely to hydraulic or other forms of pressure riveters, or will pneumatic riveters conform to this requirement?

Reply: It was the intent of the Committee that the term: "machine driven" should apply only to those types of riveting machines which are able to drive the rivets with sufficient pressure to fill the rivet holes and allow them to cool and shrink under pressure.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie
Ralph E. Flanders John T. Wilkin
O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Methods and Results of the Unemployment Conference

THE management of The Unemployment Conference called in Washington September 26, was clearly enough in the hands of a man of scientific training and practical experience, whose mind would not rest content with the convenient superstition that if a considerable number of men and women are called together and allowed to simmer, something first-rate must happen somehow. He knew that merely jumbling together some sulphur and charcoal and ammonia water never made aniline dye, not even if you stirred them with a stick—that the mere presence of the elements of a successful conference would not guarantee success. Its possibilities and impossibilities he assayed in advance, and planned and managed the job with the cool scientific purpose of getting for the country the maximum practical results. Best of all there was no belief that by some magic a lasting socio-economic influence could take form from a few weeks of conference, no matter how well managed. Hence, the several projects which the conference started are being persistently followed up by individuals or small committees under the leadership of the Department of Commerce.


Henry S. Dennison

The Conference had two principal fields of work, the curative and the preventive. It had to accept the fact that we were in an economic mess and propose measures by which we might tide ourselves over or pull ourselves out of the emergency; and it had to search out every kind of influence which might help in keeping us from getting quite so deep into the same kind of mess again.

Emergency measures were studied first, and preliminary findings were made with remarkable speed. Through its command of the counsel of men of prior experience and by promptly dividing its work among relatively small committees, the conference was able within a very short time to formulate a close approach to standard practice in the work of employment bureaus and relief agencies, which most communities are undertaking this winter. By placing the responsibility for the institution of such work upon the mayors, a perfectly specific record of accomplishment and follow-up was made possible; and the conference was no sooner over than Colonel Woods devoted his whole time to this service. Where jobs are scarce and we run into the second winter of unemployment, intelligent forehanded placement and relief will in no inconsiderable number of cities make all the difference between order and lawlessness.

While the results of the Conference in providing more jobs than would otherwise have been available must have been small, here again its greater effectiveness lay in an intimate follow-up of the public announcements. Members of the Conference and notably one president of a large employers' organization, backed up the spirit of the Conference by taking up very definitely with individual concerns the necessities of doing as much repair work, advance construction and making-to-stock as good business principles would allow, and the advantages of distributing the burden of idleness among their employees by rotation of jobs and part-time work. The same definite sort of follow-up resulted in the clearance of hundreds of State and Federal projects already acknowledged to be worth undertaking but hung up for some reason or other.

The very sense of inadequacy which any thorough exploration of the field of emergency work must arouse was a good preparation for the members of the Conference in undertaking the tasks of more permanent importance. So far the business world as a whole has seemed content to accept constantly recurring periods of inaction following periods of scarcely less expensive feverishness as visitations of any angry economic Jehovah. As yet only the pioneer bits of research into the complex of causes of the business cycle have been completed. As a result of the Conference there will be carried on during the next six months an investigation of causes more expert and extensive than has ever before been attempted. If it fails to discover our economic rats and fleas, or our commercial anopheles, at least it will come near enough to it to excite a scientific curiosity which will not be allayed.

It is not an unreasonable supposition that the exaggerations of prosperity and depression which are the source of our greatest damage might be laid largely to the present necessity of business concerns going it blind, without some of the data essential for their continuous guidance. In making definite recognition of this the Conference gave a fresh spur to the projects of the Department of Commerce and a fresh inspiration to the various trade associations to give us pertinent and prompt statistics.

In the field of government, fruit of the conference is already apparent in the Bill (Senate 2749) offered by Senator Kenyon to encourage and provide for reservation of a part of the public works determined upon and appropriated for during prosperous times to furnish worth-while work during times of depression. This will withdraw some government projects from competition in a crowded and high-priced market, to the advantage of the business and laboring community and of the government as well.

Besides the unemployment due to cycles the Conference paid attention to seasonal unemployment, and in the same spirit refused to bow to the God of Things As They Always Were. For the diagnosis of this continuous industrial sickness the managers of the conference recognized that each industry offers a problem of its own, so provided special committees to make the long study of possibilities in building trades and mining industries which is necessary before any significant suggestions for improvement can be hoped for.

In addition to all these projects the Conference undertook to put through to a point of real accomplishment a consideration of the relation of unemployment to the railroad problem, to foreign trade, and to shipping, and a statistical resurvey of the extent of unemployment. One has only to appreciate the variety of temperaments and trainings which had to be gathered together in the men and women who had done enough thinking on this formidable list of projects to have definite and individual points of view, to realize that such a group of folk plunged into open meetings would have met certain failure. Points like this were thought out in advance. The Conference therefore, was divided immediately into committees of workable size, each of which got down to the special problems prepared for it in preliminary form by an Advisory Committee appointed three weeks before the

Conference met, and began to grind itself into bearing with greater or less speed, depending upon the skill of its chairman. But this method would have lost a public interest of very great value by lack of news material, so public hearings were held beginning the second day, at which the problems of each committee were taken up in turn. When the conference as a whole was ready to meet there had already been accomplished by these methods so much adjustment of points of view and so much broadening of the understandings of the precise nature of their problems that it was easily possible to find ground for unanimous declarations of the general principles governing the various phases of the problem.

There were still left very fundamental differences of opinion as to the applications of these principles, as it was foreseen that there must be in any such gathering. By the traditional method of letting such Conferences run, these fundamental differences, being largely temperamental or environmental, and thus nonjudiciable, would have materialized into long speeches seasoned with some bitterness; and then the magical ceremonies of nose-counting would have been invoked. Now the Conference was clearly not a legislative body. Mr. Hoover had coolly estimated what it was and was for and in what ways it could serve the country. He knew that people might well be influenced by the unanimous opinions of such a group of thoughtful people, but that on any question upon which members of the conference differed, the public would first want to know who believed thus and who so. Therefore such measures as the committees failed to agree upon were presented to the country through reports signed by those whose views they represented; and matters that had been so threshed out as to constitute a final coördination of the wide range of experience represented at the Conference, were given form as unanimous declarations.

This sounds simple enough in the telling; but actually the whole procedure was a case of thoughtful and ingenious development of the technique of such conferences which, so far as I know, sets a new standard. With such an example behind us there is no more need for our making the mistakes we have made in the past in such matters than there would be for a railroad constuction engineer now to lay out curves sharper than his locomotive trucks could negotiate.

The engineering profession can find much of interest in the final accomplishments of the conference, especially when the standing committees complete their assays of the serious conditions in great seasonal activities like building and mining; but the profession cannot afford to be less interested in the example of sound social engineering which the method of management of this Conference affords. Our social structure has grown in complexity well beyond the abilities of any one or two men to chart its proper courses. We shall need more of such conferences. And it is well that an engineer has come to judgment, that they may be managed with an appreciation of the real forces and opportunities involved in them.

Henry S. Dennison.[1]

The Unique Opportunity of the Railroad Professional Division

Every individual in the land is dependent upon the power that pulls trains. In fact, the progress of the nation and the progress of transportation are inseparable. Our Society offers means for record and for discussion of developments in the application of power and equipment for transportation. This places before the Railroad Professional Division of this Society a remarkable opportunity.

Inspirations are coming from all directions, from railroad officers, from engineers connected with the builders of railway equipment, and from engineers who are in the service of companies not directly connected with the railroads or with the builders of cars or locomotives.

Wonderful results have already been obtained and even greater results are in sight, having in mind the development of electric power for transportation, steam power and equipment to carry loads, both passenger and freight. Problems are repeatedly coming up for discussion, the solution of which with the highest of efficiency will depend very largely upon the getting together of all the engineers who are devoting their lives to this progress. Our Society offers the only forum for these studies and discussions which are so important to us all.

Electric-locomotive and steam-power developments are coming on apace. Electric applications are progressing and improvements are being made. Steam locomotives have been improved and the present generation of engineers has brought to the steam locomotive improvements which were not dreamed of fifteen years ago, and the possibilities of which are not yet apparent to even railroad officials at the present time. Improvements now under development promise even greater efficiency in the steam locomotive than has ever yet been obtained.

Electricity and direct steam for railroad transportation are in competition. It is most important that those who are devoting their attention to the development of the steam locomotive should thoroughly understand what electricity is doing. On the other hand, it is equally important that electrical engineers should know that the steam locomotive of today offers possibilities that are far beyond those of the steam locomotive of ten or more years ago, and that the railroads have before them more improvements in their steam power than they have ever used. In other words, the steam locomotive as we know it right now is very different from the one we knew a few years ago.

Moreover, in a few years, if full advantage is taken of the possibilities of increasing the power per pound of weight and the power produced by a pound of coal, the steam-locomotive figures which we are now talking about will of necessity be changed. This Society offers the means for bringing out the best and latest facts regarding these developments, and of bringing together the men who know these problems. It provides the means for using to advantage the mature thought of the best engineers of this country, which of all countries is most indebted to transportation and which depends most upon transportation for its future. No other organization of engineers provides such means for getting these authorities together for mutual understanding.

G. M. Basford.

The Relation of the Engineer to the Community[1]

As GOVERNOR, the elected head of a state government, there are two angles of this question to which for a few minutes, I might call your attention. One is the practical side, simply a list of those positions in our state government which must be filled by competent engineers. Upon this I shall only dwell for a moment.

I do wish to say, however, that the State of Connecticut is proud of its Highway Department, and that this department is purely an engineering proposition. The splendid development of the road system in Connecticut is due to the work's having been done by engineers without the help of the politicians.

Our Rivers, Harbors and Bridges Commission, appointed primarily to build the million-dollar dock at New London, had and has largely engineering problems for its consideration.

Among the duties of the Shell Fish Commission are the locating and bounding of the oyster-bed leases by the state, and the engineer is a leading personality in their work.


Bachrach

Everett J Lake

The law itself requires that three of the six members of our Pollution of Streams Commission shall be engineers.

In our Department of Health the work of the engineer is as much needed and as quickly required in the case of health dangers as is that of the physician.

---

[1] President Dennison Mfg. Co.

[1] Address of the Governor of Connecticut at a banquet of The American Society of Mechanical Engineers, Hotel Bond, Hartford, Conn. Nov. 3, 1921.

It is in the Engineering Department of the Public Utilities Commission that their most numerous personnel appears.

But I will not continue a catalog of those public offices in which trained engineers must of necessity serve. I will, however, speak of what I shall call the academic angle of my subject.

There are certain fundamental characteristics of a successful engineer, characteristics which he does and must apply to his profession if he be worthy of bearing the name of engineer, and I wish to urge upon you your duties as citizens to apply them in your consideration of the problems of good government and the public weal.

Today we often hear the expression, "Government needs the business man in public office," and if this be true, the need is emphatically for the engineering qualities of the business man.

The first qualification of an engineer is concentration. He must focus on his problem like a burning glass, and not study with the eye and mind of an impressionistic artist.

The next qualification is the power of analysis. The real analytical engineer does not tear apart with ruthless hands and throw into the scrap heap all that comes between him and the point of his ultimate investigation. He rather lays aside in an orderly and tabulated array the covering or by-products, if you will, that they may be again replaced if necessary, or perhaps put to other profitable use.

The third qualification of an engineer is his power of continued application. He learns to work continuously and laboriously.

And a fourth characteristic of the engineer is the quality of thoroughness. He must in his task, in his problem, bring it to completion. A half-finished job is in his domain practically nothing done at all.

These, then, are the fundamentals of a successful engineer, and if he but avoids the one danger of his profession—that of allowing his concentration to restrict his vision, so that in the intense application to any one problem he does not see its full scope or misses an opportunity waiting at his very elbow—he becomes an ideal citizen and one of the great assets of a nation.

You engineers apply these qualities to your life work; I am asking you tonight that you give a little of them to your duties as citizens.

I read recently Fiske's opening chapter of the Beginnings of New England, wherein he describes the growth and transitions of governments.

First the oriental or ancient governments, where a conquering monarch by warfares and struggles conquered and enslaved; then through the Roman Empire and the Holy Roman Empire, when powerful rulers and governments absorbed by conquest but granted citizenship.

Through all of these years, these centuries, we find the people of the world receiving their rights, their liberties, as grants from rulers, expanded or contracted at the will of some individual monarch, or his appointed or self-appointed minister.

Then came those long years of struggle in northern Europe where men were learning self-government and applying that knowledge. One of the hardest lessons to learn was that of delegating governmental functions and yet holding their public officials from transferring their delegated power into personal authority.

With the birth of the United States at our Revolutionary War, the rule of the people was forever established. Forward has been our march both in knowledge of how to govern and our ability to apply that knowledge. So today we who are holding office are but your delegates to turn your desires, your determinations, into laws and enforcements. So, I say it is the duty of all engineers to give a little of their ability, which has made them successful, a little of their time, perhaps an hour every day, to the duties of citizenship.

There are many engineers with all the qualifications of ideal public officials who, when asked to serve, say, "I haven't the time to do it;" what they really mean is that they have not given the time to prepare themselves to do it.

No matter how successful you are in your own business, you cannot be true and square and fair to the state if you cannot or will not take time to study its problems and know what its public officials are doing. With the same technical skill which the engineer, the inventor, the surveyor, the mechanic, puts into his own profession, it is his duty every day to study public life and public affairs so that if the time comes when he is needed by the state he will be prepared for this work.

With the same concentration, the same analysis, the same determination, the same thoroughness that you study and solve the problems of a big machine, a railroad, a river, or an excavation, study and solve the problems of government, municipal and state, and you will provide better than any other class of men a solid, firm foundation for good government. And then with all of our citizenship, see that there is erected upon this foundation a structure of government clean and pure to look at, strong and firm to hold.

Everett J. Lake.

The Metric Controversy

Attention is called to the report recently issued by the National Industrial Conference Board on the Metric Versus the English System of Weights and Measures, and commented on elsewhere in this issue of Mechanical Engineering.

A committee representing interests favoring and opposing compulsory metric legislation in the United States have prepared a document which presents the facts regarding this subject in a manner worthy of careful consideration by the entire engineering profession.

The report covers the history and present status of systems of weights and measures in this country, outlines the uses of the metric and English systems in this and other countries and in special fields, and closes with the arguments for and against the substitution of the metric for the English system in the United States.

The report is indeed a notable work and the National Industrial Conference Board is to be highly congratulated for having made such a research and such a well-directed effort in presenting to the public a document of this character. It should do much to clear up the present misunderstanding regarding the controversy, which hinges on the compulsory adoption of the metric system rather than upon the merits of the metric system itself.

Calvin W. Rice.

Resolution to Prof. W. F. Durand

At a meeting of the Board of Trustees of the United Engineering Societies held in the Engineering Societies Building, New York, on November 22, a resolution was presented to Prof. W. F. Durand expressing appreciation of his services in connection with the International Engineering Congress of 1915. This Congress, held September 20–25, 1915, during the Panama-Pacific International Exposition at San Francisco, Cal., was sponsored by the following societies, the signatures of whose presidents were affixed to the resolution: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and Society of Naval Architects and Marine Engineers.

Professor Durand, as chairman of the Committee of Management, assisted by representatives of the societies sponsoring the movement, made all the necessary arrangements for the Congress, which entailed a large volume of work extending over several months. It is estimated that altogether some 750 possible authors of papers or discussions were corresponded with. Papers in foreign languages had to be translated, and papers and discussions had to be edited and revised for publication in proceedings of the Congress, which consisted of ten volumes.

The work of printing and distributing the volumes was partially completed in 1915 but distribution, especially in Europe, was delayed during the war. Professor Durand has carried on the work during these intervening years so that it is now completed and the surplus papers and volumes have been transmitted to the Engineering Societies Library.

The resolution to Professor Durand states, in part, as follows:

"The proceedings of the Congress, issued under your auspices, have come to be recognized as authoritatively portraying the status of engineering practice; and the engineering profession owes you this expression of gratitude for your enterprise, zeal, industry, and patience in the consummation of the work of the International Engineering Congress" held in the year 1915.

Marshal Foch Honored by Four National Engineering Societies

Honorary Membership Conferred upon Ferdinand Foch, Marshal of France, by Civil, Mining and Metallurgical, Mechanical and Electrical Engineering Societies at Joint Meeting in New York, December 13, 1921

IN recognition of his unparalleled service to mankind, Marshal Ferdinand Foch has been unanimously elected to honorary membership in the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. The presentation took place in the Auditorium of the Engineering Societies Building, 29 West 39th Street, New York, N. Y., on the afternoon of December 13, the day before Marshal Foch sailed for France.

J. Vipond Davies, president of the United Engineering Society, and presiding officer of the meeting, stated the purpose of the gathering and outlined briefly the organization of the four societies and of the United Engineering Society. Col. William Barclay Parsons, commander of the first engineer regiment to go abroad, delivered a brief address in French, expressing the appreciation of American engineers for the incomparable services rendered by Marshal Foch. He said, in part:

"The art of engineering was defined a long time ago as 'the art of directing the great sources of power in nature for the use and convenience of man.' No better definition can be found today. Of all the sources of power in nature, the greatest, the most valuable, and at the same time the most difficult to direct, is the energy of man himself. He who can direct human energy and turn it to the service of mankind is a great engineer. You, Marshal, have directed a greater mass of human energy than any other man has ever done. And you have successfully directed this mass for the highest uses of mankind, in that you by its aid have preserved for him one of the most precious of human possessions—liberty! Liberty not only for your own illustrious country, but for all the nations of the world."

THE FOCH MEDAL

FERDINAND FOCH, MARSHAL OF FRANCE

George S. Webster, president of the American Society of Civil Engineers then made the presentation of one engrossed certificate of honorary membership in all the societies, jointly, and of a case containing emblems of the membership in four societies. In his response, delivered in French, Marshal Foch praised the work of engineers during the war, stating that in moments requiring decision, "the engineer stood out as an essential factor in complete triumph," and expressing his gratitude and that of France for their services. The ceremonies closed with the presentation to the presidents of the four societies of silver replicas of the Foch medal.

This signal honor, the only one of its kind ever to have been conferred, expresses the recognition of these four great societies aggregating a membership of some 45,000, of the ability of Marshal Foch to supplement his military genius with the effective coöperation of the commanders of the armies of five nations and the coördination of their operations that won the war. It forms another bond of union between the engineers of the United States and those of France.

Marshal Foch studied engineering in l'École Polytechnique and l'École d'Application d'Artillerie. He served on the technical section of the Ministry of War early in life, and later was a full professor in l'École de Guerre. The fact that he was not only trained in the applications of engineering to military purposes, but has also taught some of these branches in France's notable war schools and practiced them in the field made him eminently fitted to be, first, Generalissimo of the Armies of the Allies, and later Marshal of France. The victory in which he played so large a part has well been given the name "Victoire de Foch."

Marshal Foch has received many honors. On November 21, 1918 he was elected a member of the French Academy. On the first of December of that year he received the Order of Merit from the King of England and in July, 1919, was given the title of Field Marshal by the King, this being the first instance in which a Frenchman's name was ever inscribed on the active list of the general officers of the British Army. During his recent tour of the United States, city, state and national organizations, educational, governmental and industrial bodies, have united to do honor to the world's greatest soldier.

Announcements of the DeLamater Ericsson Tablet Committee

At a meeting of the DeLamater Ericsson Tablet Committee held November 10, representatives of the twenty societies who have participated in the movement to commemorate the work of Mr. DeLamater and Captain Ericsson were informed of the activities of the Committee to date, and were requested to offer suggestions as to a further program. Those present were requested to have their respective organizations appoint representatives with authority to add to their number as needed to coöperate with the Tablet Committee in developing the tentative program for the ceremonies to occur on March 9, the 60th anniversary of the battle of the *Monitor* and the *Merrimac*. This larger Committee will formulate the details of the final program.

The four tablets which have been designed to mark the sites of the Phoenix Foundry, Captain Ericsson's residence, the DeLamater Iron Works, and the Continental Iron Works, will be unveiled at simultaneous ceremonies taking place on the afternoon of March 9. In the evening there will be a public meeting in a hall or a public dinner in a hotel where addresses will be made.

At the annual dinner of the Capt. John Ericsson Memorial Society of Swedish Engineers, held at the Engineers' Club November 26, Mr. Olaf Rodhe, who had just arrived from Sweden was present and stated his authority to represent the Swedish Engineering Societies of Stockholm in arranging for the celebration on March 9.

"Mining and Metallurgy"

Mechanical Engineering extends its congratulations to *Mining and Metallurgy*, admiring as it does its new dress and splendid editorial discussion of timely economic and engineering topics. The presentations are such that a member of the A.I.M.E. is put in touch not only with affairs within the Institute but with what is going on elsewhere in the engineering world, and through these contacts he finds himself in step with the onward march of his profession. Mechanical Engineering wishes its contemporary every success.

The "Scientific American"

The new monthly *Scientific American*, a combination of the former weekly *Scientific American* and the *Scientific American Monthly*, show that the best features of the former publications are being combined in the single journal. As a periodical in which both layman and professional scientist will be interested, it contains leading and short articles covering a wide range of subjects, touching on the new and unusual things in scientific discovery in all parts of the world. It contains special departments, among which are several on inventions and patents, mechanical and electrical, engineering, and science notes. The pictorial method of presenting facts, has been retained.

Index to Volume 43 of Mechanical Engineering

An index to Volume 43 of Mechanical Engineering is now in the course of preparation, and, it is expected, will be issued the latter part of February. A copy of this index will be sent to each member of the Society or subscriber who sends in a written request therefor. In order that no more copies than are necessary to supply the demand may be printed, requests for copies should be received at headquarters not later than February 15.

The Late Sir Charles Douglas Fox

Sir Charles Douglas Fox, upon whom in 1900 was conferred honorary membership in The American Society of Mechanical Engineers, died on November 13, 1921, at the age of eighty-one. Sir Douglas received his early education at the Cholmondeley School at Highgate, studied at King's College, London, and at the age of 17 was apprenticed to his father, Sir Charles Fox. For two of these apprenticed years he acted as resident engineer in charge of work upon the Witney Railway, and subsequently was with the Ramsey Railway in the same capacity. In 1863 he joined his father's firm as a partner; later his brother, Sir Francis, became a partner, and ultimately the name of the firm was changed to Sir Douglas Fox and Partners, of which firm he was the head at the time of his death.

Sir Douglas Fox's work covered a wide field, for his name was well known in connection with the construction of railways in South Africa and Australia as it was in England. Among his earlier work was the construction of the London, Brighton and South Coast Railway, the Cape Town and Wellington Railway, and the Cape Town-Wynberg Railway. With Sir James Brunlees, he acted as consulting engineer for the Mersey Tunnel. For his work in this connection Her Majesty Queen Victoria conferred the honor of knighthood upon him. He was also connected as joint consulting engineer with the construction of the Liverpool Overhead Railway. This work is unique in England, though on lines similar to the elevated lines in New York City. Sir Douglas and his brother were responsible for the engineering work on the Southern and Metropolitan divisions of the Great Central Railway. He also took a prominent part in underground-railway development in England. In Africa his name is associated with the Rhodesian Railway and the famous bridge over the Zambesi River at Victoria Falls. Other undertakings in South Africa were the Beira Port and Railway, Benguela Railway and the Trans-Zambesi Railway. In South America he was responsible for the construction of railways in the Argentine for the Central Argentine Railway Co.; in Colombia, for the Dorada Railway Co., and also in Brazil.

Sir Charles Douglas Fox

He was an enthusiastic advocate of standardization and was one of the early supporters of the movement which resulted in the formation of the British Engineering Standards Committee in 1901 on whose main committee he served from the time of its formation till early in 1920.

Sir Douglas Fox became a member of the Institution of Civil Engineers in 1866, was elected to the council in 1884 and served as its president in 1899–1900. During his term of office he received the American civil and mechanical engineers, who were entertained at the Guildhall on the occasion of their visit to London that year. He was also a member of the Institution of Mechanical Engineers, the Institution of Electrical Engineers, and an honorary member not only of The American Society of Mechanical Engineers but also of the American Society of Civil Engineers. He was a director of some ten companies, was vice-chairman of the South Indian Railway Co., and chairman of the Industrial Dwellings Co. and of the Northfleet Coal and Ballast Co. He patented numerous inventions connected with railway work. In 1880 he was appointed lecturer to the School of Military Engineering, Chatham, his lectures dealing with light and temporary railways. He was awarded at various times by the Institution of Civil Engineers the Manby Premium, the Telford Medal, and Telford Premium for contributions to the proceedings. He was elected a Fellow of King's College (London) in 1887. He was a justice of the peace and took a prominent part in many of the religious and philanthropic movements of the day.

NEWS OF THE F.A.E.S.

January Meeting of American Engineering Council

The annual meeting of the American Engineering Council will be held in Washington January 5 and 6. Details of this meeting are not yet available, but the program will include matters pertaining to organization, a review of the past year's activities, and decisions as to future policies. The question of finances will receive special consideration. A recently issued résumé of the activities of the Executive Board stated that although at the time the annual budget was adopted information as to probable expenditures for the fiscal year was necessarily very incomplete, and although unusual demands have been made upon the treasury, the Board has been able to function within the limits of its resources. It has been found, however, that even the moderate dues required for membership have been so high as to prevent several organizations from becoming members of the Federation.

Employment Service

In accordance with a resolution passed at the September meeting of the Executive Board a joint committee of nine, consisting of five members of the Executive Board and a representative from each of the four national engineering societies, has been appointed with power to organize uniform paid employment service for engineers. The members of this committee are as follows: Morris L. Cooke, Chairman, William McClellan, W. E. Rolfe, H. E. Howe, and William B. Powell, of the Executive Board; Richard L. Humphreys, A.S.C.E.; W. M. Corse, A.I.M.E.; Fred J. Miller, A.S.M.E.; and E. B. Craft, A.I.E.E.

The Executive Board has also voted a special appropriation of $2000 for emergency employment work.

Engineering Education

The Executive Board has received several communications relative to the subject of engineering education. The University of Iowa recommended that the American Engineering Council "establish standards of engineering education for engineering colleges of different grades and rate the engineering colleges of the country in accordance with the classification adopted." A resolution by Mr. W. W. Varney of Baltimore, a member of the Executive Board who has been among those taking a deep interest in engineering-education policies, asked that the Federation appoint "a Committee on Education to consider broadly the training of the engineer and to report on desirable changes in present-day engineering education to better prepare engineering graduates to take their proper places in the profession." Because of these requests, although the Board felt that there were other organizations more directly affected by and concerned with these matters that are giving consideration to them, it has decided to institute appropriate inquiry through a special committee on engineering education. The Committee on Procedure has accordingly appointed Col. A. S. Dwight of New York, Prof. Chas. F. Scott of Yale, and Mr. Varney to study the problem and work out a policy for the F.A.E.S.

Errata

In the paper by Dr. D. S. Jacobus on Boiler and Furnace Economy in the December issue, the temperature mentioned in the fifth line of the third paragraph from the bottom of page 782 was erroneously stated to be 500 deg. fahr. It should read 300 deg. fahr.

The November issue of Mechanical Engineering contained an account of a recent snow removal meeting of the Materials Handling Division of the A.S.M.E. in which there were some erroneous statements concerning a device evolved by Edward A. Smith of West Englewood, N. J. The size of the melting chamber of this machine is 67,400 cubic inches instead of cubic feet. Mr. Smith states that at 30 cents per cu. yd., a price which has been paid by the city of New York, it would cost $2,220,000 to remove 7,400,000 cu. yd. of snow, representing an 8-in. fall on approximately 33,000,000 sq. yd. of streets, whereas by using 100 of his machines, and working 28 hours, this amount of snow could be melted for $28,000, including the total operating expenses.

NEWS OF OTHER SOCIETIES

National Founders' Association

The twenty-fifth annual convention of the National Founders' Association was held in New York on November 16 and 17, 1921. At the opening session, President William H. Barr discussed the industrial situation and general causes of present conditions, and A. E. McClintock, commissioner of the association, urged training of forces for future expansion of industry, instruction of employees in principles of economics, and development of a spirit of loyalty within industrial organizations.

Among the speakers at the afternoon session, November 16, were Magnus W. Alexander, Mem.Am.Soc.M.E., on Wage Liquidation in American Industry, and A. C. Davis, on The Present Railway Situation. Mr. Alexander presented charts showing changes in wage rates during recent years, hours worked, percentages of employment, etc., with special reference to foundries and machine shops. These charts are based upon investigations conducted in over twenty industries by the National Industrial Conference Board, of which Mr. Alexander is managing director.

Mr. Davis, vice-president of the Gurney Ball Bearing Company, traced the development of the railroad and discussed some of the measures wherein he believed the solution of some of the present railway problems might be found.

On the second day of the conference the following addresses were presented: Foreman Training, L. V. Hartley, and Foundry Costs, Robert E. Belt. Mr. Hartley, of the Department of Vocational Education of the State of Nebraska, described the project method of training foremen used in that state and showed charts indicating savings in operation costs resulting from the installation of foreman-training courses in various plants.

Mr. Belt, who is secretary-treasurer of the American Malleable Castings Association, gave a paper which dealt with foundry costs, pointing out the importance of an accurate and uniform system and giving the relation of cost to selling price.

An extemporaneous speaker on the first day of the conference was Governor Henry Allen, of Kansas, who gave a brief history of the Court of Industrial Relations in that state. He stated that of the thirty cases decided by the court, twenty-nine have been satisfactory to both employers and labor.

The convention addressed a resolution to the United States Senate urging that railroad regulation be handled by a public tribunal and emphasizing the importance of adjusting all problems without stoppage of service.

American Iron and Steel Institute

A memorable meeting of the American Iron and Steel Institute was held in New York on Friday, November 18, 1921. The opening address by Judge Gary, president of the Institute, discussed business conditions, expressed his endorsement of limitation of armament and prophesied prosperous business conditions in the comparatively near future.

Six papers were presented at the professional sessions. John W. Kargarise, of the Edgar Thomson Works, Carnegie Steel Co., Braddock, Pa., discussed improvements in open-hearth port construction, describing early types and giving some of the results of the McKune system and the Venturi and Egler furnaces.

James M. Camp, director of the Bureau of Technical Instruction, Carnegie Steel Co., Pittsburgh, Pa., outlined the relations of the iron and steel and chemical industries.

Thomas J. Foster, chairman of the National Bridge Works, Long Island City, explained the formation of steel lumber and described various types used for building construction. He enumerated the characteristics of steel lumber which make it economical and described tests to which it has been subjected. He stated that residence work, including apartments, is twenty per cent of the total building of this country and that with an ideal steel joist a large share of these structures will be built of steel at a material reduction in price.

Fusion Welding and the Processes in Use were described by S. W. Miller, president of the American Welding Society. He gave the composition of low-carbon steel wire used for gas-welding steel and also of wire for electric metallic-arc welding. Among causes of failures in welded parts he spoke of lack of fusion, both along the

side of the V and in the weld metal itself, and also of the oxidizing action of the water vapor in the gas welding flame and that of the air on the finely divided metal passing through the electric arc. He was of the opinion that nitrogen has no serious effect so far as tensile stress is concerned but that brittleness of welds is due to the presence of oxides.

W. A. Hull, chief of the Refractories Section of the Bureau of Standards, in a paper on Refractories in the Steel Plant, made a strong plea for adequate specifications and coöperation between producer and consumer. A. E. Bourcoud, consulting engineer, New York, discussed a direct process for steel manufacture.

The meeting closed with a banquet in honor of Marshal Foch, at which there were many distinguished guests. After-dinner speakers, besides the guest of honor and President Gary, were Charles M. Schwab and W. D. Guthrie.

Society of Naval Architects and Marine Engineers

The Society of Naval Architects and Marine Engineers held its twenty-ninth general meeting in New York Thursday and Friday, November 17 and 18, 1921. Thirteen papers were presented at four professional sessions. One of these sessions was a joint meeting with the American Institute of Electrical Engineers, at which W. E. Thau, general engineer for Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., presented a paper on Electric Propulsion of Ships, and E. D. Dickinson, mechanical engineer of the Marine Department of the General Electric Company, Schenectady, N. Y., spoke on Electric Auxiliaries on Merchant Ships.

Among the subjects discussed at other sessions were The Tactical Relations between Different Classes of Men of War and Their Embodiment in Design; Development of the Three-Plane Navy, With or Without Battleships; How Can American Ships Compete Successfully with Foreign Ships; The Importance of Port Facilities in the Development of Merchant Marine and Commerce; American Apprenticeships, Schools and Scholarships; and Design and Construction of Passenger Steamers.

Special arrangements were made for the convenience of those members desiring to view the exhibition of the Marine Equipment Association of America held in New York during the week of November 14–19. The most modern auxiliaries and equipment installed on board ships as well as illustrations of various new methods in shipbuilding work were displayed at this exhibition.

The Taylor Society

The Taylor Society held its annual meeting in New York, Dec. 1, 2 and 3. The first public session, held Thursday evening, December 1, was devoted to an examination of the evaluation sheet devised and used by the Committee on the Elimination of Waste in Industry. The technique of the method employed by the committee was discussed by a large number of engineers who coöperated in the investigation.

There were two sales executives' sessions on the second day of the conference, one devoted to the report of the Committee on Sales Engineering and one to a paper on the necessity of the quota for proper sales cost accounting. There was also a plant managers' session, with a paper by C. F. O'Connor, production manager of the Universal Winding Company, Providence, R. I., and discussion of maintenance of a system of operations under varying conditions by Carl G. Barth, Wilfred Lewis, William O. Lichtner, R. G. Scott, and other engineers well fitted to deal with problems of scientific management.

At an office managers' session it was shown that such fundamental principles of scientific management as precise control of routine operations, standardization the basis of control, and investigation and experiment the basis of standardization, can be applied to offices as well as shops.

The evening session on December 2 dealt with the general control of business. In a paper presented by John H. Williams, of Day & Zimmermann, Philadelphia, it was shown that any precision in general control rests upon the foundation of precision in the details of operating organization and control. This session was planned by the Taylor Society in order to bring out discussion which may be used as a guide in its study on the problem of general administrative control. This study is being conducted by a special committee appointed by the society.

On December 3 there was a plant managers' session and a labor managers' session. The first was devoted to a study of combination routing to meet the problems of small quantities and short operations. The second presented an analysis of the elements which make a good worker and of the forces which influence these elements.

The meeting closed with a luncheon in honor of Henry R. Towne, honorary president of the Taylor Society. Addresses by Mr. Towne, Wilfred Lewis, president of the Tabor Manufacturing Company, Philadelphia, and Calvin Rice, secretary A.S.M.E., were reminiscent of the early days of scientific management and of Frederick W. Taylor, of whom Mr. Towne was always a strong supporter.

RADIO SHIP CONTROL

(*Continued from page 44*)

neering. Its success was pronounced from the start, but as with the first tests of all such apparatus, it was found that some of the parts were too sensitive, and more rugged ones were developed under the direction of the officers of the Battleship *Ohio.* Simplification of the equipment was also effected in the same manner.

PROCESS CHARTS

(*Continued from page 41*)

5 Motion study

6 Micromotion studies and chronocyclographs for obtaining and recording the One Best Way to do Work.

c Make process chart of the process as finally adopted as a base for still further and cumulative improvement.

Note that—

a Visualizing processes does not necessarily mean changing the processes

b Process charts pay.

CODE FOR DISPLACEMENT COMPRESSORS AND BLOWERS

(*Continued from page 48*)

(62)	Temperature of steam leaving steam receiver, if superheated	deg. fahr.
(63)	Temperature of steam in exhaust pipe as observed	deg. fahr.
(64)	Temperature of saturated steam in exhaust pipe corresponding to pressure in exhaust pipe	deg. fahr.

Total Quantities

(70)	Superheat, at throttle	deg. fahr.
(71)	Moisture in steam	per cent.
(72)	Total steam and water consumed by engine as measured	lb.
(73)	Total steam less water consumed	lb.
(74)	Correction factor conforming to conditions agreed upon	lb.
(75)	Equivalent total steam consumed, conforming to conditions	lb.

Unit Quantities

(76)	Steam and water (or superheated steam) consumed per hour as measured	lb.
(80)	Steam less water (or superheated steam) consumed per hour	lb.
(81)	Equivalent conforming to conditions consumed per hour	lb.

Power Input

(90)	Steam cylinder—Indicated horsepower developed, whole engine	i.hp.
(91)	High-pressure steam cylinder, crank end	i.hp.
	head end	i.hp.
(92)	Low-pressure steam cylinder, crank end	i.hp.
	head end	i.hp.

Economy Results

(105)	Steam less water (or superheated steam) consumed per i.hp-hr. (Item 80 ÷ Item 90)	lb.
(106)	Equivalent steam consumed per i.hp. (Item 81 + Item 90)	lb.
(107)	Steam less water (or superheated steam) consumed per 100 cu. ft. of air or gas compressed at intake pressure and temperature (100 × Item 73 + Item 67)	lb.
(108)	Equivalent steam consumed per 100 cu. ft. of air or gas compressed at intake pressure and temperature (100 × Item 75 + Item 67)	lb.

TABLE 4 ADDITIONAL ITEMS APPLYING ONLY WHEN THE DRIVING ELEMENT IS AN INTERNAL-COMBUSTION ENGINE

(The items of this table will be developed upon the completion of the Test Code for Internal-Combustion Engines.)

Metric vs. English System of Weights and Measures

Review by Luther D. Burlingame, Chairman of the A.S.M.E. Standing Committee on Weights and Measures, of Research Report No. 42 of the National Industrial Conference Board

Owing to the continued discussion of the question of the adoption of the metric system in this country, to supplant the established system of weights and measures, a joint committee was appointed by the National Industrial Conference Board to represent interests favoring and opposed to the adoption of the metric system in the United States, with the idea of making a thorough and impartial investigation of the situation, and publishing the results in order that a basis may be had for an intelligent decision not only by the affiliated organizations making up the National Industrial Conference Board, but by the public at large. The following Committee has served:

E. M. Herr, *Chairman*, president of the Westinghouse Electric & Mfg. Co.

Fred J. Miller, past-president of The American Society of Mechanical Engineers

Henry D. Sharpe, treasurer, Brown & Sharpe Mfg. Co.

Henry R. Towne, chairman of Board of Directors, Yale & Towne Mfg. Co.

Frank O. Wells, formerly president of the Greenfield Tap & Die Co.

Under the supervision of this Committee the investigation was carried on through trained employees of the National Industrial Conference Board, and has resulted in the publication of a report of 261 pages, divided into three parts:

- I History and Present National Status of Systems of Weights and Measures
- II Use of Metric and English Systems in Special Fields
- III Arguments for and against the Substitution of the Metric for the English System in the United States.

Part I gives first the origin of the English and other natural systems, showing how our present system has developed from the needs of men, and has become adapted to fundamental trades and industries. The history of the origin and development of the metric system follows. The present status of the two systems is then compared, showing the number of countries and population of each where the English and metric systems respectively predominate, and their relative percentages to other countries where neither predominates. This analysis shows that the English system predominates in twelve countries with a population of nearly 350,000,000, while the metric system predominates in thirty-seven countries with a population of nearly 400,000,000, the combined total, however, being less than half the population of the world, this "larger half" being listed as having neither the English nor the metric system predominating.

This part of the report deals with many of the South American countries which were considered in a paper entitled, The Weights and Measures of Latin America, presented by Mr. F. A. Halsey before the A.S.M.E. at the Annual Meeting in December, 1918; and it is interesting to compare the findings of the investigators of the National Industrial Conference Board with those in Mr. Halsey's paper. While Mr. Halsey goes much more into detail as to the lines of industry and manufacture where the various systems are used, the general trend of the present report follows very closely the findings as shown by his investigation, and countries which were reported by him as showing least progress toward the metric system in actual use, are classed as doubtful.

Under the heading Weights and Measures in the United States the present situation is summarized clearly and holds the issue up squarely to the American public, as follows (page 42 of the report):

> The situation in the United States, however, is today quite different from the situation that confronted other important countries in making a change from their local systems to the metric. In other countries considerable confusion of weights and measures existed at the time the change was brought about. In other countries, also, the change took place before the industrial life of the nation had become organized and standardized to the extent that modern production makes necessary. The countries outside of Europe which have adopted the metric system have little or no organized industry in the modern sense.
>
> In the United States today there is, in the first place, no fundamental confusion with respect to weights and measures. Furthermore, the United States unquestionably stands in the forefront of the great industrial and manufacturing nations. Its highly organized industry is based on the English units of weight and measure, and most of its vast technical literature is written in this system. All things considered, therefore, there does not exist in this country the great incentive to a change found in other nations where confusion was the rule until the metric system was adopted.
>
> In consequence the situation today narrows itself down to the question whether the advantages to be gained warrant the compulsory adoption of one unified system, namely, the metric, in the place of another unified system, namely, the English, which latter is moreover the established system and enters so intimately into the present industrial organization of the nation. It is not a question of allowing the use of the two systems side by side and giving the metric the opportunity of supplanting the English, because the metric has, as a matter of fact, been a legal system in the United States since 1866, and any one who so desires and finds it more convenient and practical may use it. The question is, shall the United States discard the English system of weights and measures entirely and absolutely and in its place substitute by compulsory law the metric system as the sole standard?

The report includes arguments for making the change and the reasons on which these arguments are based. These statements with their opposing arguments are both strongly presented.

Use of Metric and English Systems in Special Fields

Part II opens with the statement that "a nation is made up of a number of special fields of activity, in which the question of a change in weights and measures plays a little or a greater part, depending on the nature of the field and the ease or difficulty with which a change from an established to another system can be accomplished," and introduces a series of questions to be answered, such as:

1. Has a given field had its origin and development in a certain country and then spread to the rest of the world, carrying with it the weights and measures of the country of origin?
2. Does the position an industry has achieved and now holds center about standardized practices, with respect to weights and measures, built up after years of effort, and would the destruction or alteration of these practices virtually mean the giving up of the prominent place held by the industry?
3. Is the scope of a certain field limited and local, as in agriculture or mining, or international?
4. Are the weights and measures written into the very fabric of the institutions, implements or records existing in a certain field?
5. What is the relative importance of one field as against another?
6. How much demand is there for a change?

The report then goes on to analyze these various issues and to give a background, so that an intelligent answer can be given to each of these questions, under the following headings:

1 *Science and Engineering*, under which are discussed chemistry, medicine and pharmacy, electrical, mechanical, and civil engineering, etc. This division is thus summarized:

> A considerable demand for a change in systems of weights and measures in the United States comes from the scientific group and from those engaged in the manufacture of refined instruments and products, but this sentiment is not shared very much by the engineering professions......Even though this group were unanimously in favor of a change, its size is small as compared with such fields as agriculture, mining, manufacturing, and trade, and it would suffer no hardship through a change, while these others would.

2 *Agriculture, Mining, Transportation and Trade.* After an analytical and statistical discussion, it is summarized thus:

> In the four fields treated in this chapter, such little demand as exists for a change to the metric system comes from those engaged in wholesale trade, who, as has been noted, comprise a very small group, comparatively speaking. There is practically no sentiment at all in favor of a change to be found in the other fields discussed.

3 *Manufacturing*, including textiles, metal products, food products, lumber, paper and printing, leather and its finished products, etc. The summary of this part of the investigation states that:

> The survey in this chapter of various specific manufacturing industries serves to indicate how intimately weights and measures are tied up with the products of manufacture and how widely English units are used in various industries the world over.

The report cites specific instances to illustrate this, and continues:

Over 90 per cent of the metal-products industry registered decided opposition to a change. The food-products industry showed similar opposition. The lumber industry was likewise opposed and emphasized "the great confusion and incalculable expense" that would result. The paper and printing, automobile, railway car, shipbuilding, and implement and vehicle industries also went on record as decidedly adverse to any change.

The manufacturing field, employing as it does over 10,500,000 workers, and producing commodities valued at something like $25,000,000,000 annually, is unquestionably one of the most important fields of industry in the United States. The indications are that a compulsory change to the metric system would profoundly affect many manufacturing lines especially during the period of transition, which the experience of other countries suggests would be very long. The interests and desires of such an important field and the effect of a change in weights and measures upon it should naturally be carefully weighed in considering the advisability of a compulsory change.

4 *Foreign Trade.* Much attention is given to an analysis of world trade, and the arguments pro and con, as to whether a change to the metric system would be of appreciable benefit to the foreign trade of this country. The figures show that 48.2 per cent of the world's export trade is now transacted by English countries, 37.5 per cent by metric countries, and 14.3 per cent by other countries. This indicates that while more than half of the population of the world is included under the heading "other countries," the total amount of foreign trade which they represent is a very small percentage of the total.

The graphic diagrams shown in the report make very clear the relative importance of the different elements which have an influence on this discussion, and the above ratios are shown in one of these diagrams. (Page 105).

Another diagram (page 113) shows the exports of the United States to English countries as 41.9 per cent, to Latin-American English and other countries, 5.7 per cent, to European metric countries 37.1 per cent, to Latin-American metric countries, 6.3 per cent, and to all other countries, 9 pei cent.

Arguments for and against the Substitution of the Metric for the English System in the United States

Part III is in the nature of the lawyers' pleas on each side of a case before a court, and is of value as showing opposing views strongly expressed. It is divided under the headings:

1 Intrinsic Merits of the Metric and English Systems
2 Advantages and Use of Metric as Compared with the English System in Special Fields
3 Practicability of Making a Compulsory Change
4 Extent and Character of Demand for such a Change
5 Comparison of Metric and English as Universal Systems.

The arguments pro and con under these headings are presented in such a way that they are in the nature of a spirited debate, and any one who is even casually interested in great issues before this country would be not only instructed but greatly interested in carefully following the discussion. (The report may be obtained from The Century Company, New York, at $2.50 a copy.)

It is believed that with the metric question again before a congressional committee and the issue being raised before great national organizations throughout the country, a careful study of this report will help to insure sound judgment in coming to such a decision as will place the influence of the reader on the side of this momentous question where it will count to support that policy which will be for the best interests of the American people.

Waste in Industry

Waste in Industry. By the Committee on Elimination of Waste in Industry of the Federated American Engineering Societies. First edition, 1921. Published by Federated American Engineering Societies, Washington, D. C. McGraw-Hill Book Co., Inc., New York, selling agents. Cloth, 6 × 9 in., 409 pp., charts, tables, $4.

Reviewed by Joseph W. Roe,[1] New York, N. Y.

While many have been attacking the problems of waste in specific industries with steadily increasing effect, no qualified agency has heretofore attempted to do so for Industry as a whole.

One of the first acts of Mr. Herbert Hoover, as first president of the Federated American Engineering Societies, was the appointment of a committee of engineers to undertake this, and the book in hand is their formal report. The purpose was to gather concrete information, to stimulate action, and lay a foundation for other studies. No attempt was made at an academic definition of waste. It has been treated as the difference, in material, time and effort expended in production, between average practice and the best known practice; and the committee has undertaken to evaluate this difference. Its first work was to set up units and methods of measurement which could be applied to all the industries studied. This is something new and of great possibilities. With this in view a very complete questionnaire was prepared and used as a basis for a trial study of one plant in each industry. The results of these studies were brought together, reviewed by the committee and a revised questionnaire developed, which was used in all subsequent work. The quantitative comparison between different industries was made through use of a point system on "evaluation sheets," these sheets having the same grouping of information as the questionnaire, and with definite, careful instructions as to the method of arriving at the totals. The totals indicate waste in comparison with the best existing practice. Both the questionnaire and the evaluation sheets are given in full and are one of its most valuable parts of the report.

This method of rating by points supplies a common ground for the findings of 50 engineers, covering 125 plants, in 6 industries. While it cannot eliminate variations of judgment in evaluating the different elements, it makes sure that the same method is used in all cases, also that the same elements are considered and in the same relationships.

There is no hesitation in saying that the study affords the best information we have to date. It makes no claim to minute accuracy, but it does to substantial accuracy. The broad findings are summarized in the Tables 1, 2 and 3.

From Table 1 are derived percentage values for each of the agencies against which responsibility is assessed, as in Table 2.

TABLE 1

Industry Studied	Responsibility Assayed Against Management, Points	Responsibility Assayed Against Labor, Points	Responsibility Assayed Against Outside Contacts (The Public, Trade Relationships, and other Factors), Points	Totals, Points
Men's Clothing Mfg....	48.33	10.50	4.95	63.78
Building Industry......	34.30	11.30	7.40	53.00
Printing..............	36.36	16.25	5.00	57.61
Boot & Shoe Mfg.......	30.25	4.85	5.83	40.93
Metal Trades..........	23.23	2.55	2.88	28.66
Textile Mfg............	24.70	4.70	19.80	49.20

TABLE 2

Industry Studied	Responsibility Assayed Against Management, Per Cent	Responsibility Assayed Against Labor, Per Cent	Responsibility Assayed against Outside Contacts (The Public, Trade Relationships, and other Factors) Per Cent
Men's Clothing Mfg....	75	16	9
Building Industry......	65	21	14
Printing..............	63	28	9
Boot & Shoe Mfg.	73	11	16
Metal Trades..........	81	9	10
Textile Mfg............	50	10	40

TABLE 3

Industry	Points Assayed Against the Best Plant Studied	Points Assayed Against the Average of all Plants Studied	Ratio Best to Average
Men's Clothing Mfg....	26.73	63.78	1 : 2
Building Industry......	30.15	53.00	1 : 1¾
Printing..............	30.50	57.61	1 : 2
Boot & Shoe Mfg......	12.50	40.83	1 : 3
Metal Trades...	6.00	28.66	1 : 4¾
Textile Mfg....	28.00	49.20	1 : 1¾

In every industry there are outstanding examples of good management. Table 3 gives a comparison of the best plant in each industry studied, with the average of the plants.

These tables embody the general findings developed throughout the report. The results have surprised the general public, but not those familiar with management problems. Management has

---

[1] Professor of Industrial Engineering, New York University. Mem. Am. Soc.M.E.

the greatest opportunity and responsibility for eliminating waste. Labor has an important part, though smaller in proportion. The public also has a part, but less clearly defined and far more difficult to rectify. In many cases it involves change of habits and tastes. It is all very well to talk of a reduction in the numbers of styles, but only a nervy man would tell his best girl that standardization requires her to wear her last year's hat a second winter; and the worst of it is, he would quit loving her if she did.

The first of the three sections is a summary of the detailed reports, covering the sources and causes of waste, recommendations for elimination, and a description of the questionnaire and the evaluation sheet used.

The second section contains the reports of the six industries studied—the building trades, men's ready-made clothing, shoe manufacturing, printing, metal trades and textile manufacturing.

The third section comprises seven general reports, covering unemployment, strikes and lockouts, legal machinery for adjusting disputes, industrial accidents, health of industrial workers, eye conservation, and purchasing and sales policies. These are statistical in nature, but all have constructive suggestions for betterment.

This book should be read by every man in a position of industrial responsibility. It is full of matter challenging attention and maintains throughout a constructive attitude. The method of gaging wastes is especially suggestive and forms a yardstick by which a manager can measure waste in his own industry and in many cases establishes a basis of comparison which may prove a great help. The yardstick may be crude, but until a better one is devised, valuable comparative results can be obtained if everybody uses the same stick.

Book Notes

Annals of the American Academy of Political and Social Science, May 1920. Paper, 6 × 9 in., Vol. 89, No. 178. 289 pp., $1.25.

This volume of essays discusses the economic significance of present-day prices, price factors in typical commodities, wages, profits and excess profits taxes, production, coöperation, international finance and trade in their relation to prices, inflation and prices, and the world's monetary problems. The papers included are by well-known economists, business men and engineers.

Bleaching. By S. H. Higgins. Longmans, Green & Co., New York, 1921. (Publications of the University of Manchester, No. 142.) Cloth, 6 × 9 in., 137 pp., $3.75.

The idea of this volume is not to give an account of the subject of bleaching, but to act as a supplement to other books, of which there are many, dealing with this industry. The author's intention has been to discuss the important researches of recent years bearing on bleaching as a basis for further research.

Central Station Rates in Theory and Practice. By H. E. Eisenmenger. Frederick J. Drake & Co., Chicago, 1921. Fabrikoid, 5 × 7 in., 382 pp., illus.

A textbook for students of electric rates, intended to meet the needs of both beginners and experts. Discusses the cost of electric service, its price, systems of charging, rate analysis, the accuracy of rates and public regulation of public utilities. Appeared serially in the *Electrical Review*.

Centrifugal Pumps. By J. W. Cameron. Scott, Greenwood & Son, London. 1921. Cloth, 6 × 9 in., 142 pp., illus., $3.75.

This small book discusses the theory of these pumps, hydraulic losses, hydraulic efficiency, bearings, effect of vane angle on efficiency, pump details, axial thrust balancing, calculation and design of pumps, and commercial types. The work is intended for engineers and draftsmen.

Les Combustibles Liquides et Leurs Applications. By the Syndicat d'Applications Industrielles des Combustibles Liquides. Gauthier-Villars et Cie, Paris, 1921. Cloth, 4 × 6 in., 621 pp., illus.

This handbook, published by an association of French companies interested in the production and use of liquid fuel, has been prepared as a practical guide to users and dealers. It includes the regulations governing the importation and use of liquid fuels, insurance laws, brief descriptions of the chief oil-producing countries, the principal fuel oils and lubricants and methods for testing them. Descriptions of the leading French types of internal combustion engines, furnaces and boilers are given, and directions for storing and shipping oil. The final section consists of conversion tables and coefficients.

Condensed Catalogues of Mechanical Equipment. Published by The American Society of Mechanical Engineers, New York, 1921. Eleventh annual volume. Cloth, 6 × 9 in., 932 pp., illus., $4.

The eleventh issue of this convenient collection of commercial data upon mechanical equipment and accompanying directories of manufacturers and consulting engineers follows the form of preceding editions. It has, however, been enlarged considerably and revised carefully. Four thousand firms are listed, under 3000 classes, and 495 of these have published data about their products in the book. The number of consulting engineers is 1000, classified under 400 lines of specialization.

Elektrische Foerdermaschinen. By W. Philippi. S. Hirzel, Leipzig, 1921. Paper, 6 × 9 in., 304 pp., illus.

The use of electric hoisting machinery in mining is covered from several viewpoints, mechanical, electrical and economic, with special stress upon the last aspect of the question. The question, whether electric hoisting shall be adopted for a given mine, is the one to which most attention is given.

Employment Management, Wage Systems and Rate Setting. First edition. The Industrial Press, New York, 1921. Paper, 6 × 9 in., 103 pp., $1.

This concise description of systematic methods of employing and placing men, and of wage-payment systems, is based on articles that have appeared in *Machinery*, describing the practice in the Westinghouse Electric and Manufacturing Company, R. K. LeBlond Machine Tool Company, Norton Company and other manufacturing plants.

Die Forderung von Massengutern. By Georg von Hanffstengel. Vol. 1. Julius Springer, Berlin, 1921. Cloth, 6 × 9 in., 306 pp., illus., 234 M.

Volume one of the third edition of this useful treatise deals with belt, chain, bucket, screw, spiral, pneumatic and hydraulic conveyors, together with some minor types. The text is practical as well as theoretical, and covers modern practice very thoroughly. The work has been thoroughly revised.

Graphical Methods. By William C. Marshall. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 253 pp., charts $3.

A general treatise on the construction and use of graphical charts. Includes charts intended to appeal to the general public, those of interest to executives and those intended to facilitate engineering and scientific calculations. Gives many examples of the application of charts to a great variety of purposes and contains an extensive bibliography of published charts.

Steam Road Vehicles. By L. M. Meyrick-Jones. Second edition. Iliffe & Sons, Ltd., London. Cloth, 6 × 8 in., 213 pp., illus., 5 s.

This book is intended to provide an explanation of the theory and practice of steam-road transport, suited to the needs of owners and as an instruction book for drivers and mechanics. Its twenty-eight chapters describe the principles involved in the generation of steam and the construction of the various units that make up the vehicle. This edition has been revised and enlarged. The practice described is exclusively British.

Oil-Field Practice. By Dorsey Hager. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Fabrikoid, 5 × 7 in., 310 pp., illus., diagrams, $3.

The subjects treated in this volume are the acquisition of lands, development drilling, development production methods, transportation, storage, fires, avoidable wastes and losses, refining methods, valuation and buying, and general observations on the industry. The appendix contains sample forms for records, useful tables and a glossary. The book presents American methods of developing oil properties and is intended to give an intelligent insight into the petroleum industry as a whole. To a certain extent it supplements the author's earlier work, Practical Oil Geology.

COMPOUNDING THE COMBUSTION ENGINE

(Continued from page 32)

under complete control. In one instance the clutch succeeded in suppressing entirely a very serious "critical" which occurred in a 700-hp. submarine type Diesel near the normal running speed.[1]

Saving in Weight and Space over Diesels

In Fig. 13 there is shown in side elevation to the left, and end elevation to the right, the comparison between the compound divided-unit geared drive delivering to the tail shaft the same power and speed as the standard Diesel unit of the largest manufacturer. The divided unit consists of two engines, each with four combustion cylinders, in two compound units. Note each of these engines gives the same turning moments and torque diagram as an eight-cylinder Diesel. In fact, with this divided unit we have eight combustion cylinders in the two engines with less than half of the cams, etc., of a six-cylinder Diesel, with all the advantages of two engines, including immunity from shutdown, possibility of inspection and other operating advantages which are well recognized. These two views serve graphically to give some idea of the saving in weight and space.

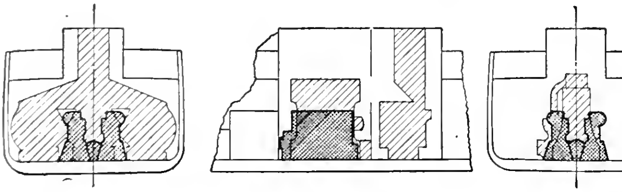


Fig. 14 Comparison between Reciprocating Steam Plant and Geared Compound Diesel Engine

To aid in the comparison with the reciprocating steam engine, Fig. 14 has been developed, giving three views of the steam plant in shaded background. Against it there is outlined the standard compound, two-engine, geared magnetic-clutch arrangement for the identical horsepower and speed at the tail shaft.

PRESIDENT CARMAN'S ADDRESS

(Continued from page 8)

Moral, the Political, and the Economic. I briefly define them as follows:

The Moral Law: God's Law, immutable, unchanging
The Political Law: Man's Law, continually changing
The Economic Law: The Law resultant from the two others.

These laws are coexisting. Their scientific application and operation is necessary, and to have an equilibrium all of them must function properly and in harmony, just as the various parts of a properly working machine must all function. There is a relationship existing between these laws just as definite as the proportional relationship existing between the elements that go to make up the strongest bar of steel, the parts of a completed machine, or the departments of a well-organized and successfully operating business.

The Political and Economic Laws *must* conform to the Moral Law, it is the basic law—and only in this way will complete harmony be secured. These three laws have all been and are in continuous operation but they fail to function as a unit, and their independent operation has produced the chaotic conditions existing today.

There has been much effort in the last decade to solve the problems of so-called "Industrial Relations." Many plans have been advanced and tried, and while there has been some improvement, nevertheless these plans have fallen far short of their goal. Let me lay special stress on this fact, for any effort and endeavor is predestined to failure unless its fundamental principle conforms to each and all of these laws. The world has been asking for thousands of years, "Am I my brother's keeper." The answer comes back through the ages, "Yes," "Love thy neighbor as thyself."

What is the remedy? There must be a speedy adjustment of affairs vital to mankind; we must secure a recognition of and obedience to all of these laws or we will soon be in the midst of the greatest conflict of all ages. We are only just beginning to admit that here is the source of most of the difficulties that we have today.

If civilization is to continue, and I am sure it is, this complete conformity must be sought for, found, accepted, and reduced to practice. If the search is not to be made by engineers, then it must be made by some other group of men or by some one man. The world awaits the solution, men's eyes are turned, looking with expectancy, some hopefully, some fearfully. They long for peace, the peace that will come only when this age-old struggle between Capital and Labor has ceased.

Engineers, even though this message has been heralded throughout the land, are slow to accept the challenge to further serve mankind. They are seemingly content to perform only a part of the work for which they have prepared.

The Federated American Engineering Societies, speaking for the American Engineers, thus defined "Engineering:"

> Engineering is the science of controlling the forces, and of utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith.
>
> As service to others is the expression of the highest motive to which men respond and as duty to contribute to the public welfare demands the best efforts men put forth—Now, therefore . . . .

If we accept this definition, and as a Society we have already done so, then we cannot escape our duty. The door is open wide. The opportunity for service is before us, a service greater by far than the glorious achievements of the past, an opportunity of weaving together the forces and materials of nature and human efforts into a composite, yet unified and synchronized unit of production, operating with satisfaction to the worker, to the capitalist, and for the benefit of all mankind.

DISCUSSION OF THE POWER WASTE SESSION

(Continued from page 26)

higher steam pressures and temperatures, said that the ideal in station design and operation was the lowest cost of current consistent with reliability. Until the price of coal is much higher, steam pressures will remain practically as at present. The study of the heat balance problem with respect to varying load factor, as emphasized by Mr. Pigott, was important, he said, and in selecting the Colfax system one was chosen which appeared to be the most flexible, most reliable, and to cover the greatest variety of operating conditions. In reply to a statement that control of duplex drive auxiliaries was difficult, he said that this was not so if proper attention were paid to the units. The question of repeating the existing installation, raised by Mr. Scott, was being answered at the Colfax Station by a duplication of the original system of heat balance in a second unit which is now being put in.

C. Harold Berry said that the figures in his paper were for an assumed rather than an actual case, the object being to define the problem, rather than to solve it. It would be interesting, as Mr. Pigott had pointed out, to make such an investigation for varying load factors. The question of duplicating the existing equipment at Conners Creek was answered by the present efforts to change auxiliaries to a direct-current drive for better speed regulation, and the probable installation in the future of economizers.

J. H. Lawrence pointed out the impossibility, in New York, of storing a sufficient quantity of fuel oil for such a station as that at Hell Gate. He had never known of trouble with duplex drive.

In answer to a statement made by Mr. Pope about the danger of overspeeding a turbine at light loads when receiving low-pressure steam in the lower stages, he explained that such connections to turbines in the Hell Gate plant were designed to close with the closing of the main steam valve and prevent over-speeding.

---

[1] See the *Sperryscope*, vol. 2, no. 9.

THE ENGINEERING INDEX

(Registered U. S. Patent Office and Canadian Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Selection of. The Proper Selection of Grinding Wheels, P. N. Cooke. Can. Machy., vol. 26, no. 15, Oct. 13, 1921, pp. 25–28. Development and advantages of modern artificial abrasives, grain and grade, manufacturing processes, production grinding; relation of work to grain and grade.

ABRASIVES

Sizing Materials. Sizing of Abrasive Materials, William P. Butler and Paul Keever. Abrasive Industry, vol. 2, no. 10, Oct. 1921, pp. 337–339, 3 figs. Wire sizes and mesh openings of abrasive sizing screens should be standardized to insure classification of uniform grain sizes. (Abstract.) Paper presented before Grinding Wheel Manufacturers' Assn. of U. S. & Canada.

ACCOUNTING

Records for Consulting Engineers. Accounting Records for Consulting Engineers, Arthur L. Mullergren. Eng. News-Rec., vol. 87, no. 17, Oct. 27, 1921, pp. 685–687, 3 figs. Arguments for keeping books with segregated costs. Details of looseleaf system. Forms for expense vouchers and time distribution.

AIR

Specific Heats. The Ratio of the Specific Heats of Air and of Carbon Dioxide, J. R. Partington. Proc. Roy. Soc., vol. 100, no. A702, Oct. 4, 1921, pp. 27–49, 2 figs. Results of experiments on the lines of Lummer and Pringsheim method, eliminating their systematic errors or bringing them under control.

AIR COMPRESSORS

Electrically Driven. Double-Acting Two-Stage Air Compressor. Engineering, vol. 112, no. 2915, Nov. 11, 1921, pp. 674–676, 16 figs. Believed to be largest compressor ever built in Sweden. Driven by directly coupled electric motor, rotor of which is actually mounted on crankshaft. Delivers compressed air to mines.

AIR FURNACES

Firing Method. Equips Air Furnace with Hopper. Iron Trade Rev., vol. 69, no. 17, Oct. 27, 1921, pp. 1082–1084, 4 figs. Coal is dumped into hopper which feeds a specially designed grate as coal is consumed. Only manual labor necessary is that required for pulling the ashes. Method adopted by Allis-Chalmers Mfg. Co.

AIRCRAFT CONSTRUCTION MATERIALS

Fabrics. Permeability of Balloon Fabrics (La Perméabilité des tissus pour ballons), A. D. Ritchie. Révue Universelle des Mines, vol. 10, no. 6, Sept. 15, 1921, pp. 621–631. Discusses rubberized materials and tests made with them.

Spruce. Investigation of Crushing Strength of Spruce at Varying Angles of Grain. Air Service Information Circular, vol. 3, no. 259, July 15, 1921, 15 pp., 10 figs. For determination of crushing or compressive strength from 0 to 90 deg.

AIRPLANE ENGINES

Improvements. Aero Engines, Alan E. L. Chorlton. Jl. Roy. Soc. Arts, vol. 69, no. 3591, Sept. 16, 1921, pp. 725–740, 2 figs. Discusses thermodynamical, mechanical and metallurgical progress made in construction of aeroengines; stratified working, regeneration, bearing loadings and load factors, two-cycle engines, etc.

AIRPLANE PROPELLERS

Theory. The Modern Theory of Aerofoils and Propellers (Die neuere Theorie der Tragflügel und Luftschrauben), E. Everling. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 44, Oct. 29, 1921, pp. 1142–1143. Investigation of lift and drag based on works by E. Trefftz and R. Fuchs in Zeit. fur angewandte Mathematik u. Mechanik, nos. 3 and 2.

The Prandtl Aerofoil and Propeller Theory (Prandtlsche Tragflächen- und Propeller-Theorie), E. Trefftz. Zeit. fur angewandte Mathematik u. Mechanik, vol. 1, no. 3, June 1921, pp. 206–218, 13 figs. Fundamental principles of theory. Deals with aerofoils which, with given lift, have minimum drag. Calculation of lift and drag of given aerofoils. Screw propellers with minimum loss of energy.

AIRPLANES

Aerofoils. The Minimum Induced Drag of Aerofoils, Max. M. Munk. Nat. Advisory Committee for Aeronautics, Report No. 121, 1921, 18 pp. Mathematical discussion covering, the lifting straight line, parallel lifting elements lying in a transverse plane, three-dimensional parallel lifting elements, lifting elements arranged in any direction in a transverse plane, etc.

De Havilland 32 Biplane. The D.H. 32 Commercial Biplane. Flight, vol. 13, no. 38, Sept. 22, 1921, pp. 629–630, 1 fig. Built by De Havilland Aircraft Co. 360 hp. Rolls-Royce engine.

De Havilland 29 Monoplane. The D.H. 29 Monoplane. Flight, vol. 13, no. 39, Sept. 29, 1921, pp. 641–647, 25 figs. Built at Stag Lane works by De Havilland Aircraft Co. 450 hp. Napier Lion engine. Internally braced wings.

Monoplanes vs. Biplanes. Monoplanes or Biplanes? A. Herbemont. Aviation, vol. 11, no. 15, Oct. 10, 1921, pp. 420–422, 3 figs. Compares several well-known European cabin machines, expressing commercial efficiency as pounds of pay load per horsepower. Translated from L'Air.

Pilotless. Pilotless Airplanes (L'avion sans pilote), A. Volmerange. Aeronautique, vol. 3, no. 28, Sept. 1921, pp. 345–351, 5 figs. Discusses automatic stability, the Sperry stabilizer, principle of distance-control, starting and landing.

[See also PARACHUTES.]

AIRSHIPS

Rubberized Fabric. Balloons, Airships and Rubberized Fabric, C. P. Burgess. India Rubber World, Vol. 65, no. 1, Oct. 1, 1921, pp. 3–6, 6 figs. Discusses principal characteristics of some typical airships and balloons, achievements of rubberized fabrics, etc.

Zeppelin. The Drag of Zeppelin Airships, Max M. Munk. Nat. Advisory Committee for Aeronautics, Report No. 117, 1921, 11 pp., 10 figs. Results of tests in which the propellers were stopped as quickly as possible while airship was in full flight.

ALLOY STEELS

Carbon and. Carbon and Alloy Steels: Their Selection and Use, P. W. Peel. Practical Engr., vol. 61, no. 1803, Sept. 15, 1921, p. 167.

Hardening. The Hardening of Tool Steel, S. N. Brayshaw. Eng. Production, vol. 3, no. 57, Nov. 3, 1921, p. 415. Results of work carried out by means of test bars and test cutters for purpose of determining effect of various annealings or heat treatments. (Abstract). Paper read before Sheffield Assn. Metallurgists & Metallurgical Chemists.

High-Resistance. Non-Magnetic, Flame-, Acid- and Rust-Resisting Steel. Chem. & Met. Eng., vol. 25, no. 17, Oct. 26, 1921, pp. 797–799, 5 figs. New high alloy steels developed in research laboratory of Crucible Steel Co. which can easily be worked and machined, but after heat-treatment become hard and resistant to attack of all agencies.

Tests. Elasticity and Strength of Special Steels at High Temperatures (Elastizitat und Festigkeit von Spezialstahlen bei hohen Temperaturen), Georg Welter. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 230, 1921, 65 pp., 99 figs. Results of tests carried out on special steels such as are commonly used in construction of steam turbines and engines, and gas, oil, automobile and airplane engines, to determine limit of elasticity at which permanent dilatation of steel begins. Describes apparatus used for tests.

ALLOYS

See BEARING METALS; COPPER ALLOYS; NICKEL ALLOYS; ZINC ALLOYS.

ALUMINUM

Annealing, Effect of. Unusual Grain Growth Due to Critical Strain, A. P. Knight. Chem. & Met. Eng., vol. 25, no. 18, Nov. 2, 1921, pp. 829–830, 7 figs. Discusses annealing of aluminum coffee pots, bottom of which was rough while sides were smooth.

Properties and Alloys. Aluminum, Its Production, Properties and Alloys (L'Aluminium, sa fabrication, ses proprietes, ses alliages), Léon Guillet. Révue de Metallurgie, vol. 18, no. 8, August 1921, pp. 461–526, 70 figs. Report of lecture at recent aluminum exposition. Appendixes giving curves for binary alloys. Bibliography.

ALUMINUM ALLOYS

Automobile Construction. Use of Wrought Aluminum Alloys in Automobile Construction, Walter Rosenhain. Automotive Industries, vol. 45, no. 18, Nov. 3, 1921, pp. 862–864. Discusses advantages and possible applications, piston difficulties, corrosion.

Bronzes. Notes on Casting Aluminum Bronze, Austin D. Wilson. Foundry, vol. 49, no. 20, Oct. 15, 1921, pp. 801–804, 27 figs. Micrographs illustrate effects of different compositions and heat treatments on structure. Presence of manganese tends to refine grain.

Castings, Cracks in. Cracks in Aluminum-alloy Castings, Robert J. Anderson. Trans. Am. Inst. Min. & Metallurgical Engrs., no. 1101-N, Oct. 1921, 22 pp.; also (in abstract), Min. & Metallurgy, no. 178, Oct. 1921, pp. 43–44. Effects of various factors on cracking; method of molding; prevention of cracks.

[See also ALUMINUM, Properties and Alloys.]

Note.—The abbreviations used in indexing are as follows
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U.S.)
Ventilating (Vent.)
Western (West)

ANEMOMETERS

Testing. Measurement of Air Velocities and the Testing of Anemometers, James Cooper. Iron & Coal Trades Rev., vol. 103, no. 2798, Oct. 14, 1921, p. 540. Discusses results obtained with a testing anemometer table based on that designed by H. Briggs many years ago and which is claimed to work perfectly.

ASH HANDLING

Conveyor. A New Ash Handling Conveyor. Eng. & Indus. Management, vol. 6, no. 16, Oct. 20, 1921, pp. 449–450, 4 figs. Describes system developed by Underfeed Stoker Co., Ltd., London.

AUTOMOBILE ENGINES

Cylinders. How Ford Cylinder Blocks are Cast, Pat Dwyer. Foundry, vol. 49, no. 19, Oct. 1, 1921, pp. 751–758, 7 figs. New River Rouge plant operated on continuous production principle; to make castings for 8,000 cars per day. Description of making cores, molds, pouring castings, melting equipment, etc.

Eight-Cylinder. Engines with Eight Cylinders in Line (Le Moteur a huit cylindres en ligne), A. Contet. La Vie Automobile, vol. 17, no. 738, Sept. 25, 1921, pp. 335–339, 12 figs. Discusses variations of eight-cylinder crankshafts and describes Panhard, Fraschini and other eight-cylinder engines.

Light-Metal. Recent Experiences with Light Metals in High-Speed Engines (Neue Erfahrungen mit Leichtmetallen in schnellaufenden Motoren), H. v. Selve. Zeit. für Metallkunde, vol. 13, no. 10, July 1921, pp. 316–318, 7 figs. Based on tests and experiences, writer strongly recommends increased use of aluminum and magnesium alloys in automobile construction and gives comparative data on weight, strength and expansion of aluminum castings and aluminum sheet pistons and magnesium pistons, as well as of connecting rods of steel and magnesium.

Rotary-Valve. A New Rotary Valve Engine. Automotive Industries, vol. 45, no. 22, Dec. 1, 1921, pp. 1065–1066, 3 figs. Chief advantage claimed is that of absolutely silent operation. Absence of valves and tappet rods at side of cylinder block allows location of accessories close to cylinders and a consequent narrow engine.

[See also CARBURETORS; CLUTCHES; CRANKCASES.]

AUTOMOBILE FUELS

Coke. Coke As a Fuel for Commercial Vehicles, Thomas Clarkson. Engineering, vol. 112, no. 2912, Oct. 21, 1921, pp. 579–580. Points out that when coke is used as motor fuel, either for raising steam or making gas, cost of transport may be very considerably reduced as compared with gasoline motor. Paper read before Instn. Automobile Engrs.

Condensation Temperatures. Condensation Temperatures of Gasoline- and Kerosene-Air Mixtures, Robert E. Wilson and D. P. Barnard. Jl. Indus. & Eng. Chem., vol. 13, no. 10, Oct. 1921, pp. 906–912, 12 figs. Describes a simple and reliable method for determining initial condensation temperature of fuels from air-fuel mixtures, an approximate method for determining temperatures of partial condensation in air-fuel mixtures, etc.

Kerosene. The Use of Kerosene in Automobile Engines (L'Emploi des pétroles lampants dans les moteurs d'automobiles), A. Grebel. Memoirs et Compte Rendu des Travaux de la Société des Ingenieurs Civils de France, vol. 74, no. 4-5-6, April-June 1921, pp. 250–269. Holds that it is not so much a question of carburization and carburetors, but of the engines, cycles, and manner of regulation. Tables of liquid fuels and their properties.

Total Heat Content. The Total Sensible Heats of Motor Fuels and Their Mixtures with Air, Robert E. Wilson and D. P. Barnard. Jl. Indus. & Eng. Chem., vol. 13, no. 10, Oct. 1921, pp. 912–915, 5 figs. Describes approximate methods in determining the total sensible heat content of Socony motor gasoline and kerosene and their mixtures with air at temperatures up to 500 deg. cent.

AUTOMOBILES

Camshafts. Manufacture of Accurate Camshafts, Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 175–180, 8 figs. partly on p. 181. Describes important operations, and gives complete tabulated data on manufacturing procedure in making camshafts in Lincoln Motor Co.'s plant.

Declutcher, Automatic. Automatic Declutcher Introduced at Paris Show. Automotive Industries, vol 45, no 19, Nov. 10, 1921, p. 922, 3 figs. Gear shifting accomplished by taking foot off accelerator pedal and waiting until engine slows down to point where it is sure to be uncoupled by new device. Gear lever is then shifted without disengaging friction clutch.

Delage. A New 11 Hp. Delage. Autocar, vol. 47, no. 1353, Sept 21, 1921, pp. 533–535, 7 figs. Four cylinder monobloc, 72 × 130 mm.; electric lighting and starting, four-speed gear; four-wheel braking system.

Duesenberg. New Duesenberg Reflects Experience Gained with Racing Cars, J. Edward Schipper. Automotive Industries, vol 45, no. 18, Nov. 3, 1921, pp. 854–857, 5 figs Equipped with eight-in-line engine, four-wheel brakes, overhead camshaft, and tubular connecting rods, high pressure oiling, semi-elliptical springs.

Electric, Suspension. Eliminating Vibrations and Shocks in Electric Motor Vehicles (Come eliminare i danni delle vibrazioni e degli urti nei veicoli automotori elettrici), Gino Turrinelli. L'Elettrotecnica, vol. 8, no. 26, Sept. 25, 1921, pp 581–584, 11 figs. Discusses methods of suspension and describes new system of suspension.

Fiat. The 10 Hp. Fiat (La 10 Hp. Fiat), A. Contet. La Vie Automobile, vol. 17, no. 737, Sept. 10, 1921, pp. 307–311, 15 figs. Discusses chassis, engines (four- and six-cylinder monobloc), speed control, etc.

Gear Release. Automatic Gear-Release (L'Auto-débrayage T. L.), G. Lienhard. La Vie Automobile, vol. 17, no. 738, Sept. 25, 1921, pp. 354–358, 12 figs. Describes the T. L. device, consisting of a wheel with a helicoidal rim, similar to the free wheel of bicyles, placed between engine and transmission gear.

German. New German Car Has Novel Design Features, Benno R. Dierfeld. Automotive Industries, vol. 45, no. 15, Oct. 13, 1921, pp. 703–706, 5 figs. Clutch design of this 30-hp. Protos is entirely new; unusual method of locking gears in position; cylinder block is excellent example of German engineering and foundry practice; no control hand levers on steering wheel; four-cylinder engine used.

Haynes. Longer Wheelbase and Larger Engine in New Haynes, J. Edward Schipper. Automotive Industries, vol. 45, no. 16, Oct. 20, 1921, pp. 764–766, 6 figs. New model "75" has 132-in. wheelbase and 299-cu. in. engine with block-cast cylinders, inclined valves, chain distribution, three-piece separate head, aluminum crankcase and hollow-shaft lubrication.

Improvements. Improvements in Automobile Manufacture (Neue Wege im Automobilbau), Otto Schwager. Motorwagen, vol. 24, nos. 26 and 27, Sept. 20 and 30, 1921, pp. 565–566 and 579–591, 15 figs. New Rumpler car with drop-pearl-shaped (streamline) frame and body based on experiences in airplane construction. The gearless Maybach car. The Atlantic two-seated cycle car.

Mack A B Chassis. Mack Chassis Now Adapted for Use as Rail Cars, Herbert Chase. Automotive Industries, vol. 45, no. 19, Nov. 10, 1921, pp. 918–921, 6 figs. Vehicles used for railway work have special axles, wheels and reverse gears, but most other parts of the chassis are identical with those used in standard Mack trucks. Special bodies seat from 25 to 35 passengers.

Pierce-Arrow Repair Service. Automotive Service Methods and Equipment Howard Campbell. Am. Mach., vol. 55, no. 20, Nov. 17, 1921, pp. 789–791, 7 figs. Tools used in remachining Pierce-Arrow transportation units. Reboring fixtures. Valve-spring tester. Welding and remilling axle shafts.

Renault 40-Hp. Testing a 40-Hp. Renault Automobile (Essai d'une Voiture Renault 40 chevaux), H. Petit. La Vie Automobile, vol. 17, no. 738, Sept. 25, 1921, pp. 340–346, 16 figs. Test data and description of engine (6-cylinder), transmission gear, chassis, etc.

Rumpler. A German Passenger Car of Radical Design. Automotive Industries, vol. 45, no. 17, Oct. 27, 1921, pp. 812–816, 12 figs. Describes Rumpler streamline car. Engine is aft and every possible obstacle on streamline body is removed to minimize air resistance.

Rumpler's New Automobile (Der neue Kraftwagen von Dr. Ing. Rumpler), A. Heller. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 39, Sept. 24, 1921, pp. 1011–1015, 11 figs. Special feature is its rear-axle drive with which only the compensating shafts oscillate and all joints are eliminated. Due to location of entire drive in rear a favorable form could be developed with regard to air resistance.

Stevens-Duryea Stevens-Duryea Producing High Grade Six, Herbert Chase. Automotive Industries, vol. 45, no. 22, Dec. 1, 1921, pp. 1061–1064, 7 figs. Describes changes made in chassis and Model E power plant, and gives details of construction.

Sunbeam 4-Seater. A New 2-Litre Sunbeam. Autocar, vol. 47, no. 1355, Oct. 8, 1921, pp. 624–627, 13 figs. Four-seater, 14-hp., four-cylinder 72 × 120 mm., overhead valves, aluminum cylinder blocks.

Suspension. The Suspension of Vehicles (Remarques sur la suspension des véhicules), P. Lemaire. La Technique Moderne, vol. 13, no. 1, Jan. 1921, pp. 7–11, 2 figs. Discusses transmission of shocks by wheels, comfortable and uncomfortable speeds, elastic constants of springs.

See also Electric, Suspension.

Wills Sainte Claire. Wills Sainte Claire Car Has Engine of Original Design, J. Edward Schipper. Automotive Industries, vol. 45, no. 19, Nov. 10, 1921, pp. 912–917, 8 figs. Eight-cylinder solid-head engine, overhead camshaft drive. Describes cooling system, oil circuit, etc. Gives specifications. 65 b.hp. at 2700 r p.m. maximum.

Wolseley 7-Hp. A New 7-Hp. Wolseley. Autocar, vol. 47, no. 1353, Sept. 24, 1921, pp. 541–543, 9 figs. Water-cooled horizontally opposed twin, 82 × 92 mm. three-speed and reverse gear.

AVIATION

Air Harbors. Canadian Airharbors. Aviation, vol. 11, nos. 16 and 17, Oct. 17 and 24, 1921, pp. 448–450 and 481–482, 1 fig. Detailed description of each; markings for air harbors; the part of Canadian Air Regulations which provides for licensing of air harbors.

B

BALLOONS

Captive, Winding Machinery for. Winches for Captive Balloons (Les treuils de ballon captif), Léon Chollet. L'Aeronautique, vol. 3, nos. 27 and 28, August and Sept. 1921, pp. 316–319 and 377–380, 6 figs. Aug.: Describes various cars or trucks driven by steam or gasoline. Sept.: Discusses power of engine, speed of bringing down the balloon, winding cable, etc.

BEAMS

Continuous. Calculations for Continuous Beams with Third-Point Loading, Ewart S. Andrews. Concrete & Constructional Eng., vol. 16, no. 10, Oct. 1921, pp. 647–654, 5 figs. Deals with beams continuous over three spans.

Maximum Bending-moment Diagrams for Continuous Beams, C. S. Gray. Mech. World, vol. 70, no. 1813, Sept. 30, 1921, pp. 266–267, 7 figs. Discusses Clapeyron's theorem of three moments.

Curved. Bending Lines of Curved Beams (Biegungslinien ringförmiger Träger), Friedrich Düsterbehn. Eisenbau, vol. 12, no. 10, Oct. 11, 1921, pp. 249–264, 7 figs. Bending lines are developed for deformation of curved beams.

Sections. The Graphics of Beam and Girder Sections. Alan Pollard. Machinery (Lond.), vol. 19, no. 473, Oct. 20, 1921, pp. 63–66, 4 figs. Method for determining the centroid, moment of inertia, swing radius, and moduli for any shape of section on drawing board.

BEARING METALS

Properties. What Metals Serve Best in Bearings? Bruno Simmersbach. Raw Material, vol. 4, no. 9, Sept. 1921, pp. 316–320. Relation between physical-chemical properties of bearing alloys and their ability to live under strenuous duty. From Chemiker Zeitung.

BEARINGS, BALL

Roller and. Anti-Friction Bearings in the Steel Mill, A. M. MacCutcheon. Blast Furnace & Steel Plant, vol. 9, no. 10, Oct. 1921, pp. 600–607, 13 figs. Discusses ball and roller bearings, their manufacture, mounting and selection. Advantages and disadvantages of anti-friction bearings. (Abstract.) Paper read before Iron & Steel Elec. Engrs.

BEARINGS, ROLLER

Tangential Load. Experiments with Roller Bearings Under Tangential Load (Undersökningar rörande rullning under tangentialkraft), Arvid Palmgren. Teknisk Tidskrift (Mekanik), vol. 51, no. 9, Sept. 14, 1921, pp. 129–132, 8 figs. Discusses results of tests made in the S. K. F. laboratory.

BELTING

Cellulose. Tests with Cellulose Driving Belts (Versuche mit Zellstofftreibriemen), H. Rudeloff. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 40, Oct. 1, 1921, pp. 1041–1044, 4 figs. Account of tests to determine strength of paper composed of equal parts of soda and sulphite cellulose in the different stages of manufacture, for purpose of ascertaining degree to which strength of cellulose employed in yarns, textures and belts is utilized.

Rubber. Getting the Maximum Service in Rubber Transmission Belting, James B. McPherson. Chem. & Eng. News, vol. 33, no. 10, Oct. 1921, pp. 29–30. Writer advises securing maximum coefficient of friction, maximum arc of contact practicable, avoiding excessive tension, reckless use of dressings, and careless fastenings.

BLAST-FURNACE GAS

Steam Power from. Steam Power from Blast-Furnace Gas, Gordon Fox and F. H. Willcox. Power, vol. 54, no. 20, Nov. 15, 1921, pp. 706–709, 3 figs. Résumé on utilization of blast-furnace gas for steam making and development in burning gas alone or in combination with other fuels. Typical data are given as to amount of gas available and variation in supply. Importance of cleaning gas is emphasized, numerous recent installations are cited and developments in design summarized.

BLAST FURNACES

High Top Heat. Causes of High Top Heat in the Blast Furnace, Wallace G. Imhoff. Chem. & Met. Eng., vol. 25, no. 16, Oct. 19, 1921, pp. 737–740. Charts recording temperature of waste gases are of value in controlling furnace operations, indicating especially clearly exact time when charging is done and if charge is alternately hanging and slipping.

Pennsylvania. New Blast Furnace of the Crane Iron Works Modernizes Plant at Catasauqua, Pa., Richard Peters, Jr. Blast Furnace & Steel Plant, vol. 9, no. 10, Oct. 1921, pp. 577–580, 4 figs. Details of improvements in new blast furnace.

600-Ton. New 600-Ton Blast Furnace Plant. Blast Furnace & Steel Plant, vol. 9, no. 10, Oct. 1921, pp. 588–597, 11 figs. Trumbull Cliffs Furnace Company new plant at Warren, Ohio, now completed. Many interesting features constructed in this plant. Record time made on construction work.

BLOWERS

Propeller Type. Propeller Blowers for Forced-Draft Furnaces (Propellergebläse für Unterwindfeuerungen), Werner Muller. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 36, Sept. 9, 1921, pp. 281–284, 12 figs. Details of the Föge propeller blower based on design of airplane propellers. Discusses shape of propeller and housing, speed, power consumption and efficiency. Installation in forced-draft furnaces.

BOILER FEEDWATER

Concentration, Control of. Priming and Control of Boiler Water Concentration, Geo. C. Cook. Power Plant Eng., vol. 25, no. 20, Oct. 15, 1921, pp. 986–988. Discusses limit of impurities in feedwater and methods of controlling degree of concentration.

BOILER FIRING

Fuel Saving in. Fuel Saving in Relation to Capital Necessary, Joseph Harrington. Mech. Eng., vol. 43,

no. 11, Nov. 1921, pp. 723–726, 2 figs. Investigation shows economy resulting from use of efficiency equipment. Concrete illustrations given in support of theory discussed. (Abstract.)

Refined Fuel. Practical Experiences in Boiler Firing with Refined Fuels (Praktische Erfahrungen im Dampfkesselbetrieb mit veredelten Brennstoffen), H. Morgner. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 33, Aug. 19, 1921, pp. 257–259. Notes on use of pulverized coal, and mixtures of anthracite and lignite.

BOILER PLANTS

Efficient Operation. Boiler-Plant Efficiency, Victor J. Azbe. Mech. Eng., vol. 43, no. 11, Nov. 1921, pp. 722–724 and 726, 5 figs. Usual wastes in boiler plants are brought out by means of tables and curves of boiler performance compiled from large number of observations. Shows to what extent these wastes are preventable or can be made to balance each other, and recommends standard for boiler operation toward which designers and operators may aim. Requirements of ideal boiler installation are summarized.

Oil-Burning. High-Pressure Oil-Burning Installation. Power, vol. 54, no. 17, Oct. 25, 1921, pp. 623–624, 5 figs. Boiler plant of Fall River Electric Light Co. converted from coal to oil burning.

Wimbledon Electrical Works. The New Boiler House Plant at Wimbledon Electricity Works. Eng. & Indus. Management, vol. 6, no. 15, Oct. 13, 1921, pp. 402–403, 1 fig. Consists of two Spearing horizontal water-tube boilers, each having actual evaporative capacity of 25,000 lb. per hr. with overload capacity for 8 hr. of 25 per cent above full load. Details of drive and feed pump.

BOILERS

Design and Settings. Boiler Equipment at River Rouge Plant of the Ford Motor Company, George T. Ladd. Proc. Engineers' Soc. of Western Pa., vol. 37, no. 3, April 1921, pp. 115–148 and (discussion) 149–157, 17 figs. Discusses design of boilers and settings. Discussion of powdered coal equipment and superheater equipment by H. D. Savage and J. R. Le Vally, respectively.

Flanging Methods. Special Methods of Boiler Flanging, George A. Richardson. Boiler Maker, vol. 21, no. 10, Oct. 1921, pp. 281–283, 8 figs. Hand flanging and sectional presses used for irregular shapes in boiler and tank fabrication.

BOILERS, WATER-TUBE

Advantages. The Advantages of Water Tube Boilers, James Kemnal. Mar. Eng. of Can., vol. 11, no. 9, Sept. 1921, pp. 22–23. Describes various cases where cylindrical boilers were replaced by water tube boilers.

BONUS SYSTEMS

Practical Application. Practical Application of the Bonus System for Increased Production (Della practica applicazione del sistema del premio di maggior produzione nelle officine del materiale fisso di Pontassieve), Giorgio Lasz. Rivista Tecnica delle Ferrovie Italiane, vol. 22, no. 2, Aug. 15, 1921, pp. 66–70. Describes experience with Rowan piece work system at an Italian railroad shop.

BRAKES

Air, Westinghouse. New Tests of the Westinghouse Continuous Air Brake (Nouveaux essais du frein continu système "Westinghouse"), M. Tête. Revue Générale des Chemins de Fer et des Tramways, vol. 40, no. 7, July 1921, pp. 22–50, 8 figs. Results of tests in France by commission appointed by Minister of Public Works are entirely satisfactory.

Automotive Engine. Motor Brakes (Motorbremsen), C. Wirsum. Motorwagen, vol. 24, no. 27, Sept. 30, 1921, pp. 600–605, 12 figs. Investigations of the braking effect of automotive engines and recommendations for design. Results of tests with Saurer brakes.

BRASS FOUNDRIES

Cast Ingots. The Casting of Brass Ingots, R. Genders. Metal Industry (Lond.), vol. 19, no. 14, Sept. 30, 1921, pp. 261–262, 2 figs. Describes experiments carried out to minimize occurrence of non-metallic inclusioos.

BRONZES

Antimony, Influence of. The Influence of Antimony in Bronze (Der Einfluss des Antimons im Rotguss), J. Czochralski. Zeit. für Metallkunde, vol. 13, no. 9, June 1921, pp. 276–281, 8 figs. Investigation of influence of antimony additions up to 3 per cent on mechanical properties of bronze with and without lead. It is shown that with antimony content up to 0.3 per cent with 5 per cent lead content the treatment and casting of bronze is favorably influenced.

Arsenic, Influence of. The Influence of Arsenic in Bronze (Der Einfluss des Arsens im Rotguss), J. Czochralski. Zeit. für Metallkunde, vol. 13, no. 11, Aug. 1921, pp. 380–383, 10 figs. Investigation of influence of additions of up to 2 per cent of arsenic on mechanical properties of bronze with and without lead. It is shown that with arsenic content of up to 3 per cent with 5 per cent lead content the casting of bronze is favorably influenced.

Cold-Drawing, Effect of. The Effect of Progressive Cold-Drawing Upon Some of the Physical Properties of Low-Tin Bronze, W. E. Alkins and W. Cartwright. Metal Industry (Lond.), vol. 19, no. 15, Oct. 7, 1921, pp. 280–285 and (discussion) p. 286, 7 figs. Gives results of experiments showing variation during cold-drawing of the three properties: tensile strength, specific volume and scleroscope hardness. Describes characteristics of individual curves. Paper read before Inst. of Metals.

C

CABLES, HOISTING

Metal. Metal Cables For Winding Engines (Les cables d'extraction metalliques ronds), M. Durnerin. Revue de l'Industrie Minérale, no. 18, Sept. 15, 1921, pp. 579–599, 5 figs. Discusses construction, choice of steels, effect of torsion, elasticity of cables and its parts, calculation of cross-sections, and describes a patented automatic "anti-torsion" which increases life of cable.

CAR LIGHTING

Gas and Electric. Railway Car Lighting, George E. Hulse. Trans. Illuminating Eng. Soc., vol. 16, no. 5, July 20, 1921, pp. 99–110 and (discussion) 110–116. Discusses gas and electric lighting, reflectors, and glassware.

CAR SHOPS

Equipment. Kanchrapara Carriage and Wagon Works, Eastern Bengal Railway. Ry. Gaz., vol. 35, no. 17, Oct. 21, 1921, pp. 598–600, 12 figs., partly on pp. 601–604. A scientifically designed layout, together with up-to-date machine, etc., equipment, combine to make Kanchrapara works of special interest.

CARS

Couplers. Measures for the Solution of the Coupling Problem for Main and Narrow-Gage Lines (Massnahmen zur Lösung der Kupplungsfrage für Haupt- und Kleinbahnen), H. Scharfenberg. Glasers Annalen, vol. 89, nos. 3 and 4, Aug. 1 and 15, 1921, pp. 27–32 and 37–42 and (discussion) pp. 42–44, 19 figs. Discusses development and different coupling systems. Address before German Mech. Eng. Soc.

Dining. Great Northern Train Service Between London and West Riding of Yorkshire. Ry. Gaz., vol. 35, no. 17, Oct. 21, 1921, pp. 607–610, 9 figs., partly on pp. 605–606. Describes new rolling stock built on twin bogie principle, with an articulated dining car train, embodying various improvements, including electric cooking.

Pressed Metal Parts. The Use of Pressed Parts in Car and Locomotive Construction (Die Verwendung von Pressteilen im Waggon- und Lokomntivbau), W. Loewe. Glasers Annalen, vol. 89, no. 3, Aug. 1, 1921, pp. 32–36, 12 figs. Describes production of pressed metal parts and suggests means of overcoming difficulties in connection with their adoption. Among their advantages over cast parts are mentioned, greater safety, elimination of use of copper, and adaptability to standardization.

CARS, PASSENGER

Design. On the Question of Passenger Carriages, E. Biard. Bulletin International Ry. Assn., vol. 3, no. 9, Sept. 1921, pp. 1205–1274. Discusses safety and comfort, types of construction and general design of carriages, component parts, chief devices and various accessories of underframe and body. Appendixes.

CARS, REFRIGERATOR

Milk Tanks, Use of. The Use of Car Tanks for Transporting Milk. Ry. Rev., vol. 79, no. 17, Oct. 22, 1921, pp. 543–514, 2 figs. Describes equipment of B. & O. R.R. for transporting milk in bulk in refrigerator cars fitted with glass-lined tanks.

CARBURETORS

Kerosene. Carburetors for Kerosene (Les Carburateurs a Pétrole), A. Mariage. Memoirs et Compte Rendu des Travaux de la Société des Ingenieurs Civils de France, vol. 74, no. 4–5–6, April-June 1921, pp. 279–290, 3 figs. Expresses the views of Compagnie Générale des Omnibus of Paris and gives results of their experiments.

CASTING

Centrifugal. Control of Centrifugal Casting by Calculation, Robert F. Wood. Mech. Eng., vol. 43, no. 11, Nov. 1921, pp. 727–728 and 730, 2 figs. Analyzes controlling factors, with view first of setting down definite mathematical relations between them, and secondly so expressing these relations as to make them useful both in design and operation of machines for casting. (Abstract.)

Melts Metal For Pipe in the Mold, E. C. Kreutzberg. Foundry, vol. 49, no. 19, Oct. 1, 1921, pp. 772–774, 6 figs. Centrifugal casting process developed by L. Cammen uses an electrically heated mold. Aluminum tubing made by this process which will be developed for casting steel.

CASTINGS

Molds, Plaster. Permanent Molds, Edward D. Gleason. Metal Industry (N. Y.), vol. 19, no. 10, Oct. 1921, pp. 391–393. Description of methods of making plaster molds for finished castings to eliminate machining operations.

Non-Ferrous. Producing Small Nonferrous Castings, Raymond H. Sullivan. Can. Foundryman, vol. 12, no. 10, Oct. 1921, pp. 30–32, 2 figs. Discusses daily production of a large number of small duplicate castings and method adopted. Paper read at Foundrymen's Convention.

CENTRAL STATIONS

Blackburn, England. New Electricity Generating Station at Blackburn. Engineer, vol. 132, no. 3434, Oct. 21, 1921, pp. 416–420, 8 figs. Station contains two turbo-alternators, each of 10,000 kw. capacity. Details of coal- and ash-handling plant; boiler plant; cooling towers; switchgear, transformers, etc.

Cotton Industry. Value of Central Station Service in the Cotton Industry, F. E. Sawyer and H. E. Duren. Nat. Elec. Light Assn. Bul., vol. 8, no. 10, Oct. 1921, pp. 586–590. Describes some mills that have changed from own power production to purchased power and its advantages.

CHAIN DRIVE

Silent. The Application and Manufacture of Silent Chain, J. Edward Schipper. Automotive Industries, vol. 45, no. 16, Oct. 20, 1921, pp. 773–778, 18 figs. Manufacture of chain parts, their assembly and inspection, is outlined.

CHROMIUM STEEL

Bibliography. A Bibliography and Abstract of Chromium Steels, F. P. Zimmerli. Chem. & Met. Eng., vol. 25, no. 18, Nov. 2, 1921, pp. 837–843. Chronological arrangement of some of the principal papers on chromium and chromium alloy steels published during the period 1798 to 1919, with brief summary of their scope.

CLUTCHES

Manufacture and Assembly. The Manufacture and Assembly of a Cork Insert Disk Clutch, J. Edward Schipper. Automotive Industries, vol. 45, no. 17, Oct. 27, 1921, pp. 823–826, 13 figs. Description of machining and assembly operations on Hudson and Essex clutches.

COAL HANDLING

Screening and Loading Installation. Screening and Loading Installation of the Bockit-Asem Anthracite Mine at Tandjoeng in Sumatra (Kolenzeefen laadinrichting voor de Bockit-Asem-steenkolenmignen te Tandjoeng op Sumatra), A. Guyot Van Der Ham. Ingenieur, vol. 36, no. 39, Sept. 24, 1921, pp. 772–774, 3 figs. Constructed by Baum Machine Works, Herne, Westfalia. Details of arrangement and equipment.

COKE

Uses. Production, Distribution, and Uses of Coke, E. W. L. Nicol. Gas Jl., vol. 156, no. 3047, Oct. 5, 1921, pp. 37–38. Discusses use of coke as fuel and adapting boiler furnaces to coke. See also Iron & Coal Trades Rev., vol. 103, no. 2796, Sept. 30, 1921, p. 471.

COMBUSTION

Equations. Combustion Equations (Die Gleichungen des Verbrennungsvorganges), R. Mollier. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 42, Oct. 15, 1921, pp. 1095–1096. The stoichiometrical ratios for incomplete combustion are developed.

High-Pressure. Gaseous Combustion at High Pressures—II, William Arthur Bone and William Arthur Haward. Proc. Roy. Soc., vol. 100, no. A 702, Oct. 4, 1921, pp. 67–84, 7 figs. Further experiments to determine a direct relation between the actual rate at which potential energy is transferred on explosion as sensible heat to its products and the magnitude of chemical affinity between its combining constituents.

Initial Temperatures. Initial Temperatures with Heated Combustion Air (Ueber Anfangstemperaturen mit erhitzter Verbrennungsluft), Otto H. Binder. Feuerungstechnik, vol. 9, no. 23, Sept. 1, 1921, pp. 219–220, 1 fig. Presents formula used by author for calculation of initial temperatures.

CONDENSERS, STEAM

New Type High-Efficiency. Steam-Condensing Plants, Paul A. Bancel. Mech. Eng., vol. 43, no. 11, Nov. 1921, pp. 711–716 and 758, 14 figs. Detailed consideration of fixed and operating charges in surface-condenser installations, and description of new type of high-efficiency condenser.

CONVEYORS

Pulverized Materials. Pulverized-Material Conveyor System. Power, vol. 54, no. 17, Oct. 25, 1921, pp. 628–629, 4 figs. Describes the Fuller-Kinyon conveying system for pulverized material, comprising a power-driven pump, function of which is to start the mass in motion; source of compressed-air supply and a pipe through which material flows.

Types. Mechanical Handling and Conveying of Materials, Richard P. Terry. Mech. World, vol. 70, nos. 1814 and 1815, Oct. 7 and 14, 1921, pp. 293–294 and 301–302. Oct. 7: Discusses bucket elevators and worm or Archimedean screw conveyors. Oct. 14: Discusses band, Zimmer, gravity and pneumatic conveyors. Paper read before Belfast Assn. of Engrs.

[See also ASH HANDLING, Conveyor.]

COOLING TOWERS

Investigation. Investigation of Chimney Cooling Towers (Die Beurteilung von Kaminkühlern), Kurt Neumann. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 41, Oct. 8, 1921, pp. 1070–1074, 3 figs. Thermodynamic investigation of phenomena occurring in chimney cooling towers. Equation is derived for determination of temperatures of the hot and recooled water dependent upon operating conditions. Gives results of tests on high-capacity cooling towers in industrial operation.

COPPER ALLOYS

Cupro-Nickel. Manufacture of Cupro-Nickel, Herbert D. Swift. Metal Industry (N. Y.), vol. 19, no. 10, Oct. 1921, pp. 394–395. Description of process going in regular order from casting to packing.

CORROSION

Electrolytic. Electrolytic Corrosion of Lead Thallium Alloys, Colin G. Fink and Charles H. Eldridge. Am. Electrochem. Soc., advance paper, no. 26, for meeting Sept. 29-Oct. 1, 1921, pp. 335–344, 4 figs. Shows that addition of thallium to lead alloys has been very effective in reducing anodic corrosion in acid copper sulphate electrolyte containing nitric and hydrochloric acids.

Heating System. Preventing Corrosion in Heating Systems, Perry West. Domestic Eng. (Chicago), vol. 97, no. 2, Oct. 8, 1921, pp 50 53 and 82-84, 4 figs. Describes deoxidizing and de-aerating methods.

COST ACCOUNTING

Classification of Surplus. Classification of Surplus, C. B. Couchman Jl of Accountancy, vol. 32, no. 4, Oct. 1921, pp. 265-278 Discusses various kinds of surpluses and their display in the accounts. Paper read before Am. Inst of Accounts

Uniform Mill Systems. Uniform Mill Cost Systems, C. Oliver Wellington. Paper, vol. 29, no. 6, Oct. 12, 1921, pp. 13-15. Discusses advantages of uniformity in cost accounting.

COSTS

Material, Recording. The Recording of Material Costs, E W. Workman. Eng. & Indus. Management, vol. 6, no. 16, Oct. 20, 1921, pp. 426-427. Describes method of dealing with material charges which has been found to work exceptionally well in large engineering firm using Hollerith system for dealing with its labor and overhead expenses.

CRANES

Bridge. New Type of Bridge Crane for Handling Sand and Gravel, W. A. Scott. Cem., Mill & Quarry, vol. 19, no 8, Oct 20, 1921, pp. 27-28, 2 figs. Has max. length of 184 ft.; clamshell bucket has capacity of 3 yd; carriage speed, 800 ft. per min.; bucket speed, 200 ft.

Locomotive. Crane Operated on a Railroad Truck (Grue pivotante sur wagon a voie normale). Bulletin Technique de la Suisse Romande, vol. 47, no. 20, Oct. 1, 1921, pp. 229-234, 3 figs. Carrying capacity of cranes 10-12 tons, radius of action 6 m. Trucks are of special construction.

CRANKCASES

Malleable-Iron. Crank Cases Made of Malleable Iron. Foundry, vol. 49, no. 19, Oct. 1, 1921, pp. 762-766, 10 figs. An extensive series of experiments in molding and in subsequent heat treatment was required before castings were produced on a commercial basis.

CUTTING METALS

Universal Oxygen-Jet. A Universal Oxygen-Jet Cutting Machine. Eng. Production, vol. 3, no. 56, Oct. 27, 1921, pp. 395-397, 3 figs. Details and uses of machine by Godfrey Eng. Works, London.

D

DIES

Automobile Parts. Making Dies for Forming Automobile Parts, Richard Dale. Iron Age, vol. 108, no. 18, Nov. 3, 1921, pp. 1127 1129, 10 figs. Explains design and construction for manufacture of such articles as brake drums and step brackets.

Carburetor Bowl. Drawing Dies for Manufacturing a Carburetor Bowl, N. T. Thurston Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 218-221, 11 figs. Shows how substantial saving was effected by drawing and forming carburetor bowl on power presses. Describes successive operations.

Self-Opening Dieheads. Making the Coventry Self-Opening Diehead. Am. Mach., vol 55, no. 17, Oct. 27, 1921, pp. 678 681, 15 figs. Materials tested in an up-to-date laboratory; parts inspected and sent to storeroom for reissue after each operation. Work carried out in self-contained factory at Edgwick, Coventry, England.

Shaving Tools. Notes on the Design of Shaving Tools, Hugo F. Pusep. Am. Mach., vol. 55, nos. 16 and 17, Oct. 20 and 27, 1921, pp. 624 626 and 686 689, 18 figs. Second operation necessary to obtain accuracy of size and contour. Discusses three general classes of shaving tools.

Wire-Drawing, Diamond. Diamond Dies for Wire Drawing, C. W. Busick. Am. Mach., vol. 55, no. 18, Nov. 3, 1921, pp. 703 705, 7 figs. How dies are lapped and tested for size. Automatic lapping machines for this work.

DIESEL ENGINES

Combustion in. Explosion and Internal-Combustion Engines (Moteurs a Explosion et a Combustion Interne), F. Huard. Arts et Métiers, vol 74, no. 11, August 1921, pp 212 216, 2 figs Discusses combustion in Diesel and semi Diesel engines. (Concluded.)

Marine. A New Nelseco Diesel Engine. Motorship, vol 6, no 10, Oct. 1921, pp 798 801, 10 figs Details of 600 b hp. marine Diesel engine designed for electric and direct drives, built by New London Ship & Engine Co., Groton, Conn. Fuel consumption at 25 per cent overload is 0.42 lb. per b.hp.

Building Marine Diesel Engines. Eng. Production, vol 3, nos 53 and 51, Oct 6 and 13, 1921, pp. 321 325 and 319 352, 21 figs Methods and equipment of the North British Diesel Engine Works, Ltd., at Glasgow, founded in 1913 for purpose of developing marine Diesel engine up to 12,000 hp.

The Marine Diesel Engine. Its Reliability in Service, Andrew J Brown. Trans Inst. Mar. Engrs, vol 33, Sept. 1921, pp. 279 307 and (discussion) 307 325, 7 figs. Discusses the various parts of engine from the standpoint of showing how reliability is ensured

Worthington Solid-Injection. The Worthington Solid-Injection Diesel Power, vol 54, no. 18, Nov. 1, 1921, pp. 675 677, 3 figs Engine operating on Diesel cycle without air injection Novel means employed to secure combustion at constant pressure with pump feed.

DROP FORGING

Modern Practice. Modern Drop-forging Practice, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 213-217, 8 figs. Comparison of drop forgings and castings, and general methods of making them.

DYNAMOMETERS

British Traction. A New British Traction Dynamometer. Automotive Industries, vol. 45, no. 18, Nov. 3, 1921, pp. 860-861, 3 figs. Description of recording instrument designed especially for use in tractor trials; registers drawbar pull, time, and distance covered.

E

ELECTRIC DRIVE

Fabric Printing Machines. Electric Drive for Fabric Printing Machines (Commande électrique des machines a imprimer les tissus), Louis Grosheintz. La Technique Moderne, vol. 13, no. 2, Feb. 1921, pp. 71-74, 4 figs. Shows that d.c. drive is most suitable.

Lumber Mills. Application of Electrical Energy in Lumber Mills, W. A. Scott. Elec. Rev. (Chicago), vol. 79, no. 19, Nov. 5, 1921, pp. 685-688, 6 figs. Saws, conveyors and other units driven by belted and direct-connected motors; special requirements peculiar to lumber industry; mill refuse as fuel to generate electric power.

ELECTRIC FURNACES

Gray-Iron Castings. Gray Iron Castings from Electric Furnaces, Thomas Robson Hay. Iron Age, vol. 108, no. 19, Nov. 10, 1921, pp. 1214-1215. Present electric practice and advantages over older method. Comparative cost.

Induction. A New Electric Induction Furnace (Nouveau four électrique a induction), H. Vigneron. La Nature, no. 2475, Sept. 10, 1921, pp. 163-165, 5 figs. Describes Northrup system and its applications.

Iron Industry. Electric Furnace Possibilities in the Western Iron Industry, R. C. Gosrow. Jl. Electricity & Western Industry, vol. 47, no. 7, Oct. 1, 1921, pp. 265-266. Analysis of opportunities open to the electric furnace in the Western iron industry, with data on costs.

Repelling-Arc Type. Something New in Electric Furnaces, E. F. Cone. Sci. Am., vol. 125, no. 14, Oct. 1, 1921, p. 229, 1 fig. Describes repelling-arc type of furnace having a self-regulating, flaming arc torch.

Superheating Iron. Superheating Iron Electrically, George K. Elliott. Iron Trade Rev., vol. 69, no. 16, Oct. 20, 1921, pp. 1007-1011. States that by using basic-lined electric furnace in conjunction with cupola, high-temperature iron can be produced, desulphurization can be accomplished easily and impurities closely controlled. Compares composition and strength. Paper presented under auspices of Am. Foundrymen's Assn. before Instn. British Foundrymen.

ELECTRIC LOCOMOTIVES

Characteristics. Characteristics of the Electric Locomotive, N. W. Storer. Jl. Franklin Inst., vol. 192, no. 4, Oct. 1921, pp 453 467, 8 figs. Deals with d.c. and a.c. locomotives, and regenerative braking.

Comparison with Steam. Some Mechanical Characteristics of High-Speed, High-Power Locomotives, A. W. Gibbs. Jl. Franklin Inst., vol. 192, no. 4, Oct. 1921, pp. 469 495, 26 figs. Deals principally with results of comparative trial of steam and electric locomotives made in 1907 to secure information in connection with design of electric locomotives for Pennsylvania terminal in New York.

Control Equipment. Electrical Considerations Which Govern in a Choice of Locomotives for Any Given Class of Service, H. H. Johnston. Coal Age, vol. 20, no. 18, Nov. 3, 1921, pp. 717 719, 4 figs. Locomotives with dynamic-braking controllers deliver current on descending grades and must have additional motor capacity. Series-and-parallel control vs. series-parallel control.

German. New Electric Passenger-Train Locomotives for the Silesian Mountain Railway (Neue elektrische Personenzug-Lokomotiven fur die Schlesischen Gebirgsbahnen), H. Loewentraut. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 17, Sept. 10, 1921, pp. 201 203, 2 figs. Specifications: Gage, 1435 mm.; driving-wheel diam.; 1250 mm.; leading wheel diam., 1000 mm.; max. speed, 90 km. per hr.; contact line voltage, 15,000 volts; frequency, 16⅔ periods.

Midi Railway, France. Mechanical Aspects of the New Electric Double-Bogie Locomotives of the Midi Railroad in France [Sur les dispositions mécaniques d'ensemble des nouvelles locomotives électriques a deux bogies moteurs (type de la compagnie des chemins de fer du Midi)], Fernand Broussouse. Le Technique Moderne, vol. 13, no 3, March 1921, pp. 97 101, 12 figs. Discusses French and American suspensions, interchangeability and balancing of Midi bogies, etc.

Selection. Mechanical and Engineering Considerations Determining the Selection of an Electric Locomotive, H. H. Johnston Coal Age, vol. 20, no. 17, Oct. 27, 1921, pp 679 681, 5 figs. Discusses mine-haulage equipment and their specifications, locomotives, speed, and weight of rail.

ELECTRIC PLANTS

Bangor, Me. Remodeling Plant to Increase Rating, Phifer Smith. Elec. World, vol 78, no. 17, Oct. 22, 1921, pp. 815 818, 5 figs. Describes new constructions at Veazie power plant of Bangor (Me.) Ry. & Electric Co., including four new units of 1,800 kw. capacity each.

Blackburn, England. Electricity Supply in Blackburn. Electrician, vol. 87, no. 2267, Oct. 28, 1921, pp. 536-539, 3 figs. Describes coal and ash handling plants, boiler house, turbo-alternators (two 10,000 kw. each driving 6,600-volt 50-period three-phase alternators), and auxiliaries of new power station.

Edinburgh. New Electricity Station at Edinburgh, S. B. Donkin. Electrician, vol. 87, no. 2263, Sept. 30, 1921, p. 407. Describes equipment, including generating plant, sea work pumps, shafts and tunnels. H. T. three-phase current; ultimate capacity 100,000 kw. (Abstract.) Paper read before British Assn.

England. Recent Extensions at Sunderland. Electrician, vol. 87, no. 2263, Sept. 30, 1921, pp. 414-415, 4 figs. Describes turbo-alternator, motor generators, busbar and switchboard construction of Corporation Generating Works.

Large Units. Some Notes on Large Electric Units, Stanley Parker Smith. Electrician, vol. 87, no. 2262, Sept. 23, 1921, pp. 378-380, 5 figs. Discusses prime movers, a.c. and d.c. production, converters, mercury rectifiers, etc. (Abstract.) Paper read before British Assn.

London Underground Railways. Chelsea Power Station—London Underground Railways. Tramway & Ry. World, vol. 50, no. 20, Oct. 20, 1921, pp. 185-189, 5 figs. Describes new equipment installed, including 15,000-kw. turbo-alternators, condensing water plant, etc.

Small. Economies in Operation of Small Power Plants, E. S. Hight. Elec. Rev., (Chicago), vol. 79, no. 16, Oct. 15, 1921, pp. 573-576, 3 figs. Discusses selection of coal, reduction of air leakage and radiation losses, engine room economies, etc. Extracts from paper before Iowa section of N.E.L.A.

Steel Works, Rumania. Operating Experiences with the Electric Plants of the Resita Steel Works (Rumania) (Einige Betriebserfahrungen mit den elektrischen Anlagen der Eisenwerke in Resita), Erick Beck. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 19, Oct. 10, 1921, pp. 225-228, 2 figs. Current is supplied from three power plants; viz., one hydroelectric station, one blast-furnace-gas engine plant, and one 2500-kw. steam turbine, all supplying a single network with 5000-volt three-phase current with frequency of 20.8 periods.

ELECTRIC RAILWAYS

Italy. Valtellina Railway is Extended, E. Huldschiner. Elec. Ry. Jl., vol. 58, no. 19, Nov. 5, 1921, pp. 816-817, 1 fig. Discusses new trolley suspension and new locomotive; tests show satisfactory operation. Translated from Elektrotechnische Zeit.

Ore-Carrying, Chile. A Visit to the Tofo Mine of the Bethlehem Chile Iron Mines Co. (Una visita al mineral del Tofo de la Bethlehem Chile Iron Mines Co.), Ricardo Solar Puga. Anales del Instituto de Ingenieros de Chile, vol. 21, no. 6, June 1921, pp. 397-403, 8 figs. Describes first electric railroad in Chile used for ore carrying. Locomotives are of 1200 hp. d.c. 2400 volt.

Third-Rail System. Experiences of Northwestern Pacific Ry. with Third Rail System, C. E. Hatch. Eng. & Contracting, vol. 56. no. 16, Oct. 19, 1921, p. 380. Experiences in operation of 37 mi. of electrified track on which third-rail system is employed. Notes on how contact rail is supported; protections at crossings and stations; method of carrying feeders; and maintenance cost. (Abstract.) Paper read before Pac. Ry. Club.

ELECTRIC WELDING, ARC

Rail Joints. Arc Welded Rail Joints. Welding Engr., vol. 6, no. 10, Oct. 1921, pp. 27-32, 13 figs. Discusses welding rail joints by the Detroit street-car system and tests made.

ELEVATORS

Electrical Troubles. Locating Electrical Trouble on Elevators, William Zepernick, Power, vol. 54, no. 20, Nov. 15, 1921, pp. 755-757, 14 figs. Grounds, short circuits and open circuits defined. Methods of grounding power systems. Examples given on how to locate electrical faults on controller equipment.

EMPLOYEES

Thrift Encouragement by Employers. Thrift Encouragement by Employers V. Leonhard Felix Fuld. Indus. Management, vol 62, no 5, Nov. 1921, pp. 287 289. Points out that investment companies appear to be ideal thrift encouragement plan for workers, as they furnish a thrift encouragement vehicle for each class of worker.

EMPLOYEES, TRAINING OF

Selection and. Industrial Training and Selection of Personnel, C R. Dooley Chem. & Met. Eng., vol. 25, no 15, Oct. 12, 1921, pp. 692 695. Outline of basic principles underlying modern methods of selecting and training employees, and some helpful suggestions for solving personnel problems.

ENAMELING

Steel Containers. Enamel-Lined Apparatus, Chester H. Jones. Chem. & Met. Eng., vol. 25, no. 20, Nov. 16, 1921, pp. 927-932, 17 figs. Plant of Elyria Enameled Products Co. at Elyria, Ohio, engages in manufacture of enameled equipment for service in many varieties of plant processing; steel and cast-iron containers; burning equipment; composition and properties of enamels; control and management of operations.

EVAPORATORS

Design. An Improvement in Evaporator Design, Robert V. Cook. Chem. Age (N. Y.), vol. 29, no. 10.

Oct. 1921, pp. 409–410, 1 fig. Describes the criss-cross evaporator.

Tests. Result of Operations With Some Evaporators (Resultats de marche de quelques appareils d'evaporation), M. Depasse. Bul. de l'Association des Chimistes de Sucrerie et de Distillerie, vol. 38, no. 10, April 1921, pp. 383–404 and (discussion) 407–409, 2 figs. Gives test data with two-stage, three-stage, and four-stage evaporators.

F

FACTORIES

Hosiery. Up-to-the-Minute Design for New Hosiery Factory, H. P. Elliott. Contract Rec., vol. 35, no. 45, Nov. 9, 1921, pp. 963–967. Plant of Holeproof Hosiery Co. of Canada, Ltd., London, Ont., is said to combine every feature that will make employees comfortable and efficient. Details of heating and ventilating, boiler house, hot-water supply, water-softening plant, illuminating system, power transmission, telephone, electric time clocks, etc.

Planning Operations. Notes on the Preparation of Work Lay Outs, H. Varley. Eng. & Indus. Management, vol. 3, no. 37, Nov. 3, 1921, pp. 491–494, 9 figs. Writer enumerates points which should be carefully considered when a part is to be laid out in operations.

Rubber Tires. Mechanical Features of Tire Factory. Iron Age, vol. 108, no. 20, Nov. 17, 1921, pp. 1259–1265, 8 figs. New Kelly-Springfield plant is said to have unusually complete interconnection of mechanical services. Notes on tunnels, piping, wiring and communication.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FANS, CENTRIFUGAL

Design. Controlling Factors in Fan Design, David Darrin. Heat & Vent. Mag., vol. 18, no. 10, Oct. 1921, pp. 49–52. Discusses required capacities, available space and attendance, allowable first cost and operating cost, etc., and gives table of present standards of fan design.

Electrically Driven. Electrically Driven Centrifugal Fans for Mine Ventilation. Mech. World, vol. 70, no. 1815, Oct. 14, 1921, pp. 303–304. Discusses characteristics of fans and motors, power requirements, etc.

Heaters and. Fans and Heaters, Charles L. Hubbard. Southern Engr., vol. 36, no. 2, Oct. 1921, pp. 44–49, 12 figs. Working data for fans, fan drives; heaters; determining size of heater, heater arrangements; heater connections, ducts and flues.

FATIGUE

Industrial. Physiological Methods for Measuring Industrial Fatigue (Les Méthodes Physiologiques actuelles d'évaluation de la Fatigue dite "Industrielle"), D. Glibert. Annales des Mines de Belgique, vol. 22, no. 3, 1921, pp. 837–847, 1 fig. Concludes that present methods are not strictly applicable.

Reduction. Reducing Fatigue in Tool Rooms, F. B. and L. M. Gilbreth. Iron Trade Rev., vol. 69, no. 16, Oct. 20, 1921, pp. 1004–1006, 7 figs. Orderly arrangement of tools, conveniently placed shelves and drawers, and white surfaces tend to improve conditions in tool crib. Ample sunlight important. (Abstract.) Paper before Soc. Indus. Engrs.

Tests. Fatigue Tests at Purdue University, George H. Shepard. Indus. Management, vol. 62, no. 5, Nov. 1921, pp. 281–286, 4 figs. How exertion and rest periods affect efficiency. Includes chart showing output in foot-pounds under certain conditions of work and rest periods.

FILING SYSTEM

Classification, Indexing and. Classification, Filing and Indexing System for Pulp and Paper Library, Carleton E. Curran. Paper, vol. 28, nos. 19, 20 and 21, July 13, 20 and 27, 1921, pp. 9–11, 23 and 30, pp. 17–19 and pp. 17–18. Gives an adaptation of the Dewey classification.

FLIGHT

Soaring. Soaring Flight, L. Prandtl. Aviation, vol. 11, no. 16, Oct. 17, 1921, p. 459, 1 fig. Discusses soaring of birds and possibilities of human soaring flight. Translated from Zeitschrift für Flugtechnik und Motorluftschiffahrt, July 30, 1921.

Some Remarks Concerning Soaring Flight, L. Prandtl. Flight, vol. 13, no. 38, Sept. 22, 1921, pp. 633–634. Utilization of wind power in gliding planes. Translated from Zeitscrift für Flugtechnick und Motorluftschiffahrt, July 30.

The Rhön Soaring Flight Contest 1921 (Rhön-Segelflug-Wettbewerb 1921), Werner v. Langsdorff. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 18, Sept. 30, 1921, pp. 278–281. List and data of competing machines and account of performances.

Spinning Curves. Flight and Spinning Curves (Flug- und Trudelkurven), Ludwig Hopf. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 18, Sept. 30, 1921, pp. 273–278, 9 figs. Discusses equilibrium in connection with stationary curve flight (spinning curve).

FLOW OF AIR

Phenomena. Flow Phenomena in Free Air Currents (Ueber die Strömungsvorgänge), Walter Zimm. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 234, 1921, 36 pp., 31 figs. Investigation of flow phenomena in air currents of low velocity which are said to be of physical and technical importance. Description of experimental apparatus and results of experiments.

FLOW OF FLUIDS

Laminary Limit Flow. The Approximative Integration of the Differential Equation of the Laminary Limit Flow (Zur näherungsweisen Integration der Differentialgleichung der laminaren Grenzschicht), K. Pohlhausen. Zeit. fur angewandte Mathematik u. Mechanik, vol. 1, no. 4, Aug. 1921, pp. 252–268, 10 figs. An integration method is developed and examples are given to demonstrate its applicability.

Laminary and Turbulent Friction. Laminary and Turbulent Friction (Ueber laminare und turbulente Reibung), th. v. Kármán. Zeit. fur angewandte Mathematik u. Mechanik, vol. 1, no. 4, Aug. 1921, pp. 233–252, 7 figs. Discusses theory of laminary friction of liquids and gases in pipes, in connection with which author seeks to explain from mathematical and physical viewpoint the basic principle of Prandtl's limit flow theory and suggests a method for simple mathematical calculation of even complicated cases, he seeks also to develop mathematical basis for turbulent friction.

FLUE-GAS ANALYSIS

Numerical Calculation. The Evaluation of Flue-Gas Analysis (Die Auswertung der Rauchgasanalyse), A. B. Helbig. Feuerungstechnik, vol. 9, no. 24, Sept. 15, 1921, pp. 229–234. Based on calculation of decomposition of all combustible components of fuel with exception of carbon monoxide in atomic volumes, a formula applicable to all fuels is developed which permits an entirely new, simple and clear calculation of heat, according to which carbon loss is determined in purely mathematical manner, and which also permits a new criterion of fuels.

Testing Apparatus. Apparatus for Testing Flue-Gas, John B. C. Kershaw. Combustion, vol. 5, no. 5, Nov. 1921, pp. 204–207 and 218, 9 figs. Describes seven gas-testing instruments which depend upon the measurement of some physical property of waste-gases, which also serves as an index of the amount of CO_2 contained in them.

FORGE PLANTS

Safety Guards in Shops. Using Safety Devices in Forge Shops. Iron Trade Rev., vol. 69, no. 19, Nov. 10, 1921, pp. 1216–1217, 6 figs. Describes simple and inexpensive guards which are being used in one shop.

FOUNDATIONS

Steam Power Plants, etc. Some Notes on Foundation Plans, Douglas Wilson. Mech. World, vol. 70, no. 1816, Oct. 21, 1921, pp. 327–328, 6 figs. Discusses foundations for prime movers, steam power installations, steam turbines, concrete and reinforcement.

FOUNDRIES

Equipment. Equipment Features Malleable Shop, H. E. Diller. Foundry, vol. 49, no. 20, Oct. 15, 1921, pp. 805–813, 14 figs. Discusses changes made in conveying, melting and annealing at new foundry of Am. Chain Co., York, Pa.

Steel. Famous British Works. Eng. Production, vol. 3, no. 54, Oct. 13, 1921, pp. 338–339, 2 figs. Details of plant and equipment of steel foundry of Edgar Allen & Co., Ltd., Tinsley, for production of high-speed, carbon and alloy tool steels, special alloy steels for automobiles and aircraft, toughened steel castings for engineering and other purposes, dynamo magnet-steel castings, Imperial manganese steel, etc.

Temperature Problems. Temperature Problems in Foundry and Melting Room, John P. Goheen. Trans. Am. Inst. Min. & Metallurgical Engrs., no. 1105-N, 1921, 5 pp. Notes on pyrometer equipment for electric brass-melting furnace; special equipment for brazing brass; core-oven temperature control; and value of annealing. Abstract in Min. & Metallurgy, no. 179, Nov. 1921, p. 36.

FUELS

Gaseous. Gaseous Fuel in the Shipbuilding World, George Keillor. Gas Jl., vol. 156, no. 3047, Oct. 5, 1921, pp. 34–37. Discusses application in annealing, hardening and normalizing. Billet, plate and rivet heating; core and mold drying; fuel consumption. See also Iron & Coal Trades Rev., vol. 103, no. 2796, Sept. 30, 1921, pp. 476–478.

Lumber Refuse. Consumers Central Heating Company's New Hog-Fuel Burning Plant. Power, vol. 54, no. 20, Nov. 15, 1921, pp. 750–753, 6 figs. Hog fuel, consisting of sawdust, shavings, groundup edgings, slabs and trimmings, is purchased from lumber manufacturing plants for fuel. Three 7500-sq. ft. vertical water-tube boilers installed. Fuel delivered by barges and handled by 5-ton electric monorail-operated clamshell bucket to system of conveyors.

Smokeless, Manufacture of. The Manufacture of Smokeless Fuel. Engineering, vol. 112, no. 2913, Oct. 28, 1921, pp. 596–601, 41 figs., partly on supp. plate; also Engineer, vol. 132, no. 3135, Oct. 28, 1921, p. 461, 3 figs. Describes works of low Temperature Carbonization, Ltd., Barugh, England, which has 20 retorts in continuous service and are carbonizing 36 tons of coal daily. Fuel produced is sort of semi-coke carrying only very small proportion of breeze, and is called coalite.

[See also OIL FUEL; PULVERIZED COAL.]

FURNACES, BOILER

Forced-Draft Grates. New Forced-Draft Furnace Grate (Crux-Rost und -Ventisolotor), H. Pradel. Elektrotechnischer Anzeiger, vol. 38, no. 153, Sept. 27, 1921, pp. 1096–1098, 7 figs. Describes forced-draft grate and direct-operating mechanical induced-draft installations recently placed on market by Hans Cruse & Co., Berlin.

FURNACES, HEATING

Reheating. The Development and Perfection of the Reheating Furnace (Der Tiefherdofen, seine Entwicklung und Vervollkommnung), A. Sattmann. Feuerungstechnik, vol. 9, no. 23, Sept. 1, 1921, pp. 217–219, 2 figs. Notes on operation and advantages of such furnaces.

FURNACES, INDUSTRIAL

Oil Burners. The "Rotamisor" Oil-Fuel Burner. Engineering, vol. 112, no. 2914, Nov. 4, 1921, pp. 631–632, 4 figs. Describes burner constructed by Combustions, Ltd., Kingston-on-Thames, most interesting feature of which is said to be method adopted for atomization. It is being developed to all requirements from heating of small muffle furnaces for tempering, etc., to firing of large marine or stationary boilers.

FURNACES, METALLURGICAL

Smelting. Smelting Furnace Practice with Regard to Different Construction Types and Present Conditions (Der Schmelzofenbetrieb unter Berücksichtigung der verschiedenen Ofenkonstruktionen und der heutigen Verhaltnisse), Carl Rein. Giesserei-Zeitung, vol. 18, nos. 22 and 23, Sept. 6 and 13, 1921, pp. 296–300 and 312–314, 12 figs. Author records his experiences since 1919, and discusses furnace systems, charging methods and devices, and removal of iron. Points out noticeable defects in present smelting practice and furnaces and offers suggestions for their elimination. Address before Assn. German Foundrymen.

Tar-Oil-Fired. German Furnaces Fired with Tar-Oil, Kuenscher. Foundry, vol. 49, no. 19, Oct. 1, 1921, pp. 770–771. (Abstract.) Paper read before Assn. of German Non-ferrous Metal Founders.

G

GAGES

Manufacturing Uses. The Need of Gauges for Modern Manufacturing, A. C. Wickman. Can. Machy., vol. 26, no. 13, Sept. 29, 1921, pp. 25–29, 8 figs. Discusses the subject of gaging screws, and the checking of gages.

McLeod. An Extension of the Range of the McLeod Gauge, A. H. Pfund. Physical Rev., vol. 18, no. 1, July 1921, pp. 78–82, 2 figs. The pressure of the gas forced into capillary is measured by means of a hot-wire gage. The ratio of compression being known, the time pressure can be determined.

Precision. Precision Gauges, M. E. Kanek. Mech. World, vol. 69, no. 1782, Feb. 25, 1921, pp. 139–141. Discusses 81-block sets, types on the market, effect of size on accuracy, material for gages, direct and comparative methods of measuring, etc.

Snap. Systems of Gauging. Eng. Production, vol. 3, no. 54, Oct. 13, 1921, pp. 345–346, 2 figs. Describes an adjustable snap gage and setting micrometer, which is said to be adaptable and inexpensive.

GAS PRODUCERS

Fuel Economy. Fuel Saving in Modern Gas Producers and Industrial Furnaces, W. B. Chapman. Mech. Eng., vol. 43, no. 11, Nov. 1921, pp. 717–621, 7 figs. Calls attention to fuel wastes in industries using gas producers and producer-gas furnaces, reviews progress in last 25 years in gas-producer construction, and describes distinctive type of recuperative furnace and extension of its use to pulverized coal and oil. (Abstract.)

GEAR CUTTING

Gear Shapers. Production Shaping. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 186–190, 10 figs. Use of shapers in production work in machine-tool building plants.

Machines. An Improved Gear Generating Machine. Eng. Production, vol. 3, no. 57, Nov. 3, 1921, pp. 412–415, 7 figs. Details of novel design for helical, straight and internal gears.

GEARS

Erosion in High-Speed. Pitting in High-speed Gearing. Machinery (Lond.), vol. 19, no. 472, Oct. 13, 1921, pp. 50–51, 2 figs. Discusses new method developed to eliminate pitting or erosion in teeth of wheels.

Hardening under Pressure. Hardening Gear Under Pressure. Eng. Production, vol. 3, no. 57, Nov. 3, 1921, pp. 426–427, 3 figs. Describes new method.

Involute. The Evolution of the Involute Gear Tooth—VIII and IX, A. Fisher. Machinery (Lond.), vol. 19, nos. 474 and 475, Oct. 27 and Nov. 3, 1921, pp. 101–103, 6 figs. and pp. 132–136, 7 figs. Involute pitch and pressure angle permutability.

Non-Metallic. Design and Manufacture of Non-metallic Gears. Machinery (Lond.), vol. 19, no. 471, Oct. 6, 1921, pp. 6–11, 12 figs. Discusses preparation of rawhide and fabric-base gear materials physical characteristics, design and machining of gear.

Power-Transmission. Gear Tooth Problems (Beitrag zur Zahnradfrage für Uebersetzungsgetriebe), O. Lasche. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 42, Oct. 15, 1921, pp. 1087–1088, 8 figs. Based on examples of gear teeth for marine and land installations, values for tooth loads and speeds are developed. Sliding conditions with standard and AEG (German Gen. Elec. Co.) teeth are compared. Suggests means of obtaining a neater and more accurate tooth.

Spur. The Production of Spur Gears, R. Waring-Brown. Eng. Production, vol. 3, no. 55, Oct. 20, 1921, pp. 364–368, 8 figs. and (discussion), no. 56, Oct. 27, 1921, pp. 389–391. Comparison of modern methods. Paper presented before Instn. Production Engrs.

Spur, Hobbed, Backlash in. Backlash in Hobbed Spur Gears, Carl G. Olson. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 222–224, 5 figs. Amount of backlash recommended to provide for unavoidable inaccuracies in machining and heat treatment.

Sykes Gear-Tooth Comparator. The Sykes Gear-Tooth Comparator. Mech. World, vol. 70, no. 1814, Oct. 7, 1921, pp. 280–282, 4 figs. May be used for comparing and definitely measuring thickness of teeth, for comparing uniformity of pitch and for ascertaining amount of inaccuracy of tooth shape.

GOVERNORS

Shaft, Adjusting. Adjusting Shaft Governors. Power, vol. 54, no. 17, Oct. 25, 1921, pp. 641–647, 16 figs. Shows how to adjust different types of governors.

GRINDING MACHINES

Surface. Economy of Surface Grinding Machines (Wirtschaftlichkeit der Flächenschleifmaschinen), F. Warsow. Betrieb, vol. 3, no. 25, Sept. 15, 1921, pp. 829–832, 6 figs. Describes machines equipped with grinding cylinders for economical machining of various flat pieces from the rough. Comparison of results show a much higher efficiency with described machines than with those operating with circumferential grinding disks with equal neatness and precision.

H

HANDLING MATERIALS

Equipment. A Survey of Material-Handling Equipment, R. H. McLain. Chem. Age (N. Y.), vol. 29, no. 10, Oct. 1921, pp. 427–431, 25 figs. Suggestions for the use of labor-saving devices in chemical manufacture.

HANGARS

Cape May. Cape May Hangar for Dirigible Built From Two Small Ones. Eng. News-Rec., vol. 87, no. 17, Oct. 27, 1921, pp. 698–700, 4 figs. Sheds at Montauk and Cape May reërected on new base sections to produce hangar of greater capacity.

Suspended Roofs. Large Roofs Suspended by Cables To Avoid Columns. Eng. News-Rec., vol. 87, no. 17, Oct. 27, 1921, pp. 638–639, 4 figs. Novel design of airship sheds, giving unobstructed full-length side openings. Translated from Génie Civil.

HEAT TRANSMISSION

Bibliography. Bibliography on Heat Transmission. Am. Soc. Refrig. Engrs. Jr., vol. 8, no. 2, Sept. 1921, pp. 150–162.

Theory for Turbulent Streams. Transmission of Heat from Solid Bodies to Turbulent Liquid or Gas Streams (Der Wärmeübergang an einen turbulenten Flüssigkeits- oder Gasstrom), H. Latzko. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 4, Aug. 1921, pp. 268–290, 10 figs. Based on laws of velocity distribution of turbulent streams developed by Prandtl and v. Kárman, attempt is made to develop systematically a theory of heat transmission for turbulent streams and of dependence of heat-transmission coefficient on shape and dimensions.

HEATING, ELECTRIC

Arc and Resistance. Arc vs. Resistance Heating (Lichtbogen- oder Widerstandsbeheizung), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 38, nos. 155, 156, 147 and 158, Sept. 29, Oct. 1, 4 and 5, 1921, pp. 1109–1110, 1115–1116, 1125–1126 and 1133–1134, 8 figs. Discusses most important features in connection with industrial arc and high- and low-current resistance heating.

Gas Heating vs. Comparison of Gas and Electric Heating (Comparaison du chauffage au gas et a l'électricité, A. Grebel. Le Génie Civil, vol. 79, no. 12, Sept 17, 1921, pp. 249–252. Compares 1 kg. of coal transformed with low tension electricity and into gas and by-products. Shows that cost of production is in favor of gas.

HEATING, HOT-WATER

Electric. Electric Hot-Water Heating Plants with Heat Storage for Schoolhouses (Elektrische Warmwasser-Heizanlagen mit Wärme-Akkumulierung für Schulhäuser). Schweizerische Bauzeitung, vol 78, no. 13, Sept 24, 1921, pp 151–153, 7 figs. Describes hot-water heating system installed in two schoolhouses in Aarau, Switzerland, in which electric current of 4000 volts is employed. Points out success and advantages of system.

HEATING, STEAM

Isolated Power Plant. Heating and Its Relation to Isolated-Plant Operation, E. L. Wilder. Power, vol. 54, no 20, Nov. 15, 1921, pp. 758–761, 8 figs. Discusses factors that make for efficiency and inefficiencies in a combined power and heating plant.

Radiation, Calculation of. Radiation Calculation Charts, D. N. Crosthwait, Jr. Heat. & Vent. Mag., vol. 18, no 10, Oct. 1921, pp. 27–29, 2 figs. Gives tables of square feet of direct cast iron steam radiation for heat loss through two pane windows, and through wall area, room temperature 70 deg. fahr. and outside temperature 0 deg. fahr. and explains application.

Stationary Heat Storage. A Steam Heating Plant with Stationary Heat Storage (Eine Dampfheizanlage mit festem Wärmespeicher), M. Hottinger. Schweizerische Bauzeitung, vol. 78, no. 10, Sept. 3, 1921, pp. 124–126, 2 figs. Results of tests carried out on electric heating installation in spinning mill of H. Buhler & Cie., Sennhof, Switzerland, described in previous issue of same Journal (July 17, 1920).

Vacuum. Operation and Advantages of Vacuum Steam-Heating Systems (Vorzüge und Wirkungsweise der Vakuumdampfheizungen). Elektrotechnischer Anzeiger, vol. 38, nos. 161 and 162, Oct. 11 and 12, 1921, pp. 1158–1160 and 1164–1165. Said to be especially adapted to small and medium-size factories.

HOBS

Gear. Inspection of Involute Spur and Helical Gear Hobs. Machinery (Lond.), vol. 19, no. 474, Oct. 27, 1921, pp. 90–95, 19 figs. Testing accuracy of hob and tooth parts; hobbing test.

HOISTING MACHINES

Safeguards. Hoisting and Conveying. Power Plant Eng., vol. 25, no. 20, Oct. 15, 1921, pp. 1000–1003. Machinery safeguards and safe operation.

HOT-WATER SUPPLY

Water-Temperature Control. Determination of Hot Water Requirements, William Wilcox. Heat. & Vent. Mag., vol. 18, no. 10, Oct. 1921, pp. 31–35, 7 figs. Essential points to be considered, with data on apartment houses and various methods of water-temperature control.

HOUSES

Wall Construction. Design and Construction of Dwelling House Walls, Carroll Beale. Concrete Products, vol. 21, no. 4, Oct. 1921, pp. 51–52. Discusses types of construction, including concrete. Reprinted from Contractor's Atlas.

HOUSING

Garden City Scheme, London. Building Garden-Cities at the London Conférence (La Construction des Villeset Cités-Jardins a la conference de Londres), M. De Heem. Annales des Travaux Publics de Belgique, vol. 22, no. 4, August 1921, pp. 595–626, 11 figs. Partly on supp. plates. Discusses the housing question and recent competition in designs in London. Gives illustrations.

Sherbrooke, Can. Housing Developments in Sherbrooke. Contract Rec., vol. 35, no. 45, Nov. 9, 1921, pp. 968–969, 8 figs. Model city built to house workers of Canadian Connecticut Cotton Mills.

HYDRAULIC MACHINERY

Packing Friction. Experiments with Packing Friction (Versuche über Stulpenreibung), Eugen Irion. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 39, Sept. 24, 1921, pp. 1016–1017, 2 figs. Results of tests on a 75-ton drop and bending machine with hydraulic gage connected directly to working cylinder. Comparison with values determined by Martens. Advantages of the simplified pressure measurement with measuring cylinders.

HYDRAULIC TURBINES

Draft Tubes. Draft Tubes—How They Operate and Why. Power, vol. 54, no. 16, Oct. 18, 1921, pp. 600–604, 17 figs. Elementary, non-mathematical explanation of hydraulic draft tubes. Use of barometer and "scenic railway" to illustrate fundamental principles involved.

Kaplan. Design and Use of the Kaplan Turbine (Die Kaplanturbine in Ausführung und Verwendung), C. Reindl. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 40 and 41, Oct. 1 and 8, 1921, pp. 1035–1040 and 1066–1069, 33 figs. Deals with development and details, including rotars, guide vanes, draft tubes, single and double turbines. Experimental results and behavior under different operating conditions. Useful possiblities and advantages.

Speed Regulation. Speed Regulation of Hydraulic Turbines, John S. Carpenter. Power Plant Eng., vol. 25, nos. 19 and 20, Oct. 1 and 15, 1921, pp. 947–950 and 990–993, 5 figs. Principles and methods of calculation involved in design of hydraulic turbine governors.

Speed Regulation in the Hydraulic Plant, N. L. Devendorf. Power, vol. 54, no. 20, Nov. 15, 1921, pp. 764–767, 6 figs. Conditions that must be met by waterwheel governor. Development from early flyball governor to present oil-pressure type. Requirements of low-head versus high-head plants. Operating in parallel

HYDROELECTRIC DEVELOPMENT

Belgium. Utilizing Hydraulic Resources of Belgium (Avant-Projet de captation des energies hydrauliques Belges), Herman Chauvin. Révue Universelle des Mines, vol. 11, no. 1, Oct. 1, 1921, pp. 1–28, 9 figs. Describes Ardennais works, reservoirs, dams, canals, power plants, their cost, capacity, equipment, etc.

Colorado River. Electrical Construction Plan for Colorado River, Charles Heston Peirson. Elec. Rev. (Chicago), vol. 79, no. 16, Oct. 15, 1921, pp. 586–588. Comprehensive development proposed to regulate stream flow for utilization of available water power.

Switzerland. Plans for Hydroelectric Development in the Bernese Oberland (Les projets des Forces Motrices Bernoises dans l'Oberhasle), Jean Ganguillet. Schweiz. Elektrotechnischer Verein Bul., vol. 12, no. 8, Aug. 1921, pp. 209–216, 2 figs. Presents plans for harnessing the Aar River and for developing in Oberhasle the future greatest source of electric energy in Switzerland.

HYDROELECTRIC PLANTS

California. Progress on Pit River Project in California. Eng. News-Rec., vol. 87, no. 15, Oct. 13, 1921, pp. 604–606, 1 fig. First plants completed. Features of development will be 220,000-volt transmission line, 7-mi., 3000-sec-ft. tunnel on Pit River No. 5, and 40,000-hp. reaction turbines under 454-ft. head in Pit River No. 1.

Great Falls, Conn. Great Falls Hydro-Electric Development. Power Plant Eng., vol. 25, no. 20, Oct.15, 1921, pp. 981–986, 11 figs. Describes equipment of Falls Village hydroelectric plant of Conn. Power Co., on Housatonic River, supplying normally 10,000 kw. at 66,000 volt, to main lines.

Italy. Hydroelectric Plants in Southern Italy (Gli impianti idroelettrici del Mezzogiorno d'Italia), Emirico Vismara. L'Elettricista, vol. 10, no. 18, Sept. 15, 1921, pp. 137–140, 4 figs. Discusses power transmission problems in connection with irrigation.

Maximum Rates. Determination of Maximum Rates for Hydroelectric Power Centrals (La fixation des tarifs maxima dans les cahiers des charges des concessions d'énergie hydraulique), G. Tochon. Révue Générale de l'Électricité, vol. 10, no. 13, Oct. 1, 1921, pp. 451–455. Discussion of standard specification for maximum rates proposed by Ministry of Public Works.

Sicily. Brief Description of the Works of the Societa Generale Elettrica of Sicily (Descrizione sommaria degli impianti della Societá Generale Elettrica della Sicilia). L'Elettrotecnica, vol. 8, no. 27, Oct. 5, 1921, pp. 604–610, 9 figs. Discusses hydroelectric construction, power houses and equipment, and system of transmission lines.

I

ICE PLANTS

Brine Agitation. Modern Propeller Design for Brine Agitation and Circulation, E. A. Burrows. Am. Soc. Refrig. Engrs. Jl., vol. 8, no. 2, Sept. 1921, pp. 127–133 and (discussion) 133–134, 10 figs. Describes experiments with Halvorsen propeller, reducing power consumption from 25 to 50 per cent.

INDEXES

Construction and Comparison. Details of Index Number Construction and Comparison of Indices, E. E. George. Eng. & Contracting, vol. 56, no. 19, Nov. 9, 1921, pp. 431–434, 3 figs. Notes on volume of production index. Bradstreet's, Dun's, and Federal Reserve Board index, standard and tests, and cost-of-living indexes.

INDUSTRIAL MANAGEMENT

Distribution of Manufacturing Expense. The Distribution of Manufacturing Expense, C. Haigh. Can. Machy., vol. 26, no. 15, Oct. 13, 1921, pp. 34–36. Discusses five methods for distributing overhead expense: man-rate; man-hour; material and labor; sold-hour; and machine-hour rate.

Factory Investigation. How Factory Investigations Reduce Costs, Albert A. Dowd and Frank W. Curtis. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 208–212, 7 figs. Discusses effect of design upon cost of machining and gives examples of savings realized by change of design; savings effected in drilling, and by use of punch press.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 25, Sept. 15, 1921, p. 160. Proposal of Works Dept. of German Federation of Technical and Scientific Societies for care and handling of automobile tires.

Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 26, Sept. 25, 1921, pp. 166–168. Proposals of Works Dept. of German Federation of Technical and Scientific Societies for care and handling of precision ball and roller bearings; installation, operation and care of transmissions.

Material Control. Material Control for the Small Industrial Plant, Henry C. Haskell. Indus. Management, vol. 62, no. 5, Nov. 1921, pp. 271–273, 1 fig. Describes simple, direct and logical method of approaching problem. Includes illustration of stock card used in system which includes material costing, ordering and planning.

Purchasing Department. Purchasing. A. B. Johnson. Paper, vol. 28, no. 19, July 13, 1921, pp. 17–19, 28 and 38. Discusses work and organization of purchasing departments. Paper read before Superintendents' Assn.

Scientific. Scientific Management XXXII, Henry Atkinson. Eng. & Indus. Management, vol. 6, no. 15, Oct. 13, 1921, pp. 400–401 and 403. Failures of scientific management and their cause.

Stores Records. Machine-Posted Balance of Stores Records, C. Moffitt Ford. Bul. Taylor Soc., vol. 6, no. 4, August 1921, pp. 139–152, 4 figs. Discusses mechanical equipment and card design; posting of cards; method of proof; filing, posting and verifying routine; etc. Paper read before Phila. Section of Taylor Soc

Tool Handling. The Handling of Metal-Cutting Tools (Die Behandlung der Werkzeuge in derFabrik), A. Fattler. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 41, Oct. 8, 1921, pp. 1063–1065, 3 figs. Notes on materials for tools; storage and distribution in factory; repair and renewal: hardening of tools.

[See also TIME STUDY.]

INDUSTRIAL ORGANIZATION

Reorganizing Small Works. Reorganizing the Small Works, H. N. Munro. Eng. & Indus. Management, vol. 6, no. 17, Oct. 27, 1921, pp. 459–462, 9 figs. Writer demonstrates importance of forming clear idea of conditions of working, capabilities of staff, and proper location and layout of plant, in describing practical system of reorganization. Notes on planning organization chart.

Stimulating Interest of Workers. Making Work Fascinating as the First Step Toward Reduction of Waste, Walter N Polakov Mech Eng, vol 43, no. 11, Nov. 1921, pp 731–734 and 765, 7 figs. Points out that such experiments as have been already conducted to uniting brain work with manual work have proved beyond any doubt that such a course liberates dormant or suppressed creative capacities of men, improves quality and quantity of production, and, above all substantially ameliorates industrial relations. Advantages to owner and labor groups are set forth. (Abstract.)

INDUSTRIAL RELATIONS

Coöperation. Experiments in Industrial Coöperation. Iron Age, vol 108, no 19, Nov 10, 1921, pp. 1207 1208. Constructive solutions of employer-employee relations presented at meeting of Acad of Political Science.

Economic Axioms. The Economic Axioms of Industry. E W Petter. Eng. & Indus. Management, vol 6, no 18, Nov 3, 1921, pp. 500–502. Notes on creation and unequal distribution of wealth, community's well-being, employer and worker, piece-work rates, unemployment doles and waste, how the State can assist. (Abstract.) Lecture arranged by Indus. League & Council.

Human Factor. The Human Factor in Industry—II, Clarence H. Northcott. Indus Management, vol. 62, no. 5, Nov 1921, pp 292 297, 4 figs. Points out importance of weighing physical and mental differences and study of job in vocational selection. Discusses motion study, fatigue, rest periods, etc.

Industrial Court, Great Britain. The Industrial Court of Great Britain and Ireland, R W. Patmore. Indus Management, vol. 62, no 5, Nov. 1921, pp. 269 271. Its history, functions and personnel.

INTERNAL-COMBUSTION ENGINES

Carburation. Study of Carburation, Thermodynamics of the Explosion Engine (Introduction à l'etude de la carburation, pyrodynamique du moteur à explosions), M Carbonaro. Memoirs et Compte Rendu des Travaux de la Société des Ingenieurs Civils de France, vol 74, no 4 5–6, April-June 1921, pp. 185–249, 13 figs. Discusses deflagration at constant pressure, ignition temperature, flame propagation and its velocity, etc.

Cooling-Water Systems. Cooling-Water Systems for Internal Combustion Engines, Edgar J. Kates. Power, vol. 54, no. 20, Nov. 15, 1921, pp. 710 713, 4 figs. Notes on quality of water use of cooling tanks; open cooling systems and their faults, inclosed cooling systems.

Increasing Power Output. Petrol Engine Performance. Times Eng. Supp., no. 564, Oct. 1921, p. 277. Notes on increasing power output.

Supercharging. Supercharging Engines, C. H. T. Alston. Automobile Engr., vol. 11, no. 155, Oct. 1921, pp. 337–341, 2 figs. Discusses advantages and disadvantages; its application to aircraft, road motor vehicles, marine, stationary, and portable engines, etc.

[See also AIRPLANE ENGINES; DIESEL ENGINES; KEROSENE; OIL ENGINES, SEMI-DIESEL ENGINES.]

IRON

Gray, Oxygen in. Discusses Problems of the Foundry, J. Shaw. Foundry, vol. 49, no. 19, Oct. 1, 1921, pp. 759–761. Discusses differing view of metallurgists regarding effect of oxygen in gray iron. Methods of making physical tests and their effects on results are pointed out.

Oxygen in, Determination. A New Method for the Determination of Oxygen in Iron (Ueber ein neues Verfahren zur Bestimmung des Sauerstoffs im Eisen), P. Oberhoffer and O. von Keil. Stahl u. Eisen, vol. 41, no. 41, Oct. 13, 1921, pp. 1449–1453, 6 figs. By employment of new method, iron- and manganese-oxygen compounds in all mixture proportions can be completely reduced, with iron- and silicium-oxygen, compounds, whose silicic-acid contents do not exceed 20 per cent, at least 93 per cent of total oxygen content can be reduced.

Pig and Cast, Composition of. Composition of Pig Iron and of Cast Iron, Y. A. Dyer. Iron Age, vol. 108, no. 20, Nov. 17, 1921, pp. 1267–1270. Chemical and structural composition. Various elements, their characteristics and effect on metal. Oxygen in iron.

IRON AND STEEL

Tests. Experiments on Properties of Iron and Steel to Resist Wear (Undersökning rörande järns och ståls samt en del andra kroppars förmåga att motstå nötning), J. A. Brinell. Jernkontorets Annaler, vol. 105, no. 9, 1921, pp. 347–398, 22 figs. Describes series of tests made, and abrasives used; gives table of results.

IRON CASTINGS

Reversed Chilled. Steel Addition to Pig Iron and Reversed Chilled Casting (Stahlzusatz zum Roheisen und der umgekehrte Hartguss), E. Piwowarsky. Giesserei-Zeitung, vol 18, no. 26, Oct. 3, 1921, pp. 356–359, 7 figs. Writer seeks to establish relation between chemical analyses and the congealing diagram of iron-carbon alloys. Bibliography.

IRON, PIG

Mixer. Pig Iron Mixer. Eng. Progress, vol. 2, no. 10, Oct. 1921, pp. 227–230, 8 figs. Advantages of mixing process, rolling and tilting mixer; electrical tilting device.

Synthetic. Synthetic Foundry Pig Irons in Germany. Iron Age, vol. 108, no. 18, Nov. 3, 1921, pp. 1137–1138. Methods of production during war to overcome scarcity of low phosphorus irons; their properties; charcoal iron. Translated from Stahl u. Eisen, June 20, 1921.

K

KEROSENE

Carburation. Carburation of Kerosene and the Action of the Walls (La carburation par le petrole lampant et l'action de paroi), G. Lumet. Memoirs et Compte Rendu des Travaux de la Societe des Ingenieurs Civils de France, vol. 74, no 3 5 6, April-June, 1921, pp. 291–300. Discusses effect of cooling the walls and gives results of tests made, also tables

L

LABOR

Hours of Work. The Eight Hour Law (La Loi des Huit Heures), Léon Repriels. Révue Universelle des Mines, vol. 10, no. 6, Sept. 15, 1921, pp. 651–676. Discusses its provisions and its application, and why Belgium cannot ratify the Washington eight-hour convention.

Organization. The Purpose of the Labor Articles in Automotive Industries, Harry Tipper. Automotive Industries, vol. 45, no. 15, Oct. 13, 1921, pp. 732 733. Points out necessity for studying human side of production activities with a view to preventing trouble rather than waiting for difficulties to arise and then attempting to find a remedy. Production cost depends largely upon human organization

LABOR TURNOVER

Problem. A Common Sense Attack on Turnover, James R. Adams. Indus. Managment, vol. 62, no. 5, Nov. 1921, pp. 298–302, 4 figs. Writer tells what has been done by Studebaker Corp. under present conditions, to make employees appreciate management's problems and to enlist their intelligent coöperation for the common good.

LABORATORIES

Applied Mechanics. A Laboratory of Applied Mechanics (Notice sur le Laboratoire de Mécanique appliquée), J. Boulvin, F. Keelhoff, G. Van Engelen, O. Steels. Annales de l'Association des Ingénieures Sortis des Écoles Spéciales de Gand, vol. 11, 5th Series, 1921, pp. 130–148. Discusses its functions, and equipment for teaching purposes.

Gas. The Industrial Laboratory of the Bourbonnais Co. (Le Laboratoire industriel de la Compagnie du Bourbonnais), J. H. Brodin. Chaleur et Industrie, vol. 2, no. 17, Sept. 1921, pp. 554–560, 4 figs. Discusses development and equipment dedicated to gas interests.

Scientific Industrial Research. A Modern Scientific Industrial Research Laboratory and Its First Results (Un exemple de laboratoire moderne pour recherches de science industrielle; ses premiers résultats), Georges Baume. Révue Générale de l'Electricité, vol. 10, no. 12, Sept. 24, 1921, pp. 396–398. Discusses laboratory of Société de Recherches et Perfectionnements Industriels, founded in 1919 at Puteaux, and how it works.

LATHE TOOLS

Circular Form Tools. Designing Circular Form Tools. Eng. Production, vol. 3, no. 55, Oct. 20, 1921, pp. 370–371, 2 figs. Describes use of practical formulas.

Apron Design. Lathe Aprons, A. Clegg. Eng. Production, vol. 3, no. 55, Oct. 20, 1921, pp. 373–378, 12 figs. Comparison between typical English and American designs.

Economical Operation. Study of Economical Lathe Operation with Special Regard to the Cutting Pressure (Ein Beitrag zur Erforschung der Wirtschaftlichkeits an Drehbänken unter besonderer Berücksichtigung des Schnittdruckes), Herbert Sack. Betrieb, vol. 3, no. 25, Sept. 15, 1921, pp. 800–813, 21 figs. Investigation of effective power and its dependence on feed and depth of cut in connection with detachment of chip. A diagram is developed from which the cutting speed for cross-section of every chip can be obtained.

Feed Reverse Mechanisms. The Design of Feed Reverse Mechanisms for Lathes, A. Clegg. Machinery (Lond.), vol. 19, no. 472, Oct. 13, 1921, pp. 34–39, 13 figs. Discusses the tumbler, fixed center, bevel, and planetary or epicyclic gears, and their advantages and disadvantages.

Headstock Design. Improved Lathe Headstock Details and their Jigs, Hubert Bentley. Eng. & Indus. Management, vol. 6, no. 15, Oct. 13, 1921, pp. 398–399, 4 figs. Describes very simple and successful type of spring-locking bolt and jig employed to ensure accuracy in drilling of locking bolt holes in both cone and gear wheel.

"Non-Stop" Methods. Devices for Repetition Work. Eng. Production, vol. 3, no. 56, Oct. 27, 1921, pp. 392–393, 4 figs. Describes certain non-stop methods, by means of which lathes or machines are kept running.

Oerlikon Works, Switzerland. Recent Machine-Tool Developments. Engineering, vol. 112, no. 2915, Nov. 11, 1921, pp. 652–656, 23 figs. Describes new lathes made by Swiss Machine-Tool Works, Oerlikon, Two designs are built, one with three-stepped belt cone pulley drive, and one with single-pulley, and all-geared head.

Turret. Production Work in the Locomotive Shop. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 228–230, 3 figs. Application of the Bullard vertical turret lathe.

Turret and High-Speed Lathes (Revolverdrehbank und Schnelldrehbank), R. Ende. Betrieb, vol. 3 no. 25, Sept. 15, 1921, pp. 789 797, 8 figs. Points out as an example that round parts can be as accurately machined on a turret as on a high speed lathe, without employment of skilled labor required for latter machine. Thus initial increased cost of installation is often made up within a year's time.

LIFTING MAGNETS

German Type. Lifting Magnets (Lasthebemagnete). Glasers Annalen, vol. 89, no. 5, Sept. 1, 1921, pp. 51 56, 8 figs. Describes construction, handling and uses of lifting magnets, with special reference to the Demag (Duisburg, Germany) type.

LIGHTING

Exterior and Interior. Improved Practices in Exterior and Interior Illumination. Elec. World, vol. 78, no. 20, Nov. 12, 1921, pp 971 974, 8 figs. Broadening applications of modern equipment yielding greater service to industry and homes.

Factory. Better Illumination Cuts Production Costs, WardHarrison, Orville F. Haas and Fred W. Dopke, Elec. World, vol. 78, no. 16, Oct. 15, 1921, pp. 763 764, 2 figs. Test data show increase in production of 12.2 per cent due to installation of modern lighting system. Tests made by Dover Mfg. Co., Dover, Ohio.

LIGNITE

Water-Soluble Ash. Importance of Water-Soluble Ash in the Evaluation of Lignite (Wichtigkeit der wasserlöslichen Asche bei der Verwertung der Braunkohle), Th. Limberg. Feuerungstechnik, vol. 9, no. 22, Aug. 15, 1921, pp. 205–207. Points out importance of analysis of composition of ash, and discusses influence of water-soluble ash on the different products of lignite.

LOCOMOBILES

German Type. The Overtype Steam Unit, H. Keay Pratt. Mech. World, vol. 69, no. 1782, Feb. 25, 1921, pp. 141–143, 1 fig. Discusses development of locomobile by R. Wolf of Magdeburg, giving 1 b.hp. per lb. of coal in special trials. Advantages and details of operation.

LOCOMOTIVE BOILERS

Fire Tubes, Mounting. Mounting and Fixing Fire Tubes in Locomotive Boilers (Le montage et la fixation des tubes a fumée dans les chaudières de locomotives), H. Gallon. La Technique Moderne, vol. 13, no. 2, Feb. 1921, pp. 59–62, 12 figs. Describes new automatic apparatus for the purpose.

LOCOMOTIVES

Boosters. The Locomotive Booster As an Operating Factor. Ry. Rev., vol. 69, no. 15, Oct. 8, 1921, pp. 461–469, 16 figs. Results of tests made with five new Pacific and one Mikado types of locomotives fitted with boosters. Operating characteristics.

Economic Use of Steam. On the Question of the Economic Production and Use of Steam on Locomotives, Maurice Lacoin. Bulletin International Ry. Assn., vol. 3, no. 9, Sept. 1921, pp. 1157–1204, 35 figs. Discusses steam superheating and compounding, packings, valves, feedwater heating water-tube boilers, scale, combustion control, etc., Appendixes.

Economical Design. Avoidable Waste in Locomotive Operation as Affected by Design, James Partington. Mech. Eng., vol. 43, no. 11, Nov. 1921, pp. 729–730. Points out that best way to overcome waste is to design locomotive so that it will fulfill efficiency requirements of (1) a drawbar horsepower for minimum amount of fuel, (2) for minimum amount of weight of locomotive and tender, and (3) for minimum cost of repairs, and shows how these are secured. (Abstract.)

Feedwater Heating. Feed Water Heating on the London & North Western Railway. Ry. Gaz., vol. 35, no. 16, Oct. 14, 1921, pp. 572–574, 2 figs. Details of latest application of Weir feedwater heating system and pump to "George the Fifth" class of express locomotive.

Floating Bushings. The Development of Floating Bushings. Ry. Rev., vol. 69, no. 17, Oct. 22, 1921, pp. 535–538, 5 figs. Describes early development, and recent application to new locomotives built by Am. Locomotive Co.

Mallet. Virginian Mallet Locomotives. Ry. Jl., vol. 27, no. 10, Oct. 1921, pp. 12–13, 1 fig. Tractive power 147,200 lb. working compound and 176,600 lb. working simple; 2-10-10-2 type. Comparison with 2-8-8-2 type.

Mexican Railways. New Power for Rehabilitation of Mexican Railways. Ry. Rev., vol. 69, no. 18, Oct. 29, 1921, pp. 578–580, 5 figs. Baldwin builds nearly 100 locomotives comprising five distinct type for service on heavy grades. See also Ry. Age, vol. 71, no. 20, Nov. 1912, 21, pp. 937–939.

Northern Pacific. New Locomotives for the Northern Pacific. Ry. Age, vol. 71, no. 17, Oct. 22, 1921, pp. 767–769, 3 figs. Pacific type for heavy fast service. Mikados, mallets and switchers follow lines of earlier designs.

Operation. Traveling Engineers Present Valuable Reports. Ry. & Locomotive Eng., vol. 31, no. 10, Oct. 1921, pp. 265–271. Discusses operation and maintenance of oil-burning locomotives, self-adjusting wedges, feedwater heaters, devices for increasing tractive power, and operating stoker-fired locomotives. Report of Executive Committee.

Paulista Railway, Brazil. Electric Motive Power for Paulista Railway. Ry. Age, vol. 71, no. 16, Oct. 15, 1921, pp. 721–722, 3 figs. Describes electric freight and passenger locomotives for Brazil; tractive efforts at 25 per cent adhesion 58,500 lb. and 51,000 lb. respectively.

Thermic Siphons. The Installation and Operation of Thermic Syphons. Boiler Maker, vol. 21, no. 10

Oct. 1921, pp. 273–277, 12 figs. Discusses application to locomotives as an efficiency-promoting device.

Valve Gear. Poppet Valve Gear for Steam Locomotives (Weiteres uber die Ventilsteuerung bei Dampflokomotiven), H. Wittfeld. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 44, Oct. 29, 1921, pp. 1141–1142, 10 figs. Supplementary to article in same journal (no. 24, p. 623), a special type of Lentz gear is described and compared with an older type.

LUBRICATION

Tests on Steam and Gasoline Engines. Comparative Lubrication Engineering. Sci. Lubrication, vol. 1, no. 9, Sept. 1921, pp. 18–21. Describes test on small-power Corliss engine, and on a Continental motor, giving some interesting dilution data.

LUBRICATING OILS

Castor and Mineral-Oil Mixture. Tests of Castor Oil and Mineral-Oil Mixtures on Gnome Rotary Engine, O. J. May and Howard Cooper. Sci. Lubrication, vol. 1, no. 9, Sept. 1921, pp. 10–14, 6 figs. U. S. Army Service report discussing method and results of tests made.

M

MACHINE CONSTRUCTION

Allowances. Determination of the Required Allowance Dimensions for Different Constructions (Feststellung der erforderlichen Passmasse fur die verschiedenen Erzeugnisse), W. Kühn. Betrieb, vol. 3, no. 26, Sept. 25, 1921, pp. 406–411, 8 figs. Explains when limit gages should be used and how selection of allowance dimensions for a given construction piece should be made.

Record of Materials. Record of Materials Used in Machine Construction. Machinery (Lond.), vol. 19, no. 471, Oct. 6, 1921, pp. 1–3, 4 figs. Gives details of a "commodity book" in which are recorded all materials and standard parts used by the firm, these records are kept up-to-date. Various advantages are claimed for this book.

MACHINE SHOPS

English. Famous British Works. Eng. Production, vol. 3, nos. 55, 56 and 57, Oct. 20, 27 and Nov. 3, 1921, pp. 362–363, 4 figs., 386–388, 4 figs., and 410–411, 2 figs. Oct. 20: Worcester works of Heenan & Froude, Ltd., for manufacture of Froude dynamometers, Heenan air filters, oil and water coolers, refuse destructors, and refrigerating machinery. Oct. 27: Works of Marshall, Sons & Co., Ltd., Gainsborough, Lincolnshire, for manufacture of engines, boilers and machines. Nov. 3: Works of John Fowler & Co., Ltd., Leeds, for manufacture of steam plows, road-transport and heavy-haulage engines, traction engines, etc.

The Wellman-Smith-Owen Engineering Works at Darlaston. Iron & Coal Trades Rev., vol. 103, no. 2798, Oct. 14, 1921, pp. 545–546, 18 figs. on pp. 547–550. Describes machine, fitting and erecting, and pattern shops, laboratory, welfare section, etc.

Layout. Building Machine Tools in a New Plant, F. L. Prentiss. Iron Age, vol. 108, no. 17, Oct. 27, 1921, pp. 1070–1075, 16 figs. Arrangement, transportation system, routing of material and lighting are features of Colburn Machine Tool Co., Cleveland, Ohio.

Factory Lay-out as an Aid in Reducing Costs. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 182–185, 8 figs. Describes new plant of Colburn Machine Tool Co., Cleveland, Ohio, laid out with view to economy in manufacturing.

A Machine Tool Shop of Unusual Construction, Fred H. Colvin. Am. Mach., vol. 55, no. 17, Oct. 27, 1921, pp. 668–670, 8 figs. Description of Colburn Machine Tool Co., Cleveland, Ohio.

Steam Turbine. New Works of the Compagnie Électro-Mécanique at Bourget (Seine) [La nouvelle usine de la Cie. Électro-Mécanique au Bourget (Seine)], Ch. Dantin. Le Génie Civil, vol. 78, no. 26, June 25, 1921, pp. 541–545, 8 figs. Describes constructional details of works, all reinforced concrete.

MACHINE-TOOL INDUSTRY

Orient as Market. The Orient As a Machine-Tool Market, W. H. Rastall. Am. Mach., vol 55, no. 18, Nov. 3, 1921, pp. 730–5. Data on pre-war growth of foreign business and growth since 1913; foreign markets other than European. How to sell machinery in Asia. Address before Machine Tool Builders.

MACHINERY

Dismantling. Valuable Hints on the Dismantling of Machinery. Can. Machy., vol. 26, no. 15, Oct. 13, 1921, pp. 29–32, 8 figs. Discusses separation of rusted parts, seized parts, forcing methods, and bolt action.

Perforated-Record Control. The Control of Machines by Perforated Records, Emanuel Scheyer. Am. Mach., vol 55, no. 19, Nov. 10, 1921, pp. 743–747, 8 figs. Principles of pneumatic and electric control of machinery. Difficulties of automatic control. Machines controlled by paper records.

Power Consumption. Determination of the Power Consumption of Machinery (Bestimmung des Kraftbedarfes von Arbeitsmaschinen). Elektrotechnischer Anzeiger, vol 38, nos. 149, 150, 151, 152 and 153. Sept. 20, 21, 24 and 27, 1921, pp. 1065–1066, 1073–1074, 1079–1080, 1087–1088 and 1095–1096. 11 figs. Notes on numerical determination of power consumption, determination by comparison with machines of same construction type, but different output; determination through measurement.

MANGANESE STEEL

Castings, Grinding. Grinding Manganese Steel Castings, F. B. Jacobs. Foundry, vol. 49, no. 19, Oct. 1, 1921, pp. 767–770, 8 figs. Frogs and switches produced from accurate patterns and carefully molded. Ground because too hard to machine. Annealed before grinding. Wheels are coarse grit in hard grades.

MARINE STEAM TURBINES

S.S. Giulio Cesare. The Machinery of the Four-Screw Geared Turbine S.S. "Giulio Cesare." Engineering, vol. 112, no. 2915, Nov. 11, 1921, pp. 662–664, 18 figs. partly on supp. plate and p. 666. Constructed by Wallsend Slipway and Eng. Co. Ltd.

MATERIALS

Testing. Testing Materials, T. W. MacAlpine. Eng. & Indus. Management, vol. 6, no. 18, Nov. 3, 1921, pp. 498–499. Plea is advanced for formation of a British national testing organization.

MEASURING MACHINES

Internal Diameters. A Machine for the Measurement of Internal Diameters, G. A. Tomlinson. Engineering, vol. 112, no. 2912, Oct. 21, 1921, pp. 558–560, 6 figs. Describes method and machine developed at Nat. Physical Laboratory, Teddington, England, which is said to give high accuracy and allow inside diameter to be explored to any extent necessary.

METALLOGRAPHY

Foundries. Applications of Metallography in Iron, Steel and Malleable Foundries (Anwendungen der Metallographie in der Eisen-, Stahl- und Tempergiesserei), Rudolf Stotz. Giesserei-Zeitung, vol. 18, nos. 24, 25 and 27, Sept. 20, 27 and Oct. 11, 1921, pp. 325–328, 341–344 and 370–372, 43 figs. Notes on microscopic investigation of iron castings. Paper read before Assa. German Foundrymen.

Microscopic Examinations. Metallography—The Microscopic Study of the Structure of Metals, Henry S. Rawdon. Am. Mach., vol. 55, no. 17, Oct. 27, 1921, pp. 659–664, 29 figs. Value of metallurgical science in industry; uses of the microscope. Study of metallic structures. Results of microscopic examinations.

Optics of. The Optics of Metallography, W. I. Patterson. Trans. Am. Soc. for Steel Treating, vol. 2, no. 2, Nov. 1921, pp. 108–132, 36 figs. Deals with important optical parts of microscopes.

METALS

Cold Work, Effect of. Strengthening Metals by Cold-Work, E. Heyn. Chem. & Met. Eng., vol. 25, no. 16, Oct. 19, 1921, pp. 735–736, 2 figs. Explains nature of changes in cold worked metal, elastic and plastic deformation, etc. From Metall und Erz, 1918, Nos. 22 and 23.

Protective Coatings. Metal Coatings as Protection Against Corrosion (Metalüberzüge als Rostschutzmittel), Werner Lange. Zeit. für Metallkunde, vol. 13, no. 9, June 1921, pp. 267–275, 36 figs. Discusses protective coatings of lead, tin and aluminum.

Refinement Tests. Refinement Tests with German Metals (Veredelungsversuche mit inlandischen Metallen), H. Hanszel. Zeit. für Metallkunde, vol. 13, no. 10, July 1921, pp. 319–329, 1 fig. Deals with aluminum, mild steel, cast iron and electron, and discusses methods for testing of metals and alloys.

Rolling. Metal Rolling (Le Laminage), Sigma. La Métallurgie, vol. 53, no. 40, Oct. 6, 1921, pp. 1881–1887. Discusses longitudinal or parrallel rolling; cross or circular rolling, i.e., reeling; and helicoidal or oblique rolling, as for Mannesmann tubes.

Structural Properties. Structural Properties of Metals and Alloys, R. W. Woodward. Am. Mach.; vol. 55, nos. 15 and 16, Oct. 13 and 20, 1921, pp. 596–599 and 636–638, 2 figs. Applicability of metals; factors of strength and elasticity; compression; ductile and brittle materials; fatigue; thermal, magnetic and optical properties; corrosion.

METRIC SYSTEM

Arguments Pro and Con. The Metric System of Weights and Measures, David A. Mulitor. Jl. Eng. Inst. Can., vol. 4, no. 11, Nov. 1921, pp. 569–572. Advantages of system, legal problems, transition steps.

Metric versus English System. Eng. & Contracting, vol. 56, no. 18, Nov. 2, 1921, pp. 426–427. Summarizes points in favor and opposed to metric bill. Reprinted from Lefax.

MILLING CUTTERS

Formed. Formed Milling Cutters, George H. Strain. Machinery (Lond.), vol. 19, no. 474, Oct. 27, 1921, pp. 109–112, 18 figs. Factors in design which eliminate waste of driving power; cutting angles, rake and clearance of circular tools; standards for convex and concave formed milling cuttings.

MILLING MACHINES

Heavy Vertical. Investigation of a Heavy Vertical Milling Machine (Untersuchung einer schweren Senkrechtfräsmaschine), Willi Mitan. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 43, Oct. 22, 1921, pp. 1116–1118, 13 figs. Construction and operation of new machine by Fritz Werner Corp. Berlin-Marienfelde, for unwieldy workpieces. Calculation of feeds and speeds. Performance tests.

Rotary. Reducing Costs by Rotary Milling. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 202–205, 10 figs. Examples of work advantageously handled on Becker vertical rotary milling machines.

MOLDING MACHINES

Modern. Modern Molding Machines (Neuere Formmaschinen), U. Lohse. Giesserei-Zeitung, vol. 18, nos. 23, 24 and 25, Sept. 13, 20 and 27, 1921, pp. 308–311, 331–335 and 344–348, 20 figs. Construction development during recent years. Deals with hand and power-molding machines, pattern machines with lifting carriage, stripping-plate and roll-over machines, etc.

MONEL METAL

Welding. Monel Metal Welding, Michael Dzamba. Welding Engr., vol. 6, no. 10, Oct. 1921, pp. 41–42. Discusses welding generally, also welding of rods, sheets and castings, and soldering.

MOTOR PLOWS

Engines. The 45/60-Hp. B.M.W. Motor-Plow Engine (Der 45/60 B.M.W. Pflugmotor), Otto Schwager. Oel- u. Gasmaschine, vol. 18, nos. 6 and 10, June and Oct., 1921, pp. 97–104 and 164–165, 7 figs. Details of engine built by the Bavarian Motor Works Corp., Munich, based on their experiences in construction of aeroplane engines. Test results with described engine.

MOTOR TRUCKS

Future. The Motor Truck of the Future, Rollin W. Hutchinson. Indus. Management, vol. 62, no. 5, Nov. 1921, pp. 257–261, 4 figs. What permanent highways, pneumatic tires and ferro-steel will do in revolutionizing motor-truck engineering.

German. German Motor Trucks and Tractors (Der Kraftwagen als Nutzfahrzeug). Allgemeine Automobil-Zeitung, vol. 22, nos. 29, 30 and 31, July 16, 23 and 30, 1921, pp. 23–26, 26–30 and 21–26, 32 figs. Details of various types, including delivery trucks, tippers, timber-hauling trucks, hearses, street sprinklers, hook-and-ladder cars, omnibuses, etc.

N

NICKEL ALLOYS

Nickel-Aluminum-Copper. The Properties of Some Nickel-Aluminium-Copper Alloys, A. A. Read and R. H. Greaves. Metal Industry (Lond.), vol. 19, no. 13, Sept. 23, 1921, pp. 232–239, 23 figs. Discusses preparation; rolling and machining; tensile tests; properties of cast, cold-rolled and heat-treated alloys, etc. Paper read before Inst. of Metals.

NICKEL METALLURGY

Rolling. Rolling Pure Nickel, A. E. Surface. Sci. Am., vol. 125-A, no. 17, Nov. 1921, p. 34, 3 figs. Describes rolling of 99-per cent pure nickel into the various shapes into which mild steel is rolled, according to method developed by Charles T. Hennig and carried out at plant at Hyde, Pa.

NUTS

Acme Thread. Making an Accurate Acme Thread Nut, B. M. W. Hanson. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, pp. 197–199, 4 figs. Notes on difficulty of obtaining proper contact between screw and nut; use of roughing and finishing taps; lubrication when tapping; holding an Acme tap in a turret lathe.

O

OIL ENGINES

Marine. Oil Fuel Burning Installation on S.S. "Paris" (Installation de la chauffe au pétrole sur le paquebot "Paris"). Bulletin Technique du Bureau Véritas, vol. 3, no. 8, August 1921, pp. 181–185, 4 figs. (In English on pp. 186–188.) Discusses storage, piping, pumps, burners and operation, and gives test data.

Still. The Still Engine. Mar. Engr. & Naval Architect, vol. 44, no. 528, Sept. 1921, pp. 36–40, 4 figs. Describes engine which may be two-stroke or four-stroke type; burns gas, petrol or oil. Advantages, starting, overload, efficiency, etc.

OIL FUEL

Burning. The Burning of Oil Fuel, A. Keens. Mar. Engr. & Naval Architect, vol. 44, no. 529, October 1921, pp. 76–85, 12 figs. Discusses various types of machinery and its arrangement for burning oil fuel. Observations and comments derived from experience.

Combustion. Combustion of Fuel Oil, Percival J. Woolf. Iron & Coal Trades Rev., vol. 103, no. 2797, Oct. 7, 1921, p. 501. Discusses drawbacks of excess of air supplied for rapid combustion, advantages and disadvantages of an additional combustion chamber, and the Sklovsky patent for eliminating excess air. Extract of paper read before Refractory Matls. Section of Ceramic Society.

Handling. Security in Handling Inflammable Liquids Chem. Age (Lond.), vol. 5, no. 119, Sept. 24, 1921, pp. 372–373, 1 fig. Describes Mauclère patent for storage and protection of petrol which also permits distribution either in a continuous flow or in predetermined quantities.

Mexican. The Production and Combustion of Mexican Fuel Oil—VII, J. M. Pettingell and J. R. Carlson. Combustion, vol. 5, no. 5, Nov. 1921, pp. 209–212, 7 figs. Describes use of Mexican oil in various metallurgical furnaces, although sulphur content is high.

Power Uses. The Application of Oil to Power Purposes, Sydney H. North. Trans. Inst. Mar. Engrs., vol. 33, Sept. 1921, pp. 325–331. Shows increase in water evaporated per lb. of oil, and in thermal efficiency of Diesel engines.

OIL STORAGE

Shipyard Plant. Shipyard Bulk Storage Oil and

Paint Plant. Engineering, vol 112 no 2914 Nov 4, 1921, p. 632, 10 figs. partly on p. 634 Describes installation at new yard of Furness Shipbuilding Co., designed with steel storage tanks and automatic measuring pumps for distribution of oils, layout being such as to reduce cost and increase ease of handling.

OILS

Linseed. Air Required in Baking Cores Made With Linseed Oil, A. A. Grubb and U. S. Jamison. Chem & Met Eng vol 25 no 17 Oct 26, 1921, pp 793 795. Results of laboratory and plant experiments on consumption of air and oxygen in baking linseed oil-bound cores together with a review of available data on absorption of oxygen by linseed oil in drying.

P

PARACHUTES

Aeronautical Life Belts. Parachutes. T. Orde Lees. Aviation vol 11, nos 16 and 17, Oct 17 and 24 1921 pp. 451-453 and 485-488, 5 figs. Discusses parachutes in the sense of aeronautical life-belts for pilots and passengers. Lecture before Roy. Aeronautical Soc.

PETROLEUM

Catalytic Oxidation. The Catalytic Oxidation of Petroleum Oils, C. E. Waters. Jl. Indus & Eng. Chem., vol 13, no 10, Oct. 1921, pp 901-903. Discusses briefly relation between oxidation of petroleum oils and formation of deposits in internal-combustion engines to sludging of transformer oils and to deterioration of turbine oils.

PIPE, CAST-IRON

Manufacture. Cast Iron Pipe. The Method of Manufacture and Its Inspection, William R. Conrad. N. E. Water Works Assn. vol 35, no 3 Sept 1921, pp 205-220 and (discussion) pp 220-227, 6 figs. Discusses manufacturing details, including drying, pouring, cleaning and testing.

Standardized. Standardized Cast Iron Pipes. Eng. Production vol 3 no 56, Oct 27, 1921, pp 401-404, 10 figs. Describes methods of Stanton Ironworks Co., Ltd., Nottingham, England, as example of advantages attendant on standardization of foundry products.

PIPE, STEEL

Butt-Welded. Recent Improvements in the Manufacture of Welded Pipe, F. N. Speller. Blast Furnace & Steel Plant, vol. 9, no. 10, Oct. 1921, pp. 580-582. While there have been many improvements in appliances for butt-welding pipe since introduction of this process, the method of finishing has not been materially changed for some time.

Hammer-Welded. A Hammer-Welded Steel Pipe. Iron Age, vol. 108, no. 18, Nov. 3, 1921, pp. 1130-1131, 3 figs.; also Iron Trade Rev., vol. 69, no 18, Nov. 3, 1921, pp. 1148-1151, 7 figs. Product of National Tube Co., Pittsburgh. Steel plates are bent to required shape and overlapping edges are heated and welded under hammer. Hammer-weld process adapted to large sizes of pipe. Protective coating applied.

Hammer-Welded Pipe; Its Manufacture and Use. Eng. & Contracting, vol. 56, no. 19, Nov. 9, 1921, p. 445, 1 fig. Notes on sizes and thickness; manufacturing process; physical properties of material; joints, elements of economy and efficiency. Describes a hammer-weld gas line. (Abstract.) National Bul. No. 13 published by Nat. Tube Co.

Manufacture. Bessemer Plant of Steel & Tube Company, Gilbert L. Lacher. Iron Age, vol. 108, no. 19, Nov 10, 1921, pp. 1199-1205, 11 figs. Latest developments in design and equipment embodied in addition to Mark works, Chicago, for manufacture of pipe.

PISTONS

Aluminum, Machining. Precision Machine Work in the Production of Aluminum Pistons, J. Edward Schipper. Automotive Industries, vol. 45, no. 15, Oct. 13, 1921, pp. 722-725, 15 figs. Methods employed in manufacturing pistons for Essex engine. Special care exercised in machining piston pin hole square with piston axis, and in aligning piston with cylinder bore.

Machining. Machining Hudson Super-Six Pistons. Machy. (N. Y.), vol 28, no 3, Nov. 1921, pp. 225-227, 5 figs. Methods used by Hudson Motor Car Co. in producing pistons with high-production machinery at low cost.

PLATES

Perforated, Stresses in. Increased Stress Caused by Circular Holes in a Plate Under Tension (Ueber die Spannungserhöhung durch kreisförmige Löcher in einem gezogenen Bleche), Th. Pöschl. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 3, June 1921, pp. 174-180, 3 figs. Derivation of formulas for determining increase in stress caused by a number of holes, as for example, rivet holes in a plate.

POWER

Industrial, Analysis of. Analysis of Industrial Power, H. Goodwin. Power, vol. 54, no. 16, Oct. 18, 1921, pp. 584-588, 3 figs. Investigations based on latest census returns from North Atlantic States show more than 76,000 industrial plants, using in aggregate over 9,000,000 hp. of which over 2,000,000 hp. is supplied by steam engines, 600,000 by steam turbines, 540,000 by water power, 279,000 by internal-combustion engines, and remainder purchased power.

POWER GENERATION

Cost Systems. How to Follow Up Power Costs, N. A. Graigue. Indus. Management, vol. 62, no. 5, Nov. 1921, pp. 275-279, 3 figs. Analysis and distribution of operating costs to consumers.

Fuel Economy. Fuel Economy by the Adoption of Scientific Management in Power Generation and Utilization, David Brownlie. Eng. & Indus. Management, vol 6, no 14, 15 and 16, Oct 6, 13 and 20, 1921, pp 393-394 and 396, 421-424 and 433-436, 13 figs. Notes on flue-gas analysis and boiler feedwater meters.

POWER PLANTS

Coal Mine. Mixed-Pressure Turbine Installation with Regenerator Appreciably Decreases Power Costs at Nokomis, C. W. Smith. Coal Age, vol 20, no 19, Nov 10, 1921, pp 753-757, 7 figs. Describes very modern coal-mine power plant at Nokomis mine, Illinois, of Nokomis Coal Co.; capacity 1,300 kw. of which 1,000 kw. is mixed-pressure and 300 kw. high-pressure turbine power.

Design. Developments in Power Station Design—XII, XIII and XIV. Engineer, vol 132, nos. 3432, 3433 and 3435, Oct. 7, 14 and 28, 1921, pp. 361-365, 390-392 and 445-447, 13 figs. Oct. 7: Babcock boilers for utilization of waste heat from coke ovens and blast furnaces. Oct. 14: Halberg-Beth blast-furnace-gas-cleaning plant; Kirke waste-heat boiler with integral economizer; and waste-heat boilers with vertical tubes. Oct. 28: Describes Bonecourt gas-fired boiler unit; Thomson boilers operated with coke-oven gas; Brett drop-forging-furnace waste-heat unit; Babcock & Wilcox furnace for burning saw-mill refuse.

Mine-Mouth. Seward Plant of Penn Public Service Corporation. Power Plant Eng., vol. 25, no. 19, Oct. 1, 1921, pp. 937-947, 17 figs. A mine-mouth power plant supplying industries in Johnstown district. Details of equipment, mechanical and electrical.

Modern Practice. Refinements of Practice in Modern Power Plants, I. L. Kentish-Rankin. Power Plant Eng., vol. 25, no. 20, Oct. 15, 1921, pp. 988-990. Discusses features regarding furnace construction and the overcoming of difficulties with superheater operation.

Superpower. The Performance and Cost of the Superpower System, Arthur R. Wellwood. Power, vol. 54, no. 19, Nov. 8, 1921, pp. 725-730, 10 figs. As result of work of Superpower Survey, certain vital facts concerning performance and cost of superpower system are presented, and conclusions drawn.

POWER TRANSMISSION

Machine Shops. Transmission of Power in Machine Shops, F. A. Pike. Mech. World, vol. 70, no. 1815, Oct. 14, 1921, p. 298, 3 figs. Advocates more direct driving.

PRESSES

Automobile Parts. Presses and Dies used in the Production of Motor-car Body Parts. Machinery (Lond.), vol. 19, no. 475, Nov. 3, 1921, pp. 117-121, 10 figs. Description of tools and machines used by Austin Motor Co., Ltd., Longbridge Works, Birmingham.

PRICES

Stop-Loss, Finding. Finding the "Stop Loss" Price Point, H. R. Boston. Indus. Management, vol. 62, no. 5, Nov. 1921, pp. 266-268. Definite way of estimating how far a price may be cut.

PRODUCER GAS

Qualitative Regulation. Device for the Qualitative Regulation of Producer Gas (Vorrichtung zur qualitativen Regelung von Generatorgas), Robert Nitzschmann. Feuerungstechnik, vol. 9, no. 22, Aug. 15, 1921, pp. 209-211, 2 figs. Discusses basic principles for qualitative regulation and describes arrangement which is said to fulfill required conditions.

PULVERIZED COAL

Advantages and Disadvantages. Firing With Pulverized Coal (Le Chauffage au charbone pulvérisé), P. Frion. Memoirs et Compte Rendu des Travaux de la Société des Ingenieures Civils de France, vol. 74, no. 4-5-6, April-June 1921, pp. 123-172. Report of Commission of Fuel Utilization, appointed by Minister of Pub. Works. Discusses actual developments in use of pulverized coal. Describes installation using it, its advantages and possibilities, and its inconveniences and dangers. See also Révue Universelle des Mines, vol. 11, no. 1, Oct. 1, 1921, pp. 48-56.

Firing With Pulverized Coal (Le Chauffage au charbon pulverisé), Sigma. La Métallurgie, vol. 53, no. 38, Sept. 22, 1921, pp. 1781-1782. Discusses disadvantages and draws conclusions comparing these with advantages. (Concluded.)

Boiler Firing. Burning Powdered Coal and Blast-Furnace Gas at River Rouge, Thomas Wilson. Power, vol. 54, no. 18, Nov. 1, 1921, pp. 664-670, 9 figs. Arrangement and construction of big boilers and their control. Pulverized-coal equipment and layout of gas piping and burners. Performance guarantees and operating force required.

Burning Powdered Coal in Boiler Furnaces, K. Kita. Jl. Inst. Elec. Engrs. of Japan (Denki Gakkwai Zasshi), no. 399, Oct. 1921, pp. 713-740. Author tries to make comparison of combustion of powdered coal with that of ordinary method, and points out important factors to be considered in construction of furnace. Bibliography. (In Japanese.)

PUMPING

Centrifugal and Air-Lift. Modern Pumping. Colliery Guardian, vol. 122, no. 3170, Sept. 30, 1921, pp. 933-934. Paper on "Modern High Speed Centrifugal Pumps" by S. F. Barclay and paper on Experiments in Air Lift Pumping by J. S. Owens. Read before British Assn. See also Eng. & Indus. Management, vol. 6, no. 18, Nov. 3, 1921, pp 503-506.

PUMPS, CENTRIFUGAL

Design and Application. The Centrifugal Pump, S. F. Barclay. Engineering, vol. 112, no. 2914, Nov. 4, 1921, pp 642-644, 8 figs. Notes on mechanical design and application. (Abstract.) Paper read before British Assn.

Manufacture. Manufacturing Centrifugal Pumps. Western Machy. World, vol. 12, no. 10, Oct. 1921, pp. 392-395, 12 figs. Describes machine operations on pump bases, brackets, spiral bodies, impellers, etc.

PUNCHING MACHINES

Efficiency. Increasing the Efficiency of Punching Machines (Zur Frage der Leistungssteigerung bei Lochwerken), Hugo Becker. Betrieb, vol. 3, no. 25, Sept. 15, 1921, pp. 832-838, 16 figs. Comparison of costs of punching work in the plating of a freight steamer with use of a simple punching machine and of a roller table machine shows economy of latter.

R

RADIOMETALLOGRAPHY

Possibilities. X-Ray Photography and Material Testing (Röntgenphotographie und Materialprüfung), R. Schenck. Stahl u. Eisen, vol. 41, no. 41, Oct. 13, 1921, pp. 1441-1449, 24 figs. Discusses nature of Röntgen rays and possibilities for their use in material testing and metallography.

RAILS

Magnetic Surveys. Magnetic Surveys of Railroad Rails. Iron Age, vol. 108, no. 20, Nov. 17, 1921, pp. 1271-1273, 7 figs. Determination of fissures obscured by heavy damage from gagging presses. Improvements being made in section and in straightening.

Second-Hand, Use of. Classification and Distribution of Second Hand Rail for Use in Track. Eng. & Contracting, vol. 56, no. 20, Nov. 16, 1921, pp. 463-464. Notes on supply and demand for used rail; variables to be considered in use of rail; recommended method of assigning and distributing rail.

RAILWAY CONSTRUCTION

Germany. Construction of the Railway Between Tongres and Aix-la-Chapelle (Der Eisenbahnbau Tongern-Aachen), E. Hünerwadel. Schweizerische Bauzeitung, vol. 78, nos. 14, 15 and 17, Oct. 1, 8 and 22, 1921, pp. 163-167, 182-184 and 201-205, 22 figs. Describes section including bridges and tunnels built by Germany between years of 1915 and 1918, said to be one of largest and most important works of engineering carried out during war.

RAILWAY ELECTRIFICATION

Austria. The Electrification of the Austrian Federal Railway (Die Elektrisierung der österreichischen Bundesbahnen), H. Baecker. Glasers Annalen, vol. 89, no. 5, Sept. 1, 1921, pp. 48-51, 1 fig. Notes on projects, hydroelectric and power-transmission plants.

Brazil. The Paulista Railway Electrification, S. B. Cooper. Ry. Rev., vol. 69, no. 16, Oct. 15, 1921, pp. 507-509, 8 figs. Describes Westinghouse equipment recently delivered and conditions making electrification desirable.

Heavy Traction. Electrification Report of the A.E. R.A. Ry. Elec. Engr., vol. 12, no. 10, Oct. 1921, pp. 391-396, 1 fig. Report of Committee of the Am. Elec. Ry. Assn. on heavy electric traction. Compares locomotives and multiple unit-cars. (Abstract.)

Italy. Economic Aspects of Electric Traction in Italy (Aspetti economici della trazione elettrica in Italia), Pietro Lanino. Ingegneria Italiana, vol. 7, no. 170, Sept. 10, 1921, pp. 144-146. Summarizes needs of Italian electrification and gives list of impending constructions.

Electrification Progress on Italian Railways, Giovanni B. Santi. Ry. Elec. Engr., vol. 12, no. 10, Oct. 1921, pp. 371-375, 6 figs. Discusses development of electrification on account of high price of coal and no oil resources. The Valtelline three-phase, 15-cycle, 3000-volt system has been working for 20 years.

Steel Plant. Electrification of the Steel Plant Railroad, R. B. Gerhardt. Blast Furnace & Steel Plant, vol. 9, no. 10, Oct. 1921, pp. 613-617. Discusses savings effected in fuel, repairs, labor, and depreciation; also discusses safety, frogs and switches, etc. (Abstract.) Paper read at Assn. Iron & Steel Elec. Engrs. Convention.

RAILWAY MOTOR CARS

Gasoline. Petrol Rail Motor Cars, Kalka-Simla Railway. Ry. Gaz., vol. 35, no. 15, Oct. 7, 1921, pp. 535-539, 7 figs. Describes car for narrow-gage mountain service in India under severe working conditions, due to steep inclines and many sharp curves. Design includes several noteworthy features particularly gearing and transmission, frame construction, and combination of coupled wheels and radial trucks to give flexibility on curves.

RAILWAY OPERATION

Automatic Train Control. Automatic Safety Apparatus and Automatic Train Control (Appareil automatique de sûreté et de contrôle des trains), Maurice Gouineau. Révue Générale de l'Élec-

tricité, vol. 10, no 12, Sept. 24, 1921, pp. 406–412, 10 figs. Describes Regan system as adapted to French railroads.

Cab Signaling and Automatic Stopping of Trains (La répétition des signaux sur les machines et l'arrêt automatique des trains), J. Netter. La Technique Moderne, vol. 13, no. 3, March 1921, pp. 101–104, 7 figs. Criticism of Regan system recently tested on Paris-Dreux line; comparison with Rodolausse apparatus, systems used by principal French railroads.

Interchange of Rolling Stock. On the Question of Interchange of Rolling Stock, C. W. Crawford. Bulletin International Ry. Assn., vol. 3, no. 9, Sept. 1921, pp. 1275–1321. Discusses the question as it affects United States, Canada and Mexico. Gives summary of their regulations and practices, also answers to questions sent. Appendixes.

Passenger Traffic. Handling Heavy Passenger Traffic at Doncaster. Ry. Gaz., vol. 35, no. 14, Sept. 30, 1921, pp. 493–496 and 507, 4 figs. Describes the special traffic arrangements made by Great Central and Great Northern Railways in connection with the race traffic.

RAILWAY REPAIR SHOPS

Contract Shop, vs. The Cost of Contract vs. Railway Shop Repairs, J. W. Roberts. Ry. Age, vol. 71, no. 16, Oct. 15, 1921, pp. 729–731, 2 figs. Total cost to railroad was 28 per cent greater in its own shop than in a contract shop.

Experimental Scheme. An Experiment in Railroad Repair Work, Fred H. Colvin. Am. Mach., vol. 55, no. 20, Nov. 17, 1921, pp. 807–808. Securing greater interest by local management. Improved machinery and buildings. Describes scheme adopted by Erie R.R. at Hornell, N. Y.

Requirements. The Requirements for a Modern Car Repair Shop, H. H. Dickinson and Paul Schioler. Ry. Age, vol. 71, no. 19, Nov. 5, 1921, pp. 890–893, 3 figs. Type of building, character of tools and general plan for both steel and wood equipment.

RAILWAY SHOPS

American Practice. Railway Machine Shop Practice—III. Machinery (Lond.), vol. 19, no. 473, Oct. 20, 1921, pp. 67–69, 9 figs. Examples of American practice in machining bearing brasses, axle boxes and wedges.

Machine Tools for. Railway Shop Machine Tool Equipment. British Machine Tool Eng., vol. 1, no. 2, September-October 1921, pp. 277–399, 188 figs. A series of articles on railway-shop equipment, including locomotive boiler shop, wheel and axle shop, frame shop, spring shop, grinding shop, general machine shop, capstan and turret lathes, carriage and wagon frames, girder work, etc.

RAILWAY SIGNALING

Alternating-Current. Principles of Alternating Current Signaling, John S. Holliday. Ry. Signal Engr., vol. 14, no. 11, Nov. 1921, pp. 443–445, 9 figs. Explanation of motor and generator motion and transformer action that produces rotation in an induction motor.

Automatic. Road Test of New Automatic Train Control. Ry. Signal Engr., vol. 14, no. 11, Nov. 1921, pp. 431–432, 4 figs. Test conducted on system in which no physical contact is made between apparatus on locomotive and on roadway.

Automatic Block. Proposed Modification of Stop-and-Proceed Rule. Ry. Age, vol. 71, no. 19, Nov. 5, 1921, pp. 867–869, 4 figs. Details of practice on fourteen roads using "tonnage" signals, relaxing the stop-and-proceed rule. See also Ry. Signal Engr., vol. 14, no. 11, Nov. 1921, pp. 429–430.

Automatic Color Light. The Re-Signaling of the Liverpool Overhead Railway. Ry. Gaz., vol. 35, no. 16, Oct. 14, 1921, pp. 571 and 576, 4 figs., partly on p. 570. Describes automatic signaling system on electrically operated railroad, using color light signals only.

Block System. Absolute Permissive Block Signal System, C. A. Dunham. Ry. Signal Engr., vol. 14, no. 11, Nov. 1921, pp. 438–440, 7 figs. Study of single track signaling showing track layout and circuit diagram and explaining operation of trains between sidings. (Abstract.) Paper read before Kansas City Sectional Committee Meeting.

Electric. Principles of Alternating Current Signaling, John S. Holliday. Ry. Signal Engr., vol. 11, no. 10, Oct. 1921, pp. 389–390, 12 figs. Explaining an easy method of constructing vector diagrams and the application to track circuit problems.

Interlocking. Interlocking at a Railway Bridge in England, James Benjamin Ball. Ry. Signal Engr., vol. 14, no. 11, Nov. 1921, pp. 424–428, 7 figs. Interesting signaling features on Keadby Deviation Railway and movable span over Trent river. (Abstract.) Paper read before Inst. Civil Engrs.

One-Lever Route. One-Lever Route Signaling. Ry. Gaz., vol. 35, no. 18, Oct. 28, 1921, pp. 643–648, 9 figs. A new design of power locking frame whereby one lever is used to set up each route, signalman is given a visible indication of all that occurs, conflicting movements are rendered impossible and separate point levers are dispensed with entirely.

Progress, America. Progress of Railroad Signaling in America, H. S. Balliet. Ry. Signal Engr., vol. 14, no. 11, Nov. 1921, pp. 433–437. Detailed history of apparatus and methods used from the days of the smoke blanket to present efficient systems. Paper delivered before N. Y. Signal Sectional Committee.

Tunnel Signals. The Electric Signaling System in the Arlberg Tunnel (Zur Geschichte der elektrischen Fernmeldeeinrichtungen des Arlbergtunnels), L. Kohlfürst. Elektrotechnische Zeit., vol. 42, no. 34, Aug. 25, 1921, pp. 939–943. Describes numerous troubles experienced with system installed in 10.25-km. tunnel through which trains driven by steam locomotives are operated. A telephone cable, which when installed measured 8000 microhms resistance per km. from copper to lead sheath dropped in six years to only 0.2 microhm.

RAILWAY TRACK

Concrete Supports. Concrete Block Track Supports on Italian Railways. Eng. News-Rec., vol. 87, no. 17, Oct. 27, 1921, pp. 689–690, 2 figs. Fixed and rocking blocks placed longitudinally have rail seats at each end. Rockers insure vertical loading.

Maintenance. Distributing Expenditures in Track Maintenance, J. L. Starkie. Ry. Maintenance Engr., vol. 17, no. 11, Nov. 1921, pp. 403–405, 4 figs. Gulf, Colorado & Santa Fe is obtaining increased interest and efficiency by means of new work records.

Advantages of Budget System for Track Work, C. A. Morse. Eng. & Contracting, vol. 56, no. 16, Oct. 19, 1921, pp. 370–372. Points out that there should be a carefully prepared budget made up in fall of year including all probable expenditures of coming year outside of ordinary upkeep of track and roadbed. Apportioning amounts covered by budget. Paper presented before Roadmasters & Maintenance of Way Assn.

Scandinavian Construction. On the Question of the Construction of the Road-Bed and of the Track, K. Ahlberg. Bul. International Ry. Assn., vol. 3, no. 9, Sept. 1921, pp. 1147–1156. Concludes that Scandinavian countries will doubtless increase the load per locomotive axle considerably without changing maximum speeds. Appendix.

Turntables. Twin-Span Turntables on the Chesapeake & Ohio. Ry. Rev., vol. 69, no. 18, Oct. 29, 1921, pp. 563–568, 12 figs. Particulars of design and advantages to be realized in use of this type of turntable. Length 100 ft.; carrying capacity 450 tons; built by Bethlehem Bridge Corp.; used for heavy Mallet type of locomotives.

RAILWAYS

Consolidation. Consolidation of Railroads. Ry. Rev., vol. 69, no. 14, Oct. 1, 1921, pp. 423–437, 29 figs. Proposed consolidation of railroad properties of United States into a limited number of systems. Tentative plan of interstate commerce commision based upon Ripley report.

Shanghai-Nanking. Notes on the Shanghai-Nanking Railway. Ry. Gaz., vol. 35, no. 18, Oct. 28, 1921, pp. 637–638, 3 figs. Describes general characteristics, standard gage, high-capacity rolling stock, train control, train service, buildings, etc.

REFRACTORIES

Fireclays. Effect of Impurities in Fire Clays, C. E. Bales. Brick & Clay Rec., vol. 59, no. 10, Nov. 15, 1921, pp. 723–725. Points out that high-grade fireclays must be akin to kaolin. Explains coloration processes and neutralizing of harmful ingredients.

Furnace Lining. Carborundum Linings for Brass Furnaces, M. L. Hartmann. Can. Foundryman, vol. 12, no. 10, Oct. 1921, pp. 34–35. Explains how carborundum refractories are applied to problems in crucible, tilting or rotary, and reverberatory furnaces, with records of certain installations. Paper read at Foundrymen's Convention.

RIVETED JOINTS

Efficiency. A Criticism of High Efficiency Riveted Joints, John S. Watts. Boiler Maker, vol. 21, no. 10, Oct. 1921, pp. 278–279, 3 figs. Calculations indicate that use of multiple riveted joints does not increase seam efficiencies.

ROLLING MILLS

Bar Mills for Alloy Steel. Adapts Bar Mills to Alloy Steel, J. D. Knox. Iron Trade Rev., vol. 69, no. 20, Nov. 17, 1921, pp. 1275–1281, 12 figs. New 12 and 18-in. merchant units installed by Ohio steelmaker rounds out rolling equipment. Unique guide box prevents scrap loss. Rolls adjusted by set screws. Description of mills.

Chambéry, France. Rolling Mill and Foundry of the Société l'Aluminium Francais at Chambéry (Ateliers de laminage et de fonderie de la Société l'Aluminium français à Chambéry), Marcel Blondin. Révue Générale de l'Électricité, vol. 10, no. 12, Sept. 24, 1921, pp. 401–405, 5 figs. Describes equipment.

Electrically Driven. Some Methods of Obtaining Adjustable Speed With Electrically Driven Mills. K. A. Pauly. Proc. Engrs.' Soc. of Western Pa., vol. 37, no. 3, April 1921, pp. 158–178 and (discussion) 179–188, 19 figs. Discusses rolling mill practice, speed of rolling and systems of speed control.

S

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SEMI-DIESEL ENGINES

Open-Crankcase. The Open-Fronted Surface Ignition Engine, F. G. Butt-Gow. Trans. Inst. Mar. Engrs., vol. 33, Sept. 1921, pp. 239–269 and (discussion) 270–279, 22 figs. Discusses closed and open engines and compares cost of manufacture, running, overhauling, lubrication, etc. Describes various types of open-crankcase engines.

SHAPERS

Toolroom Work. A New Shaping Machine. Eng. Production, vol. 3, no. 55, Oct. 20, 1921, p. 372, 3 figs. Describes machine introduced by The Butler Machine Tool Co., Ltd., Halifax, designed especially for toolroom work.

SOLDERS

Investigation. Metal Solders (Zur Kenntnis der Metallote), L. Sterner-Rainer. Zeit. für Metallkunde, vol. 13, no. 11, Aug. 1921, pp. 368–379, 6 figs. Deals with tin-lead, aluminum, binary copper-zinc, and silver solders, copper-zinc solders containing tin, and iron, steel and gold solders. Determination of composition, melting point, tensile strength and hardness, based on which valuation of the different solders is given.

SPRINGS

Coil. The Manufacture of Coil Springs, A. W. Allen. Machinery (Lond.), vol. 19, no. 474, Oct. 27, 1921, pp. 85–89, 17 figs. Coiling machines; open coil barrel springs; press operations; eye forming; cutting, eyeing and bowing.

Compression. Nested Steel Compression Springs, T. F. Stacy. Am. Mach., vol. 55, no. 20, Nov. 17, 1921, pp. 795–796, 2 figs. Deals with design of concentric springs so proportioned that all springs are worked to maximum fiber stress.

Design. The Design of Springs, Joseph Kaye Wood. Am. Mach., vol. 55, no. 17, Oct. 27, 1921, pp. 674–677, 10 figs. Control of the "spring criterion." Formulas for leaf springs constrained at one or both ends. Characteristics of coil, spiral and buffer springs.

A General Method for Spring Design, Joseph Kaye Wood. Am. Mach., vol. 55, no. 19, Nov. 10, 1921, pp. 757–762, 3 figs. Types of springs. Economy index and load-deflection rate. General formulas and table of constants. Parallel scale chart. Importance of material index.

STANDARDIZATION

Automobile Industry. Industrial Standardization, Geo. W. Watson. Automobile Engr., vol. 11, no. 155, Oct. 1921, pp. 356–358. Advocates more standardization in British automobile industry, including agricultural tractors, etc. Résumé of presidential address before Instn. of Automobile Engrs.

STEAM

Callendar Equations. The Callendar Equations for Steam, Gerald Stoney. Beama, vol. 9, no. 4, Oct. 1921, pp. 345–350, 3 figs. Abstract of some of the best and easiest ways in which to use these equations, with special reference to steam turbine practice.

Production and Distribution Accounting. Accounting for Steam Production and Distribution, A. R. Smith. Power, vol. 54, no. 17, Oct. 25, 1921, pp. 630–633, 1 fig. Describes two forms of balance sheets and enumerates possible losses which can be detected by their use. Ways and means and advantage of metering boiler outputs.

STEAM-ELECTRIC PLANTS

Diagrammatic Recording in. How Can the Executive Keep in Touch with Plant Economy? C. H. Delany. Jl. Electricity & Western Industry, vol. 47, no. 7, Oct. 1, 1921, pp. 267–268, 4 figs. Diagrammatic method of recording results in operation of a steam electric power plant.

STEAM ENGINES

Uniflow. A 200 hp. Uniflow Steam Engine. Power House, vol. 14, no. 18, Sept. 20, 1921, pp. 21–23, 4 figs. Built by Galloways Ltd., Manchester, Has a novel high-speed valve gear and compression release.

[See also LOCOMOBILES.]

STEAM METERS

Types. Modern Feedwater and Steam Meters (Neuere Speisewasser- und Dampfmesser), W. E. Germer. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 33, Aug. 19, 1921, pp. 259–261, 3 figs. Details of piston disk meter with cylindrical measuring disk; the Woltmann meter for turbine condensate; Venturi meter for water and steam.

STEAM PIPES

Reducing Resistances in. Economies Obtainable by Reducing Resistances in Steam Piping, O. Denecke. Mech. Eng., vol. 43, no. 11, Nov. 1921, pp. 735–738, 2 figs. Discussion of general principles on which design of steam piping in power plants should be based, with comparison of formulas suggested for various elements affecting steam consumption as function of resistances encountered to flow of steam. Translated from Zeit. fur Dampfkessel u. Maschinenbetrieb.

STEAM POWER PLANTS

Modern Design. Modern Steam Power Station Design, Frank S. Clark. Jl. Franklin Inst., vol. 192, no. 4, Oct. 1921, pp. 413–452, 11 figs. Notes on present status of turbine design; economical and mechanical features of station design; operation of plant.

STEAM TURBINES

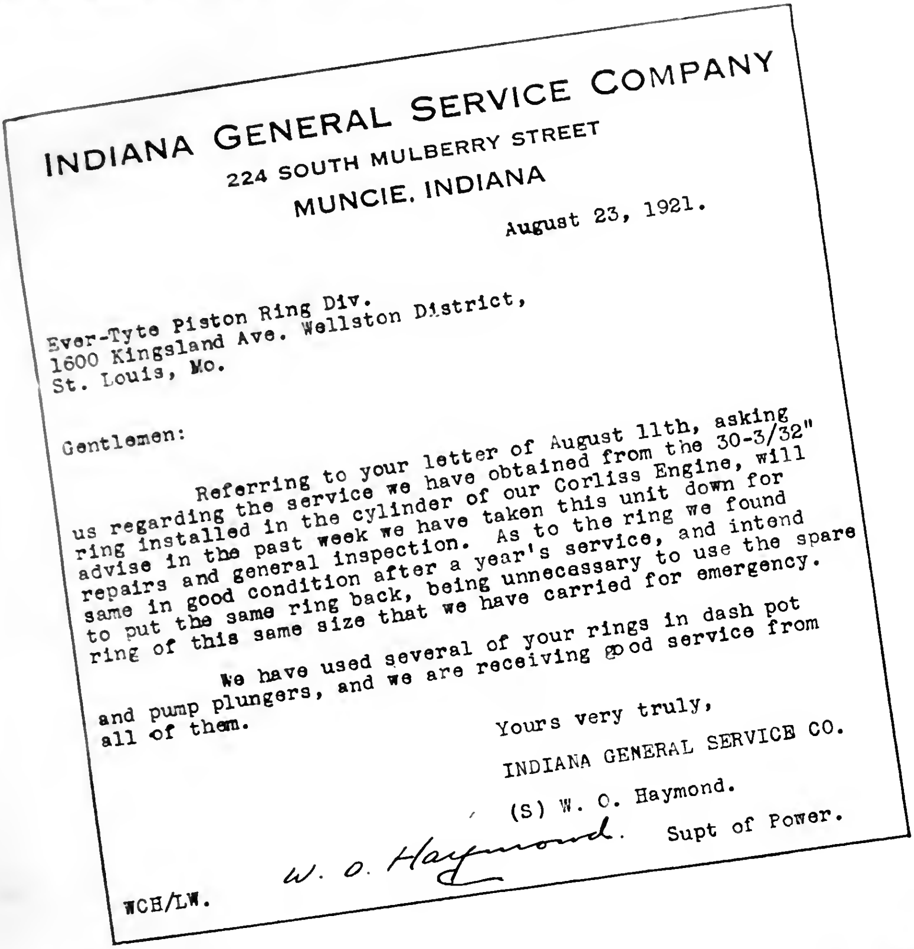
Blading Failures. Low-Pressure Turbine Blading Failures in Destroyers, D. F. Ducey. Engineering, vol. 112, no. 2913 and 2914, Oct. 28 and Nov. 4, 1921, pp. 615–619 and 647–650, 15 figs. Results of chemical analysis of damaged blades, metallographic examination, various heat-treatment, impact-shear and bend tests carried out at experiment station. (Abstract.) Reprinted from Jl. Am. Soc. Nav. Engrs.

STEEL

Artificial Seasoning. Artificial Seasoning of Steels, H. J. French. Am. Mach., vol. 55, no. 19, Nov. 10, 1921, pp. 768–771. Review of available data on length changes and spontaneous generation of heat in hardened steels. Results of preliminary experiments on artificial seasoning. Printed by permission of Bur. of Standards.

Automobile Gear. Investigation of Tooth Wear

It's what the USER says that counts



INDIANA GENERAL SERVICE COMPANY
224 SOUTH MULBERRY STREET
MUNCIE, INDIANA

August 23, 1921.

Ever-Tyte Piston Ring Div.
1600 Kingsland Ave. Wellston District,
St. Louis, Mo.

Gentlemen:

Referring to your letter of August 11th, asking us regarding the service we have obtained from the 30-3/32" ring installed in the cylinder of our Corliss Engine, will advise in the past week we have taken this unit down for repairs and general inspection. As to the ring we found same in good condition after a year's service, and intend to put the same ring back, being unnecessary to use the spare ring of this same size that we have carried for emergency.

We have used several of your rings in dash pot and pump plungers, and we are receiving good service from all of them.

Yours very truly,
INDIANA GENERAL SERVICE CO.
(S) W. O. Haymond.
W. O. Haymond. Supt of Power.

WCH/LW.

Less Fuel
Less Oil
Longer Life
Higher Efficiency
More Power

The right-angled interlock is your safeguard

Order On Trial

EVER-TYTE PISTON RING DIVISION

ST. LOUIS
(Wellston District)

Send for Evidence Booklets—12 Volumes

Representatives Wanted

ENGINEERING INDEX (Continued)

With Automobile Gear Steels, E. R. Ross. Automotive Industries, vol. 45, no. 18, Nov. 3, 1921, pp. 865 869 10 figs. Steel with minimum of 0 45 carbon that is capable of treatment giving a scleroscope hardness of 75 or over is recommended for oil treating. Specification limits should be close enough to insure uniform results from a standard heat treatment.

Bar, Weight of. Estimating the Weight of Bar Steel, Hyman Levine. Machy. (N. Y.), vol. 28, no. 3, Nov. 1921, p. 190. Formulas for calculating approximate weights of various sections and lengths of steel.

Cast, Carbonizing Parts. The Carbonizing of Cast Steel Parts, William G. Conner. Trans. Am. Soc. for Steel Treating, vol. 2, no. 2, Nov. 1921, pp. 148-149. Writer finds that all parts or pieces should be cooled in pots to atmospheric temperature.

Cast, Impact Tests on. Study Impact Tests on Cast Steel, F. C. Langenberg. Iron Trade Rev., vol. 69, no. 18, Nov. 3, 1921, pp. 1145–1147 and 1151, 6 figs. Results of investigations on cast steels of varied compositions and heat treatments. Higher shock strength is shown to be obtained from low phosphorus material.

Crystalline Structure. Crystalline Structure of Steel (Stålets kristallbyggnad), Arne Westgren. Jernkontorets Annaler, vol. 105, no. 10, 1921, pp. 401–430, 8 figs. Discusses theory, methods of testing, structure of allotropic modifications of iron, structure of hardened steel, etc.

Hardness Formulas. Determines Hardness Formulas, E. J. Janitzky. Iron Trade Rev., vol. 69, no. 17, Oct. 27, 1921, pp. 1079–1081, 3 figs. Investigation conducted on steel specimens shows that Brinell hardness can be computed by use of mathematical formulas. Outline of method for deriving formula. (Abstract.) Paper presented before Am. Soc. for Steel Treating.

Impact Properties. Impact Properties of Various Steels, F. C. Langenberg. Chem. & Met. Eng., vol. 25, no. 20, Nov. 16, 1921, pp. 910–912, 5 figs. Cylinders of steel, centrifugal cast, were sectioned and tested, a set of steel bars, with increasing carbon content, and some steel casting were tested after various heat-treatments; comparison of impact for forged and cast steels.

Liquid, Surface of. The Surface of Liquid Steel, Cosmo Johns. Engineering, vol. 112, no. 2913, Oct. 28, 1921, p. 619. Supplementary to previous papers by author on appearance of liquid steel as it flows from the launder of an acid open-hearth furnace, and evidence of existence of vapor of iron or steel. Paper read before British Assn.

Nitrogen in Carburized. Nitrogen in Carburized Steels, W. E. Ruder and G. E. Brophy. Chem. & Met. Eng., vol 25, no. 19, Nov. 9, 1921, pp. 867–871, 7 figs. Describes micrographic methods for detection of nitrogen compounds.

Properties. The Properties of Steel. Eng. Production, vol. 3, no. 57, Nov. 3, 1921, pp. 417–418, 1 fig. Notes on influence of various elements.

Stainless. Stainless Steel for Turbines. Electrician, vol. 87, no. 2267, Oct. 28, 1921, pp. 540-541, 5 figs. Examination after 3471 hours run showed that stainless steel blades, polished and unpolished, were practically untouched. See also Iron & Coal Trades Rev., vol. 103, no. 2800, Oct. 28, 1921, pp. 626–627, 8 figs., partly on p. 628.

Stainless Steel in Engineering. Eng. & Indus. Management, vol. 6, no. 17, Oct. 27, 1921, pp. 466-467, 2 figs. Describes demonstration at Thos. Firth's & Sons, Sheffield, England, showing behavior of turbine blades, made from stainless steel, under working conditions. See also Eng. Production, vol. 3, no. 56, Oct. 27, 1921, p. 405, 2 figs.; Engineering, vol. 112, no 2913, Oct. 28, 1921, pp. 592 594, 7 figs.; and Engineer, vol. 132, no. 3435, Oct. 28, 1921, pp. 447 450, 7 figs.

[See also ALLOY STEELS; CHROMIUM STEEL; MANGANESE STEEL; URANIUM STEEL.]

STEEL CASTINGS

Heat Treatment. Heat Treatment Improves Castings, Martin M. Rock. Foundry, vol. 49, no. 20, Oct. 15, 1921, pp 797 799. Tensile tests of unannealed, air cooled and water quenched steel castings do not disclose marked difference in strength but impact tests show water-quenched product excels others.

Welding. The Welding of Steel Castings (Schweissen von Stahlformguss), L. Treuheit. Stahl u. Eisen, vol. 41, no. 39, Sept. 29, 1921, pp. 1361 1366, 21 figs. Notes on different processes with special consideration of electric arc and autogenous welding. It is concluded that for steel castings oxygen-acetylene and fire welding are best processes, and should be used exclusively for highly stressed castings. (Abstract.) Paper before Assn. German Foundrymen.

STEEL, HEAT TREATMENT OF

Hardening. Discussion of the Hardening of Steel and Other Alloys, Oscar E. Harder. Trans. Am. Soc. for Steel Treating, vol 2, no. 2, Nov. 1921, pp. 139 147, 1 fig. With particular emphasis on important part played by solution and precipitation.

Hardness Variation. Hardness Variations in Heat-Treated Steel, Carle R. Hayward Chem. & Met. Eng., vol. 25, no. 15, Oct. 12, 1921, pp. 695 696. Gives some tables of figures for shore center and half-way tests showing greater hardness in center.

Influence of Mass. A Contribution to the Problem of the Influence of Mass in Heat Treatment, E. J. Janitzky. Trans. Am Soc. for Steel Treating, vol. 2, no. 1, Oct. 1921, pp. 55 62, 3 figs. Writer seeks to show that law which relation of mass has to physical properties exists and can be determined mathematically.

Quenching. Efficiency of Various Quenching Mediums With Their Practice and Applications, James B Morey. Trans. Am. Soc. for Steel Treating, vol 2, no. 1, Oct. 1921, pp 63–69, 4 figs. Discusses effect of brine, oil, sperm, lard, sea or salt water.

Tempering. Notes on Tempering (Remarques sur la trempe), L. Grenet. La Technique Moderne, vol. 13, no. 3, March 1921, pp. 104 111, 2 figs. Criticism of Dejean's article dealing with factors affecting tempering, mechanics of tempering, tempering iron and various iron and steel alloys etc. Close of discussion by P. Dejean.

STEEL, HIGH-SPEED

Electric Tool. Features of Electric Tool Steel Practice, W. J. and S. Stuart Green. Iron Age, vol 108, no. 17, Oct. 27, 1921, pp. 1061–1064, 3 figs. Points out that standardized shop practice is necessary. Large ingots are recommended. Top pouring preferred for tool steel.

Ingots, Heat Treatment of. The Heat Treatment of Heavy Ingots of High-Speed Tool Steel (Beitrag zur Frage der Warmformgebung schwerer Blöcke aus Schnellarheitsstahl), W. Oertel. Stahl u. Eisen, vol. 41, no. 40, Oct. 6, 1921. pp. 1413–1416, 8 figs. The formation of cracks with forging of high-speed steel ingots is attributed to presence of coarse carbide concentrations, whereas observed disintegration of a forging in a circular or core part is caused by phenomena in connection with forging in angle saddle. Explains how this disintegration can be prevented.

Treatment. How to Make the Most out of High Speed Steel, A. J. Wilson. Can. Machy., vol. 26, no. 13, Sept. 29, 1921, pp. 35–36. Steel must be heated uniformly. Tools should not be hardened direct from forging operation. Should be annealed.

Tungsten Content, Effect of. Effect of Tungsten Content on the Specific Gravity of High Speed Steel, Arthur S. Townsend. Trans. Am. Soc. for Steel Treating, vol. 2, no. 2, Nov. 1921, pp. 133–138. Observations made in writer's laboratory tend to establish general rule for annealed steels that the higher the tungsten content the higher the specific gravity.

STEEL MANUFACTURE

Enameled Steel. Enameled Steel Manufacture, Chester H. Jones. Chem. & Met. Eng., vol. 25, no. 19, Nov. 9, 1921, pp. 883–886, 9 figs. Development of glass-lined steel containers; fabricating and finishing the steel; mixing and firing the enamel.

STEEL WORKS

Electrical Development in. Electrical Development in Steel Mills, R. B. Gerhardt. Iron Age, vol. 108, no. 18, Nov. 3, 1921, pp. 1135–1136. Report of progress during past year. Advance in control equipment.

French, Rebuilding. French Modernize in Rebuilding, L. Guillet. Iron Trade Rev., vol. 69, no. 18, Nov. 3, 1921, pp. 1152-1154. Better equipment than was used before war installed in iron and steel works. Products of American engineering skill used in some plant. Résumé of restoration. (Abstract.) Paper before British Iron & Steel Inst.

Scotland. The Valuation of Steel Works in Scotland. Colliery Guardian, vol. 122, no. 3169, Sept. 23, 1921, pp. 870-871. Evidence given in connection with reassessment.

STELLITE

Use for Cutting Tools. Stellite and Its Use for Cutting Tools (Le "Stellite" et son emploi pour les outils de tour). L'Ouvrier Moderne, vol. 4, no. 6, Sept. 1921, pp. 227 230, 26 figs. Properties of stellite, degrees of hardness, operating tools, etc.

STOKERS

Elvin Mechanical. Distinctive Features of the Elvin Mechanical Stoker. Ry. & Locomotive Eng., vol. 34, no. 10, Oct. 1921, pp. 259-264, 10 figs. Details of its construction and operation, and improvements made without changing fundamental principles of its design. Applied to Mallet locomotives.

Pluto. The Pluto Stoker and Its Development in the Last Decade (Der Pluto-Rost und seine Entwicklung im letzten Jahrzehnt), H. Pradel. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, no. 32, Aug. 12, 1921, pp 249 251, 6 figs. Describes improvements since 1911 in forced draft traveling step grate manufactured by Pluto Grate Co , Weiss & Meurs, Ltd., Berlin.

T

TERMINALS, LOCOMOTIVE

Oklahoma City. M. K. & T. Improves Its Facilities at Oklahoma City. Ry. Age, vol. 71, no. 16, Oct. 15, 1921, pp. 713-716, 7 figs. Engine terminals and yards have been reconstructed to take care of increased business.

TERMINALS, RAILWAY

Snow and Ice Handling. Handling Snow and Ice in Railway Terminals, J. J. Navin Eng & Contracting, vol. 56, no. 20, Nov. 16, 1921, pp. 462 463. (Abstract.) Paper read before Maintenance of Way Club of Chicago.

TEXTILE MACHINERY

Construction. Machining Operations on Textile Machine Parts. Machinery (Lond.), vol. 19, no. 473, Oct. 20, 1921, pp. 57 62, 14 figs. Review of methods employed by British Northrop Loom Co., Ltd., Daisyfield, Blackburn.

TEXTILE MILLS

Hosiery. Durham's New Dyehouse and Steam Plant, Frederick Albert Hayes. Textile World, vol. 60, no. 20, Nov. 12, 1921, pp. 57 63, 9 figs. Describes equipment of Durham Hosiery Mills, Durham, N. C., and gives details of mercerizing buildings in course of construction.

Ventilation. Ventilation and Humidification of Textile Factories, H N. Leask. Domestic Eng. (Lond.), vol. 41, no. 34, Oct. 1921, pp. 155–159, 1 fig. Describes an apparatus designed by A. B. Cleworth meeting all the requirements of humidity and ventilation, etc. Extract from paper read before Rochdale Cotton Spinners' Mutual Improvement Soc.

THERMODYNAMICS

Pressure-Volume Chart. Application of the Logarithmic Pressure-Volume Diagram to Heat Phenomena (Anwendung des logarithmischen Druck-Volumen-Bildes für Wärmevorgänge), K. Körner. Zeit. fur angewandte Mathematik u. Mechanik, vol. 1, no. 3, June 1921, pp. 189–194, 5 figs. Describes how diagram can be developed, giving theoretical and actual logarithmic pressure-volume diagram of a Diesel engine, from which temperature and entropy for every point can also be directly read.

TIDAL POWER

Proposed System. Using the Power of the Tides (L'Utilisation de l'energie des marées). L'Industrie Electrique, vol. 30, no. 702, Sept. 25, 1921, pp. 345–352, 11 figs. Discusses the various systems proposed, classed as, using the water level, velocity of water, or weight of water.

Severn Project. Long Distance Transmission and Tidal Power, T. F. Wall. Electrician, vol. 87, no. 2263, Sept. 30, 1921, pp. 408–410, 3 figs. Discusses the Severn scheme of the Ministry of Transport for an average generation of 500,000 hp. over a 10-hr. day. Scheme involves d.c. generators driven by water turbines; transmission of power to London at 120,000 V. pressure. Electrical difficulties involved. (Abstract.) Paper read before British Assn.

System for Utilizing. Long Distance Transmission of Electrical Energy with Special Reference to Tidal Power, T. F. Wall. Engineering, vol. 112, no. 2912, Oct. 21, 1921, pp. 587–588, 3 figs. Preliminary outline of system obviating difficulty of varying speeds of turbines, permitting use of a.c. generators driven directly from turbines, and offering other advantages. Paper read before British Assn.

TIME STUDY

Stop-Watch. Stop Watch Time Study. Does It Promote Industrial Efficiency? Eng. & Indus. Management, vol. 6, nos. 16 and 17, Oct. 20 and 27, 1921, pp 437–440 and 463–465. Oct. 20: An indictment of the Stop Watch, by Frank B. and L. M. Gilbreth. Defense of stop watch by Carl G. Barth and Dwight V. Merrick in discussion held under auspices of Taylor Society.

U

UNEMPLOYMENT

Factors Affecting. What Construction Can Do for the Unemployed, R. C. Marshall. Eng. & Contracting, vol. 56, no. 16, Oct. 19, 1921, pp. 378–379. Outlines factors vitally affecting unemployment emergency, and discusses steps for reviving construction. Memorandum submitted to President's Unemployment Conference.

URANIUM STEEL

Microstructure. Uranium Steels, Hugh S. Foote. Chem. & Met. Eng., vol. 25, no. 17, Oct. 26, 1921, pp. 789-792, 13 figs. Discussion of microstructure of steels containing a similar percentage of carbon and increasing percentages of uranium. Brief description of influence of uranium as an alloy in structural and high-speed steels.

W

WAGES

Limitation of Output. Limitation of Output, H. M. Vernon. Eng. & Indus Management, vol. 6, no 16, Oct. 20, 1921, pp 428 432, 3 figs. Based on chapter in writer's recently published book on Industrial Fatigue and Efficiency. Includes statistical information obtained during war and now published for first time Discussion as to what is best form of wage and piece-rate payment.

Problems. Wages Problems. Iron & Coal Trades Rev., vol 103, no 2791, Sept 16, 1921, pp. 395-397. Paper by W. L. Hichens on "The Principles by which Wages are Determined" and paper by Prof. Kirkaldy on "The Wages System and Possible Developments." See also Colliery Guardian, vol. 122, no. 3168, Sept. 16, 1921, pp. 797-798 and p. 805.

Z

ZINC ALLOYS

Copper-Aluminum-Zinc. Tenax Metal (Tenax-Metall), Willy Schulte. Giesserei-Zeitung, vol. 18, nos. 18, 19 and 20, Aug. 9, 16 and 23, 1921, pp. 258 260, 268 270 and 278 280. Zinc alloy containing 2.88 per cent copper and 4 44 per cent aluminum, developed during war, practicability of which was confirmed by official investigations and private experiences. Results of tests to determine its value for construction of rods, as a substitute for brass.

MECHANICAL ENGINEERING

Volume 44 February, 1922 Number 2

A Review of Industrial Education and Training

Symposium at Annual Convention of A.S.M.E. Develops Many Principles of Value in Formulating Standard Code of Procedure in Industrial Education

FOR several years The American Society of Mechanical Engineers has maintained a relationship with the universities and colleges of this country, and it was but natural that in time the interest of this organization should be extended toward the technical and trade schools which play such an important part in our system of industrial education.

Two years ago the scope of the Committee on Relations with Colleges was extended to include Education and Training for the Industries, and the name of the committee changed to the more comprehensive one of Education and Training.[1] The symposium on this subject at the recent Annual Meeting of The American Society of Mechanical Engineers was the second public meeting held under the auspices of the enlarged committee. While conforming with the central idea of the convention, by showing how "technical education for industrial employees is for the purpose of *preventing waste* of money, materials, mechanical power, and human energy," the papers and discussions brought out many principles which will be utilized by the committee in formulating a standard code of procedure in industrial education. This can be adopted by the Society and recommended to the industries and the educational authorities.

Two papers were presented and discussed at the session held on the evening of Monday, December 5, in the auditorium of the Engineering Societies Building, New York. Dean R. L. Sackett, State College, Pa., presented the first paper, on Education and Training in the Industries, and D. C. Buell, Director of The Railway Educational Bureau, Omaha, Neb., presented the second, on Education and Training on Railroads. President E. S. Carman presided over the session and Chairman W. W. Nichols of the Committee presented the speakers. An abstract of the papers and discussions follows.

Education and Training in the Industries

By R. L. SACKETT,[2] STATE COLLEGE, PA.

THE education of the worker in the United States has been neglected, while in Europe special types of instruction have been in use for some time. The continued growth of apprentice and continuation schools there indicates that they perform a valuable service. However different the conditions abroad and here may be, the fact remains that more systematic methods must be employed to improve skill, to prepare men for promotion, and to inform our wage earners concerning American industrial methods and ideals.

The early apprentice and his master constituted the first industrial school. The apprentice system failed to meet the need of changing industry and became relatively unimportant, when the age of power and labor-saving machinery arrived about 1876.

CONTINUATION SCHOOLS

Probably the earliest continuation school was that organized in Munich, Germany, where daytime attendance at commercial and industrial schools was made compulsory for all under eighteen years of age engaged in commerce or industry. Besides the continuation of their general education in history, German, mathematics and citizenship, separate classes are arranged for the youths of each trade and in these classes both practical and theoretical instruction are given in the trade by skilled workmen and special instructors. It is to be noted that Germany, in the beginning, brought the public schools and industries into close coöperation in the conduct of the continuation school.

In Great Britain the Fisher Bill for compulsory continued education was passed in the Education Act of 1918. This bill provides for a national system of public education for those 14 to 18 years of age. The system is being applied gradually and the number of students will increase from 600,000 to about 1,200,000 in 1925. Attendance of two half-days per week is required and the subjects are divided into—

a Study of English, Geography, History, Mathematics, etc.

b Instruction in Handicraft, Practical Science, Vocational Instruction.

c Physical Training, including drill, swimming, gymnastics, organized games.

The possibilities of the continuation school were first recognized in the United States about eight years ago, since which time twenty states have established such schools. The need for them as a part of our state system was emphasized by Charles W. Eliot, President Emeritus of Harvard College, who said in 1916:

> A survey of the programs of existing American secondary schools—public, private and endowed—would show that as a rule they pay little attention to the training of the senses and provide small opportunities for acquiring any skill of eye, ear, or hand, or any acquaintance with the accurate recording and cautious reasoning which modern science prescribes.

In support of the continuation school and of industrial instruction in general, the National Association of Manufacturers in convention May, 1913, declared:

> First, It is the purpose of vocational education to save, educationally, that 50 per cent of the children of the land who now leave school at the end of the sixth grade, undirected, unskilled, uninformed, and to train them and others of all ages in the essentials of successful and happy workers in their chosen occupations, in commerce, in manufacturing, in agriculture, and in home making.[1]
>
> Second, It is essential that the teachers in vocational schools shall have had extended experience in actual employment in the occupations taught, to the end that the instruction be practical and meet actual conditions.
>
> Third, Failure has marked every attempt at vocational education not directed principally by employees and employers from the vocations, thereby assuring that the instruction given shall justify the confidence and hope of students, parents and the vocational interests whose coöperation is essential.

In 1913 the state of Wisconsin began a continuation-school program requiring one half-day per week attendance by those between 14 and 16 years of age. Following this example nearly half the states have since enacted laws of a similar character, but most of them require attendance two half-days per week.

In general, the program of the continuation schools in this country has included instruction in English, mathematics, history and then vocational instruction along the trade which the employee is pursuing. Classes in any community are therefore divided according to the principal occupations in the local industries. Attendance is required during two half-days per week and this time

---

[1] W. W. Nichols, *Chairman*, C. R. Richards, R. L. Sackett, J. C. Spence, Ira N. Hollis.

[2] Dean of Engineering School. Mem.Am.Soc.M.E.

Abstracts of papers presented at the Annual Meeting, New York, Dec. 5 to 9, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

[1] *American Industries*, vol. 13, no. 11, pp. 27–38.

is deducted from the maximum number of hours of employment permitted per week. The employer is required to make provision for the absence of those who are required to attend the continuation school.

Pennsylvania was the second state to provide continuation schools, and in 1915 when the act was passed there were probably "at least 50,000 children between the ages of 14 and 16 who had left school to go to work." Why do they leave the common schools? A very recent report of the Pennsylvania Department of Public Instruction says, "Many children when asked why they leave school to go to work give economic necessity as the reason." Careful and conclusive investigation shows that very few children leave school to go to work because of financial necessity. Thirty-five per cent of the children when first asked give economic necessity as a reason, but the invariable result of investigation is to reduce this number to between 10 and 15 per cent. In the majority of cases further questioning brings out the statement that the desire to leave school is the result of "lack of interest, the failure to make the next grade, dislike of a teacher, distaste for one or another of the prescribed studies, the desire for clothes, spending money, or a craving to try something different." Whatever the reason may be, the fact remains that the secondary- and high-school systems which have been built up in the United States, valuable as they are, do not serve all the needs of all the people and the continuation school is an attempt to appeal to and to serve the objective type of mind, the restless, those who are not adapted to our public schools, or are led to think they do not meet the workers' needs.

The instruction given in the typical continuation school requiring attendance eight hours per week is about as follows:

	Hours
I General Classes:	
English, Vocational Guidance and Occupational Analysis	2
Industrial Geography, Citizenship, Hygiene, Music, Recreation, Arithmetic, Drawing	2
Industrial Arts and Home Projects	1½
Reading for Appreciation	½
II Prevocational Classes for "Self-Discovery:"	
English, Vocational Guidance and Occupational Analysis	2
Industrial Geography, etc.	2
Related Arithmetic and Drawing	2
Commercial Household Arts or Industrial Prevocational Work	2
III Vocational Classes:	
English, Social Science, Industrial Geography	2
Related Arithmetic, Drawing and Hygiene	2
Commercial Home Making or Industrial Vocational Work. (In school, shop or in place of employment under special instructor)	4

Students are assigned to one or the other, according to their preparation and their needs.

What are the purposes of the continuation schools? I quote from the Pennsylvania Bulletin showing a realization of a supreme need and of an immense service which these schools may perform if rightly directed.

> These children must learn how to adjust themselves to the task of earning a living, realize that for practically all of them promotion will be slow and must be earned, that shifting from job to job is a wasteful practice, that they must learn to be responsible punctual, industrious, willing to render cheerful service, if they are to succeed.
>
> Industry grants them little opportunity for instruction on the present job, the line of promotion, or the next job. Especially does industry fail to give them outlook and opportunity toward the permanent job which in a few years will replace the present and temporary job.
>
> Therefore, the continuation school must provide opportunity in fundamental subjects for review and drill on what is already known, for advanced work on what is yet unknown; and for applying what is studied in school to the experiences of every day. The school must help the child to analyze the present job and the job to come, give vocational counsel and vocational guidance, provide opportunity for prevocational shop experience which eventually will become vocational experience. While making the child more efficient on the present temporary job the school must prepare the child for the probable permanent life job.
>
> Because many of these pupils are irresponsible at fifteen years of age and may be more so at nineteen years, there must be training in the things that make for decent, restrained, respectable citizenship and community relations. And because all, both boys and girls, will soon be voters, there must be training in civics, in knowledge of the structure and functions of democratic government.
>
> Lest the pupils become careless in personal habits and in regard to the safety of themselves and others, there must be training in personal hygiene, community hygiene, and safety-first principles.
>
> Because the gang spirit is strong and is the inevitable characteristic of adolescent youth, it must be made a force for right doing through the influence of assembly gatherings and the development of school spirit. Because normal youth must have recreation and leisure, the school must train and guide in the profitable use of recreation and leisure.

The Need for Coöperation. A school system which can perform all these functions or one-half of them is such a valuable asset to industry and hence to society that its aid should be invoked. As the English Labor Party pointed out, these aims cannot be reached without the closer coöperation of the industries with this type of school. None of the legislation so far passed provides for the active advice of industrial leaders in the community. This is important if the continuation school is to fulfill all its functions as above set forth. On the other hand, it would be a serious error to make this type of school merely a manual-training vestibule to factory employment. It is a social institution as well as an industrial one. It is even more important to industry just now that half the effort of our schools be applied to fundamental training in habit and character formation, to right thinking and right acting about work and citizenship.

Apprentice Schools

The Union Pacific, the New York Central System, the Santa Fe, and the Pennsylvania Railroad organized schools for apprentices of one kind or another beginning in 1874 when the Lake Shore & Michigan Southern Railroad began a school for apprentices at its Elkhart, Indiana, shops, but attendance was not compulsory until 1901. In 1886 evening classes for apprentices were organized at the Jackson, Michigan, shops of the Michigan Central Railroad. Later the class hour was shifted to the close of the work but was not on company time. Still later the instruction was shifted to the morning hours and on company time, which is now the general rule. The Pennsylvania Railroad began its apprentice school in 1911 and has gradually extended the plan until there are now eleven schools east of Pittsburgh. At first the position of labor unions toward industrial education was one of hostility, but this has changed in the main and now the International Typographical Union has its own extensive schools, the first of which was established in 1908.

To the foresight and frugality of Germany is due the completeness of her educational program, which for a half-century has excelled in the applications of chemical and electrochemical research to the promotion of her industries. The beet-sugar industry, the production of synthetic dyes, the by-product coke oven, reforestation, the improvement of river navigation, have been the product of scientific education directed toward the development of new resources and the reduction of costs. More recently she has anticipated the solution of the human problem in industry by a plan of intensive practical education for every youth who leaves school to earn a living. Furthermore, her industries have been copartners with the state in the conduct of the program—an important factor in which she still leads the United States.

The experience and present developments in European industrial education are of interest because they exhibit the trend of educational affairs and the effects of the war. Germany now probably possesses the most complete educational system of any country in Europe. Boys are required to attend the usual courses in elementary school instruction up to the age of 14, but during the last year they are allowed in some cases to work in the trade-school shops during their Saturday half-holiday, provided that their health is good.

The trade apprenticeship course is from three to four years in length, which is somewhat shorter than is usual in Great Britain. The distinctive thing about German trade training is that it is given in company shops rather than in public trade schools. For instance, the Siemens & Halske Company have special school shops where apprentices attend for one year and also return for the last three months of their apprenticeship to make a "test piece." The latter is used as a part of the examination for licensing as a journeyman. At the end of the course the apprentice goes before an examining committee of experts who test his knowledge of the trade and to whom he submits his "test piece." Successful ones secure a journeyman's certificate. The apprentice then goes on and obtains a master's certificate. The apprentice training in the industry must be supervised by one having a

master's certificate. Special short courses of about eight weeks' length are given for those who desire a master's certificate. Those who attend the apprentice school in a recognized plant are exempt from attendance at the government continuation schools.

In France there is no national scheme for training artisans. In Paris and other industrial centers, however, evening and Sunday morning classes afford opportunity for trade instruction and there are certain day schools for the combined practical and trade instruction of young men who intend to become expert workmen or foremen.

In Switzerland there is no national system of apprentice training, but a plan of continuation education embodying trade instruction somewhat similar to that of Germany, is carried on.

In Great Britain apprentice training has probably been a more important factor in supplying skilled mechanics than in the United States. One of the most notable schools for the training of employees who enter as apprentices is that conducted by the British Admiralty for more than 75 years, with marked success. The object is to train men for positions as draftmen and subordinate dockyard officers, to select the most capable for advanced training as designers, and to give an employee the largest opportunity.

In the *Journal* of the Institution of Electrical Engineers of Great Britain, vol. 53, p. 571, there is a discussion of the various types of industrial education in operation in Great Britain. The principal ones are as follows:

- *a* A trade apprenticeship combined with evening or part-time study
- *b* A short period of, say, a year in works, then a college course followed by works apprenticeship for college graduates
- *c* Taking a complete college course and then a works course
- *d* Sandwiching college and works training as in the coöperative plan frequently used in the United States
- *e* Taking a complete works course and then a college course.

Mr. Fleming of the British Westinghouse company, describes their course for ordinary apprentices and says that:

> . . . they are first carefully selected on their educational qualifications and character. After a short probational period to test their practical aptitude they are admitted to the apprentice school.
>
> Instruction is given about five hours per week to all apprentices on company time and the firm also supplies books and stationery.
>
> The apprentice is paid the regular rate during his school hours.
>
> The instruction is of two kinds: general and trade. The first is a continuation of the apprentice's regular education and is important as the standard of education is low for this class of people in England.
>
> The trade instruction is given by members of the engineering staff, including leading foremen and shop engineers. Drawings, lantern slides, and shop demonstrations are used to teach processes.
>
> An interesting feature is an elective committee of apprentices representing the different trades, which coöperates with the school staff.
>
> The most promising apprentices are selected as a result of their school work and are sent for one day per week to the Manchester Municipal School of Technology on company time and expense.

Another works school which has caused considerable comment is at Manchester, England. It is devoted to general education and to trade education. I quote a significant paragraph from the description:

> Before a trade training in England can be effectively given it has been found necessary to lay the foundation of a general education of a deeper and more solid character than can at present be obtained in a primary school.

Is this true in the United States? Are we attempting to make skilled workmen, and losing sight of the importance of general education and intelligent citizenship?

In one British plant, which is believed to be the Vickers Company, the apprentice attends school four hours per week for four years. His general education includes 18 months of mathematics with shop applications, elementary science, that is, fundamental physics, principles of heat, electricity and mechanics. He has also freehand drawing to relate the hand and eye. The general subjects include also civics, industrial history, written and spoken English, the laws of health and first aid.

The trade instruction begins after the above period of 18 months of general education. The students are now divided into two classes—those to follow mechanical engineering lines and those to follow electrical engineering lines. The treatment of the two is quite similar and only one will be described.

Six months are devoted to the development of mechanical principles, after which the groups are divided into some 12 trades and are taught the principles of their trade with demonstrations by expert foremen.

> Boys meet their foreman in the school room and there discuss with him in class matters of trade practice. This is of the most healthy character, and is doing much to remove that natural diffidence which boys normally experience in approaching their foreman upon such matters.
>
> The lecturing staff at the works school is composed of half-time lecturers all of whom are works engineers. Mostly university graduates volunteer their services.
>
> This association of future leaders with future workmen and foremen, superintendents, etc., is *valuable*. These advantages belong only to works schools.
>
> During the last two years a unique development has occurred. The main body of apprentices is self-governing. Each class elects one of its number to represent its interests and these come together once a week and form an apprentice council. The Council has a chairman and secretary. Council organizes social functions and acts as an apprentice tribunal.

In the latter capacity it has already done good service. It has settled minor differences, and arbitrated in such cases with more satisfaction to apprentices than could have been given by any other method.

Apprentice Training in the United States

While the number of apprentices in proportion to the number of skilled workmen may be less today than in the past, the training of apprentices is an important factor in some of our industries—in railway motive power, in the metal trades and to a lesser extent in other fields. There are two classes: first, those who have had a grammar-school or a high-school education, and, second, special apprentices who are graduates of technical colleges.

The practice of one of the electrical companies will illustrate a typical plan for the first class. Apprentice trade training is given to prepare draftsmen, patternmakers, foundrymen, machinists, toolmakers, electricians and junior engineers.

Applicants are first accepted on probation for a period of three months.

> At the completion of each month of the probation period their names are brought to the attention of the Trades Apprentice Committee, at which time their record is reviewed for the purpose of determining their aptitudes and characteristics. At the completion of the third month a definite decision is made by the committee as to whether the young man shall be placed on the course, recommended for a regular position in the organization where they can be under further observation, or released from the company as unsuited for the work.
>
> When the probation period is completed an agreement is entered into between the company and the apprentice and his parents, and outlining what the company expects of the apprentice during his course and what the apprentice may expect from the company. The apprentice is then placed in a special training department in the factory where he receives preliminary instruction in the operation of various machine tools under the direction of especially qualified instructors.
>
> The training department turns out a product the same as other departments in the factory, but it is particularly equipped to take care of young men who have had no previous experience on machine-tool operation. Supplementing the shopwork each apprentice reports to the trades apprentice school four hours per week. Two hours of instruction are given up to blueprint reading, sketching and mechanical drawing, including tool design. The other two hours per week are devoted to economics, science and a study of shop problems, including the application of mathematics to manufacturing operations.
>
> After several months' experience in the apprentice training the young men are placed in the different manufacturing divisions on various kinds of work to thoroughly acquaint them with our products, organization, personnel and policies. As they progress through the course more difficult assignments are given them, both in the shop and in the trade apprentice school.

Students are "upgraded" and promoted and wage scales determined by careful supervision and records of performance, character and habits. The drafting course and junior engineering course are open only to high-school graduates. Advanced technical training is available for all trade apprentices in an evening school supported by the industry and in evening classes at technical institutions in the city.

Special Apprentice Courses

Special apprentice or graduate-student courses for college technical graduates are given by an increasing number of corporations. These courses are designed for the dual purpose of acquainting the student with the processes and product of the company and of finding the line to which each student is best adapted. The method frequently employed is to devote one year to practical experience in design, assembly, and testing with weekly conferences with and

instruction by the engineers and executive staff. After the particular line of work for each to pursue is decided the subsequent training is more intensive in that particular line and leads to design, research, testing, and sales or executive positions.

The motive-power departments of the Pennsylvania and New York Central systems have had courses for college graduates which have led students in the past to enter a few of our technical schools that provided special training preliminary to service in the motive-power departments. This plan was successful until the railway shop unions were able to obtain an agreement with the director of the railroads under government control that college graduates should not be so employed. This was not only short-sighted but unfair to college-trained men and to the railroads.

The general apprentice courses are effective where they are employed in training skilled mechanics and in preparing men of ability to become foremen and minor executives. The special apprentice courses serve as vocational guides and acquaint the student with the product, methods of manufacture and business ideals and practices of the company. There is no doubt of the value of such courses. The objection is raised that they are too long and that college students avoid apprentice courses, some of which are four years in length. This objection could be partly met by a coöperative plan in which the industries accepted undergraduates as apprentices, employing them before graduation for one or two summer periods of three months.

General Instruction for Skilled and Semi-Skilled Employees

This country has developed types of instruction unknown abroad, adapted to the needs of mechanics, electrical workers and a wide variety of other trades unknown in other countries.

Correspondence Courses. The English type of extension lecture course was first introduced here about 1891 and it soon replaced the old lyceum. This variety of extension instruction was not adapted to the needs of the average industrial employee. It was soon supplemented by correspondence courses, and private correspondence schools for instruction in a wide variety of subjects sprang up and flourished. A number of them are still active—one claiming to have a million students enrolled. The public and private correspondence schools have done a great service for those who had the ambition and ability to pursue the work.

The Pennsylvania Plan. Classes are organized in the shops, power plants, and wherever a group of men or women desire to study industrial or engineering subjects. A teacher is selected from the executives, who knows by experience the problems of the machine shop, boiler room or other parts of the industry in which the group is employed. The subject which they desire is prepared in special form adapted to the type of instruction.

The class meets with a teacher once or twice a week in a room equipped and provided by the plant or in the city schools or in the Y. M. C. A. The time is usually at the close of work hours and before the workers go home. An increasing number of companies allow a part or the whole instruction to be given on company time. Some pay the cost of lessons, drawing materials and instruction as a bonus to those completing the course satisfactorily.

Supervised Home Study. A plan devised where the group desiring a subject is too small to warrant the expense of an instructor or where an isolated employee desires an advanced subject, is to provide correspondence lessons as is usual but have an instructor or supervisor in reach of such student, who may be consulted at a stated place and time to answer questions and explain difficulties. The answers are sent to the college teachers for grading.

The Engineering Extension Division of the Pennsylvania State College organizes the three types of instruction, viz., correspondence and extension classes and supervised home study, for over 7000 men and women employed in the industries of Pennsylvania. The subjects cover a wide field which is constantly being extended. Special lesson material has been and is being prepared; or the texts produced by the University of Wisconsin Extension School are used. Courses for college credit in engineering are given by both institutions mentioned under proper restrictions.

Coöperative Courses for Technical Students. It is not the purpose of this outline of the various types of industrial education to discuss college curricula for technical students who expect to enter industrial or engineering occupations. A word concerning the various forms of coöperation between the schools of technology and the industries, however, seems appropriate.

For years the industries have employed college men during the summer vacation, or for a half-year or more before graduation. The coöperation was at first more or less loose and informal, with a growing tendency to require reports from the industries and from the students on the quality of work done, its character, and the comments of the "boss" on the human qualities of each student.

The first systematic attempt was that made by the University of Cincinnati, under Dean Herman Schneider, in 1906. The plan is for the student to spend two weeks in pursuing his studies in course and the following two weeks in a shop somewhat as an apprentice learning a trade. Thus alternate periods are devoted to class and to practical work. Groups alternate so that the same subject is repeated in class and in the industry. The student is paid a wage increasing with his practical experience.

The plan was first applied to students in mechanical engineering and later to civil engineering students and those following business pursuits. It took about five years of eleven months each to complete the course, and it was stated that "present coöperative students who have been at the University of Cincinnati four years are of more value to the industries than the ordinary college graduate who has had a four-year course and two or three years as a special apprentice.

A number of other institutions have adopted a coöperative plan differing only in the length of the period spent in the class room between periods in the shop or in other details. The plan has certain merits now well recognized.

The Massachusetts Institute of Technology has established a course in coöperation with the General Electric Company at its Lynn, Mass., works which was described in detail by Prof. D. C. Jackson and M. W. Alexander at the May, 1921, meeting of the A.S.M.E. in Chicago.

Under this plan the student pursues two years of the regular course at the Institute as heretofore. At the close of the sophomore year, the summer period of 13 weeks is spent by all those accepted as coöperative students at the Lynn Works of the General Electric Company. The succeeding terms of 13 weeks each are spent alternately by one-half the class at the works and at the Institute except that the last term is pursued at the Institute by all students. The coöperative course is five years of eleven months each in length, a month of vacation following each eleven months' term.

Foremanship Training. Probably no educational factor in industry has been so emphasized by the war as the need of special training for the foreman. The character of his job has changed and his importance has increased. He determines certain factors which decide whether production is on an economical or a wasteful basis. He also represents the management or may do so in the new relations with employees. He is no longer employed to "hire and fire," but to organize, assist the accounting department in analyzing costs and reducing them, to coördinate more closely with other departments and to maintain good personal relations with his men as the representative of the management.

Numerous plans of instruction have been prepared to be given in short intensive courses of two weeks, or by correspondence, or by weekly works meetings of the foremen in a plant. Quite frequently, however, it is the management that needs to take the course in order that the importance of the foreman's job may be appreciated and in fact officials are taking new and increased interest in education for workingmen, foremen and for minor officials.

Foreman Teacher Training. Congress passed the Smith-Hughes law designed to give each state a specified amount of federal funds if matched by an equal appropriation of state funds for the purpose of training industrial teachers. This has been interpreted as applying to foremen who may be given "foreman teachers' training." The good foreman has always been a teacher, but recent industrial conditions and the numerous coöperative schemes for training secondary-school, high-school and college students in industry have magnified the foreman's importance as a teacher. Many are inclined to smile at the idea of formal training for the foreman teacher, but the fact is that the act offers opportunities for practical training of foremen in the art of teaching that may have an important effect on the loss of material, human effort and wages in poor work or retarded production.

It is a wise industry which utilizes every honest strategy to prepare it for world competition. If the Manufacturers' Association were to confer with the Federal Board for Vocational Training which administers the Smith-Hughes funds and approves courses, a much more valuable training might be devised.

The Young Men's Christian Association has for years conducted courses in mathematics, drawing, auto mechanics and other subjects of service to those employed in the industries and has aided thousands of young men to get a better knowledge of their daily job. Kindred organizations are doing likewise.

Conclusion

There are numerous demonstrated educational aids to the worker, and whatever helps him will improve industry and society at large. Neither our public-school authorities nor the industries have fully realized the stabilizing value of practical education. The reduction of waste and the increase of efficiency in production are matters of education of which both the employer and the employee have need.

Furthermore, our educational work in the industries has been mainly to help the man in his daily job. We need to look farther ahead and use sound pedagogical methods in presenting to the employee the principles of economics, of simple finance, of factory operation and company policies. Some improvement in our industrial relations is possible by the use of the simplest educational principles heretofore largely ignored.

Education and Training on Railroads

By D. C. BUELL,[1] OMAHA, NEB.

THE education and training of railroad men is a subject which has received considerable attention from railroad executives for many years. The history of pioneer railroad-development work in this country forms one of the romances of the new world. Less than 100 years have elapsed since the first American railroad was projected, and the subsequent development carried with it those possibilities that attract men, both young and old.

In the early days the whole railroad was a school. Home boys importuned the agents of the railroad to be allowed to learn telegraphy and station work. It was a privilege to be allowed to ride on an engine or on a train so as to learn to be a fireman or a brakeman, or to help switch cars in the yard or truck freight in the freight house, or even to work in the track gang or around the engines in the roundhouse. There was always a trained man ready to step into almost any minor job on the railroad and handle the work connected with the job successfully.

While the old apprentice systems obtaining in most shops were in effect in the railroad shops of the country at an early date, nevertheless the first educational work of a general nature inaugurated by the railroads was in connection with associations of engineers, executives, and others brought together for the purpose of adopting standards of equipment, engineering, and operation. Much of the educational work on railroads has been done through the medium of such associations, members of which in many cases had the power to pass officially on standard methods and practices presented for their consideration.

These men were confronted with standardization problems because of differences of gage of the railroads, the necessity for transferring freight and passengers from one road to another, etc. Their deliberations and conclusions have made possible our unified transportation methods of the present day.

New Educational Requirements of the Roads

Up to the last twenty years sufficient new railroad mileage was built each year so that enough new positions were created to make promotion rapid. Today things are entirely different. There has been so little new mileage built in the last few years that opportunities for promotion in railroad service have been far below normal. Men ready for promotion have had to wait years before their opportunity came.

During the last fifteen years political interference, both state and government, in railroad operation tended to remove from the railroad executive his power of initiative and his ability to do big things in a big way. Consequently, in a manner almost unnoticed by himself or his community except in its cumulative effect, his prestige was reduced. During this same period the labor unions placed barriers in the way of their members training men to take up railroad work. Rules and restrictions forced upon the railroads and counter rules and restrictions imposed by the railroads made railroading much less attractive to the youth of the country than formerly. There is a reaction at the present time following the experiment of government control of the railroads, that would indicate the possibility of a partial return to the older conditions of management which made railroading more spectacular and consequently more attractive to youth.

Railroad executives have not been insensible to these changing conditions. Most of the railroad companies in the past twenty years have experimented with the training of apprentices in the shops. Some of the companies have very efficient apprentice systems, among which those of the Sante Fe and New York Central stand out preëminently.

Individual executives fired with enthusiasm have made sporadic efforts at educational work of almost every kind in almost every department in individual organizations, but it was not until about 1905 that a comprehensive plan of educational work for a railroad organization was seriously considered.

Basic Efforts in Educational Work

At that time the late E. H. Harriman called on the executives of the various lines under his control to work out some plan of educational work which would provide opportunity for ambitious employees to increase their knowledge and efficiency and fit themselves for promotion.

On the Southern Pacific Railroad, under the leadership of Mr. Kruttschnitt, a plan of training students in railroad operation was evolved which was in effect for a number of years. Young men selected for this training were given a four years' course of directed practical work to give them experience in the various departments of the railroad and to fit them for supervising positions when their period of training was completed. This plan, like any other new plan, had its faults as well as its good features. The fact that it is no longer followed is due to lack of placement opportunities rather than to a failure of the system per se.

Following the lead of the Southern Pacific, the Union Pacific Railroad Company in 1909 organized a Railway Educational Bureau on much broader lines than the Southern Pacific's plan and with an entirely different objective.

The Union Pacific idea was to offer to every ambitious employee in the service an opportunity to increase his knowledge and efficiency and place himself in line for promotion. In order to make the service equally available to all employees instruction was offered by correspondence.

In building up this Union Pacific educational plan it was necessary to prepare practical lesson texts on almost every phase of railroad work. The problem of preparing such texts for all classes of employees involved the expenditure of several years' time and of a considerable number of thousands of dollars. The response of the employees to this educational opportunity was greater by far than had been anticipated. There were as high as thirty to thirty-five per cent of the employees of the Union Pacific enrolled as students under this plan.

Operation of Railway Educational Bureau

As an example of the operation of this plan, track laborers were given opportunity to study those things which they needed to know to become successful section foremen. Not only actual problems of track work but other subjects such as a working knowledge of the time table and the book of rules, a non-technical knowledge

---

[1] Director, Railway Educational Bureau, Omaha, Neb. Mem.Am.Soc.M.E.

concerning the operation of signals, instruction concerning emergency repairs to the telegraph line, instruction concerning the operation of track motor cars, instruction about such uses of concrete as might be a part of a section man's routine of duties, a thorough drill in section foreman's accounting for labor and material, etc., were offered them for study. In other words, the Bureau furnished to employees practical information about their duties and the duties of the positions ahead of them that would assist them to become more efficient and place themselves in line for promotion.

Other railroads interested in this educational work undertook the problem of working out similar service for their employees. A start was made on the Chicago & Great Western and on the Pennsylvania to establish similar educational work, but the time required to prepare the texts and the considerable cost involved in inaugurating the plan seemed to prevent other companies from going very far with the idea.

The Union Pacific educational work was extended to other Harriman lines, including the Illinois Central and the Central of Georgia. Plans were then made for extending this educational service to all of the Harriman lines, but the demand for this kind of work all over the country was such that Harriman line officials in conference decided to turn over the work to the author, who had originated and directed the plan, and thus made this educational service general in its nature and available for any and all railroads interested.

Since 1913, the Railway Educational Bureau with its office at Omaha, Neb., has functioned as a semi-commercial institution coöperating with any railroad management interested in offering educational opportunities to its employees. At the present time this Bureau is coöperating with nearly 100 railroad companies, representing well over one-third of the railroad mileage of the United States. Interested employees pay a nominal fee for the service, the railroad companies making the collections for the Bureau in the same manner they do for insurance companies, watch companies, board, etc.

While this Bureau has provided the railroads with a comprehensive educational plan available for their employees, changing conditions require that much more than this be done.

Even Broader Solution Must be Sought

Old methods of apprenticeship no longer function. There must be new methods inaugurated for training new employees before inducting them into the service, for the training of foreigners and those with educations too limited to allow them to study by correspondence. Then, too, there is needed special training for employees selected for promotion to minor supervising positions before they actually take up their work of supervision.

A number of prominent railroad executives are giving careful thought to methods by which the educational necessities outlined in the preceding paragraph may be accomplished in a practical manner.

There is also needed, some method of keeping railroad employees informed of current problems, changes in standards, new methods and practices.

The Railway Educational Bureau at the present time is coöperating with the Society for Visual Education in Chicago, in the working out of a plan for a library of railway moving-picture films which will be available for all of the railroads in the country on a distribution system similar to that in effect through film exchanges to the motion picture theaters. This plan presupposes the purchase by individual railroads of projection machines which will be located at division points, general offices, etc., so that weekly programs of educational pictures can be furnished for employees and their families.

It is realized by railroad executives that the whole subject of railway educational work ties up with two other very important problems, one the employment of men and the other, directed personnel work following employment.

It is the belief of some of those who have made a study of this subject that the trend of thought in the railroad world will lead to the adoption of a centralized office to which railroad executives can go for aid in educational and personnel problems. One of the functions of this centralized office would be to prepare educational matter suitable to, and available for, the use of the railroads. This centralized office should handle the railway library of moving-picture films, and should also coöperate with individual roads in working out individual educational problems in connection with the training of new employees, apprentice training, intensive training for men selected for minor supervising positions, etc.

DISCUSSION ON EDUCATION AND TRAINING

Dr. Ira N. Hollis,[1] Past-President A.S.M.E., emphasized that the need is to train men not only for high efficiency in the industries, but also for greater satisfaction with their work. The inevitable consequence of the latter would be that their spare hours would be usefully occupied in those things that tend to the greatness of our country. He hoped that the A.S.M.E. as it gains in opportunities and progresses in influence, might have the foresight to take a hand in this most important question before the industrial world today.

Dean A. A. Potter[2] thought that in industrial education, too little attention had been paid to the talents of the learner.

Prof. A. L. Williston[3] while agreeing with the authors of the papers that progress has been made in industrial education, contrasted what has been done with the need that exists in all the different lines of industry today. He criticised the industries themselves for making almost no effort to supply this need.

He hoped that the Society would go into this matter with a considerable degree of seriousness, and that it would have vision enough to see that back of this is a contribution comparably greater than any other it can make to the profession and to the country.

To J. A. Randall[4] it seemed that since industry wants individuals trained more definitely for the job, it is necessary to have more definite conceptions of the duties to be performed in the industries.

In addition, employees should be trained in company policy, in attitude toward the company, the community, and society.

The problem of industrial training is so large that no single industrialist or group can solve it, and he suggested that the Society join with other organizations in improving courses, which so far have given the means of getting a living without conveying the power to live a life.

Edward Robinson[5] gave a few vital statistics showing just what fraction of the population the problem in hand applied to, and he, in turn, considered the committee was on the right track and hoped the Society would support further work.

L. W. Wallace[6] thought that much could be done through the Federal Board of Vocational Training if the engineer-citizens of the country would take a greater interest in its work. He said that an engineer could, with advantage, be appointed on the Board.

C. B. Connelly[7] emphasized Mr. Wallace's statement. This Society stands for education, if it stands for nothing else, and it is the duty of the Society to take up this important work. We have an engineer in the cabinet—the first since the time of George Washington, and the engineering point of view is being incorporated into government matters. Now, therefore, is the greatest opportunity for success.

A. B. Clemens[8] contributed a written discussion of both papers. His discussion of Dean Sackett's paper detailed the work of the correspondence schools under contract or agreement with industrial concerns for the instruction of employees, and his discussion of Mr. Buell's paper supplemented this information with a review of the work of the correspondence schools with the railroads.

---

[1] Pres., Worcester Polytechnic Institute, Worcester, Mass. Mem.Am.Soc.M.E.

[2] Dean, Purdue University, Lafayette, Ind. Mem.Am.Soc.M.E.

[3] Principal, Wentworth Inst., Boston, Mass. Mem.Am.Soc.M.E.

[4] Secretary Advisory Board, War Plans Div., Genl. Staff, War Dept., Washington, D. C. Mem.Am.Soc.M.E.

[5] Professor Mechanical Engineering, University of Vermont, Burlington, Vt Mem.Am.Soc.M.E.

[6] Executive Secretary, American Engineering Council, F.A.E.S., Washington, D. C. Mem.Am.Soc.M.E.

[7] Commissioner of the Dept. of Labor and Industry, Commonwealth of Pennsylvania, Harrisburg, Pa. Mem.Am.Soc.M.E.

[8] Principal, School of Mechanical Engineering, International Correspondence Schools, Scranton, Pa. Mem.Am.Soc.M.E.

Avoidable Waste in Car and Locomotive Operation

By WILLIAM ELMER,[1] ALTOONA, PA.

The average freight locomotive travels less than 60 miles per day. It spends about half of its time either in the hands of the transportation department moving trains or ready to move them, or in the hands of the motive-power department being repaired and prepared. There is naturally avoidable waste in each department, and questions which may accordingly be asked relate to whether the engines are properly loaded and properly used. The present paper outlines the procedure for determining this, and one of its several appendices gives a method of working out the most economical tonnage for loading the freight engines of any division, based on actual practicable performance in everyday operation. The treatment considers the value of the locomotive, taking account of interest, depreciation and taxes; the relationship between straight-time and overtime rates for road crews; the quickening up of the time of the trains by a reduction of tonnage and the increase of the time the crews are on duty by an increase in tonnage. When these matters have been sufficiently studied in the light of the recorded facts, the question relating to proper loading can be intelligently answered.

The author discusses avoidable waste in the operation of cars under three heads: (a) Their utilization in the hands of agents, shippers and consignees; (b) their handling and dispatchment in yards and on the road; and (c) their repair and inspection.

Things contributing most to the reduction of waste in car and locomotive operation are coöperation and teamwork. If a division superintendent can be assured that everything is being done that can be done to have every available engine in service that can be put in service and that every engine dispatched is being loaded to the maximum number of cars it can economically haul, then he is assured of an economical performance and an avoidance of waste in the operation of both locomotives and cars.

LOCOMOTIVES, the first of the two divisions set forth in the title, are classified into major groups as freight, passenger, shifting and work locomotives. There are 65,000 locomotives on the railroads of the United States and half of them are in freight-train service. Thirty-two thousand and eighty locomotives earned a freight revenue of \$4,325,078,866 in 1920, or an average of \$135,000 per locomotive per year. Each engine made an average of 59.3 miles per day or 1800 miles per month. The average freight engine earned for its owners \$370 per day or \$6.25 per mile run. This is at the rate of \$15.40 per hour or about 26 cents per minute. The striking thing in the group of facts above presented is the figure of 59.3 miles per day made by the average freight locomotive. How can we excuse an average mileage for all the freight locomotives in this country of less than 60 miles per day? We can picture the average freight locomotive rolling along the rails at 15 miles per hour and that means less than four hours out of each twenty-four actually moving trains. The locomotive spends its entire time either in the hands of the Transportation Department moving trains or ready to move trains, or in the hands of the Motive Power Department being repaired and prepared. Roughly we may say that the engine is in the hands of each of these departments about half the time. Of course there is avoidable waste in each.

Taking up first the Transportation Department, there are two broad inquiries which may be made: (*a*) Are the engines properly loaded? (*b*) Are they properly used? Assuming that suitable engines have been furnished the Transportation Department, or taking the engines on any division as we find them, how are we to know when they are properly loaded? If a dynamometer car is available, road tests may be run to determine the drawbar pull of the engines and to measure the resistance of trains of various make-ups on the ruling grades at the desired speeds. In the absence of this facility it may be desirable to outline the procedure.

A—Are the Engines Properly Loaded?

A track chart of the road is necessary, giving the distances from the starting point to the beginning and ending of each curve and tangent, with the degree of curve, and elevations of points where the grade changes. With these data a true profile may be plotted, showing the elevations above sea level and the actual grades; but this profile will not be fully representative of the resistances encountered by moving trains until it has been transformed into an equivalent compensated profile by superimposing the curve resistances on top of the grade resistances for each direction of traffic. We can imagine a level railroad so full of sharp curves that a very considerable resistance would be experienced by a moving train. Many experiments have been tried in an effort to find how much resistance various curves offer to a moving car, and we will take 1 lb. per ton of 2000 lb. per degree of curve. The resistance due to grade is fortunately an exact mathematical quantity—20 lb. per ton for each 1 per cent of grade. Therefore each degree of curve offers the same resistance as a 0.05 per cent grade. A 6-deg. curve had the same resistance as a 0.3 per cent ascending grade. A grade which is climbing upward at the rate of 26.4 ft. per mile or 0.5 per cent and has in it a 6-deg. curve, or 955-ft. radius, will therefore have superimposed on the true grade of 0.5 per cent the equivalent resistance of a 0.3 per cent grade due to the 6-deg. curve, or a total equivalent grade of 0.8 per cent. Of course, to a train coming down this hill the equivalent grade would be the difference between these values, or 0.2 per cent.

Having determined the equivalent grade, it will be necessary to decide whether it can be operated as a momentum grade or not. If the length of the grade or other physical conditions on the approach prevent attaining any considerable speed, the dead pull of the locomotive will have to be depended on to get the train over. The tractive power of a locomotive is readily calculated from a very simple formula where p is the boiler pressure in pounds per square inch by gage, d the diameter of cylinders, l the length of stroke and D the diameter of the driving wheels, all in inches. For a simple two-cylinder engine, tractive power = $0.85pd^2l/D$. When a locomotive is moving, some of its tractive-power effort is used to overcome friction of the engine and tender, and on a grade some more is needed to lift its weight against gravity, and at speeds of more than six or eight miles per hour the boiler becomes a factor in its inability to furnish enough steam to follow the pistons with full pressure under long cut-off conditions, so that some more complicated formula becomes necessary in the calculation of the tractive power required for moving trains. Besides the resistances due to curves and grades, trains are affected by journal and flange friction, wind, rolling resistance, temperature, etc.

It is a well-known fact that trains cannot be loaded on tonnage alone. One hundred empty cars weighing 20 tons each would be a 2000-ton train, and might overload an engine to the stalling point, whereas the same engine on the same grade would handle twenty-five 80-ton cars with no trouble. The number of axles is the important factor, and in order that a long empty train may have the same resistance as a short loaded train, it is necessary to use a factor for each car known as the adjustment factor, and this factor will vary with the different physical conditions met with on different divisions.

Having discovered the adjustment factor for any given division, and knowing the principal types of freight engines in use on that division, it is well to construct tractive power-speed curves for the various engines, and plot on the same sheet adjusted-tonnage train-resistance curves on various level and compensated-grade tracks, so that the intersection of the tractive power curve with any given grade will show the speed that could be maintained with a full-tonnage train on that grade.

After having completed the above described investigations and having before us the equivalent profiles and the speed curves on various grades, we can lay out a schedule of the running time between the various towers, adding the necessary time to cover the initial and final terminal delay, water stops, coal and fire-cleaning stations, interference from passenger trains, etc., and bearing in mind the overtime limit based on a speed of $12^1/_2$ miles per hour for the distance between terminals and the time the crew is on duty.

---

[1] Superintendent, Middle Division, Pennsylvania Lines, Altoona, Pa. Mem.Am.Soc.M.E.

Presented at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. Abridged. All papers are subject to revision.

Now comes the crux of the whole matter. After the tonnage has been established, what are the results on the road? Do the trains lose so much time sponging or setting off cars with hot boxes, or draw heads out or brake rigging down, or due to interference from other trains that they cannot get over the road without excessive overtime? If the dispatching and terminal and road supervision are all that they should be and a record has been made for a sufficient period from which may be drawn reliable conclusions, we can determine whether the overtime is excessive—in which event the tonnage should be decreased—or if the majority of the trains get over the road within the overtime limit, then the tonnage should be increased. Appendix No. 1 contains the description of a graphical report showing each morning the performance of each of the previous day's trains, both slow and fast freight, plotting the time on duty from called to relieved against the percentage of the full tonnage loading of the engine utilized. This gives the train master, road foreman of engines and superintendent a review of the preceding day's operations, and any falling away from the standards set up on the part of the subordinate officials whose duty it is properly to load the trains is quickly brought to light. In Appendix No. 2 is given the method of working out the most economical tonnage for loading the freight engines of any division, based on actual practicable performance in everyday operation. The treatment considers the value of the locomotive, taking account of interest, depreciation and taxes; the relationship between straight time and overtime rates for road crews; the quickening up of the time of the trains by a reduction of tonnage and the increase of the time the crews are on duty by an increase in tonnage. When these matters have been sufficiently studied in the light of the recorded facts, we are in a position to answer the question, Are the engines properly loaded?

B—Are the Engines Properly Used?

So far as the Motive Power Department is concerned, it is important to have reliable reports which present promptly to the responsible operating officers, on the succeeding day if possible, all the pertinent facts concerning the performance of the locomotives available. These reports should cover not only the utilization made of the serviceable locomotives but also of all those laid off for repairs, both in the roundhouses and the back shops. The more promptly the work is done the more engines will be available for service and the smaller will be the number required to be purchased and to bear interest and depreciation charges. To this end the facilities at the engine terminals should be ample to inspect promptly the incoming locomotives and send the reports to the dispatcher, who can at once call a crew in case the engine has only light work which can be completed by the time the crew reports. The fire-cleaning pits and facilities for handling ashes, coal, sand and water should be in duplicate at important points, and at one well-known freight-engine terminal it is possible to clean the fires and prepare for service 400 locomotives per day. Hot-water systems for washing and filling boilers save time, and drop tables or unwheeling hoists should be provided for handling driving wheels, spring rigging and driving-box repairs. Ample jib or overhead cranes should be installed in all important enginehouses, as the rods, pumps, pistons, smokebox fronts, etc., of modern locomotives are now so heavy that mechanical appliances must be used to reduce the cost of handling and save time in running repairs. The enginehouse referred to above at times furnishes the power for ten eastbound trains in two hours and at the same time ten to fifteen engines an hour for westbound trains. An operation of this magnitude requires close supervision in order that waste of power and loss in efficiency may be avoided.

CARS

The avoidable waste in the operation of cars may be considered under three heads:

a The utilization of cars in the hands of agents, shippers and consignees

b The handling and dispatchment of cars in yards and on the road

c The inspection and repair of cars by the maintenance of equipment department.

A—The Utilization of Cars in the Hands of Agents, Shippers and Consignees

The committee of engineers appointed by Secretary Hoover some months ago to investigate waste in industry made a most amazings report. They undoubtedly gave this question careful study and the report that they made brought out the fact that the production of this country could be immediately increased about 50 per cent by the full utilization of existing facilities. The managements of the industries of this country are acknowledged to be the most efficient known and the railroad managements are no exception, therefore it is the more surprising to find such disparity between the present efficiency and the attainable.

So far as the railroads are concerned, one great means that suggests itself is the increased use of cars in the hands of agents and shippers, which necessarily involves the promptness with which they are loaded and unloaded and the extent to which they are loaded, i.e., that the maximum loading be secured for the car in the minimum time, etc.

Maximum car loading is a matter of dire necessity during periods of car shortage. If is also very essential to the economic conduct of transportation. During recent months the necessity for conserving cars has been decreased by the small volume of tonnage handled by the railroads; the requirement of economy is more urgent than at any time within the past eighteen months. This is all a matter of education and a spirit of coöperation on the part of the public. When the railroads had more business than they could handle the local officers were being urged to get out and interview the shippers, the underlying idea being to secure their coöperation, especially in the matter of better and heavier carloads. Distinct improvements were noticeable and the effort proved its worth. With the slump in traffic the "drive" lost its punch and there is a tendency on the part of the shippers and railroad men alike to let down in their efforts to secure maximum loading. This "line of least resistance" method is resulting in considerable less-than-capacity loading.

It is a fact, not generally recognized, that car loading affects the cost of railroad operation very seriously, not only because the paying load may be a small percentage of the gross train load, but also because lightly loaded cars require more tractive effort per ton than heavily loaded cars; e.g., the average weight of a car is from 15 to 20 tons while the average weight of all commodities is averaging approximately 27 tons. The load of the car itself must be hauled with every movement of the contents and requires as much tractive effort on the part of the locomotive per ton to move this weight as it does for the contents, therefore the importance of keeping the percentage of lading to total weight as high as possible is self-evident. This question has assumed a very different aspect to the shipper since the passage of the Transportation Act, which stipulates that the rates must be sufficient to earn a fixed return on the value of the properties. Any waste due to the light loading of cars adds to the operating cost and thereby to the rates necessary to earn the specified return. The shipper therefore has a new interest in effecting economies of transportation and can contribute to that end most effectively by coöperating in the heavier loading of cars.

During the period February to August, 1920, the average loading of cars in the United States increased from 28.3 tons to 29.8 tons per car. As a result of this coöperation on the part of shippers there was a gain of carrying capacity equal to approximately 112,500 cars. From time to time we have noticed by the public press that there is a shortage of 100,000 cars in the United States, and as such is considered a serious matter to the trade of the entire country, it is very apparent that the simple feature of increasing the load in each car 1.5 tons more than liquidated the alleged shortage.

General practice permits the loading of cars 10 per cent in excess of the marked capacity. There are great possibilities in the utilization of this margin, for with many classes of loading great advantage may be taken of it to gain one car in every ten and to increase the average carload correspondingly.

There are many commodities moving which will permit of the making of trade units to correspond to the capacity of the car; this has been done with cement and other like commodities. The trade unit for cement shipments was set at 144 bbl. for a 50,000-lb.

capacity car; 173 bbl. for a 60,000-lb. capacity car; 231 bbl. for an 80,000-lb. capacity car and 289 bbl. for a 100,000-lb. capacity car. The establishment of this standard encourages the loading of cars to capacity. If this were done with flour and all similar commodities great assistance might thus be rendered to the railroads.

The agent through close association with shippers is in the best position to encourage maximum loading. It is often decidedly hard to convince shippers that they are not loading their cars to cubical capacity. This is particularly true of the coal operators. The best means of producing convincing evidence of the empty space in a car is to show the shipper a photograph of the car which will speak for itself, and we have found a kodak to be a most helpful instrument in increasing the tons per car. The cars may easily be intercepted and photographed at scales or in classification yards.

The prompt release of cars under load is a large factor in the efficiency of the car. Most shippers and consignees are reasonable in this respect and will give us their best efforts if the matter is handled with them in a diplomatic way. After urging the shippers and consignees, the railroad then has a very important part to play by the prompt movement of cars, whether loaded or empty; it being purely psychological that after urging the shipper or consignee and then failing on our own part would necessarily breed antagonism.

B—The Handling and Dispatchment of Cars in Yards and on the Road

After cars have been loaded and waybills furnished by the agent to transport freight from point of origin to destination, it becomes the duty of the train master to arrange for movement and delivery with the least possible delay consistent with economical operation. This necessarily involves good organization and effective supervision to accomplish proper movement through yards and over the road. Normally cars are weighed at the first track scale encountered after departure from shipping point, for the purpose of ascertaining proper charges for transporting freight which involves the agent at the scales, who is responsible for securing accurate weights as a basis for applying the freight charges. As a rule, the weighing is performed in a yard consisting of receiving and classification tracks. Trains arriving in the receiving yard are subjected to inspection and minor repairs to insure safe movement over the road between terminals, sending to the repair yard any bad-order cars that must be "shopped" for this purpose. After inspection and repairs have been completed, the train is prepared for switching from receiving yard to classification yard, which process requires car markers to chalk-mark cars for their respective classification tracks, according to destination and routing, also furnishing corresponding switching lists for the conductor in charge of switching crew, and switchmen who operate switches leading into the classification yard. Yard locomotives and a force of trainmen are required to switch trains into the classification yard at proper speed for accurate weighing at points where cars pass over a track scale; also requiring brakemen, commonly designated as "car droppers," to ride cars into the classification yard and control them by use of hand brakes to bring them to a stop at the proper point and to avoid damage by impact with preceding cars standing on track.

The train from receiving yard has now been distributed on various tracks in the classification yard, usually from ten to thirty tracks, depending on the size and importance of the yard operation. The original train having thus lost its identity, following trains, classified in like manner to the same tracks, are required to assemble cars that will comprise new trains to be dispatched when the required tonnage is accumulated. A variety of conditions arise at this stage of the operation that seriously influence the time consumed by cars enroute to their destination, which may necessarily be repeated from one to many times between the originating point and destination of cars, depending on the distance and the territory over which they are moving. The time required to assemble sufficient tonnage for a train in the classification yard is very largely dependent on the steady or intermittent arrival of trains in the receiving yard; also on the hauling capacity of road locomotives used on trains dispatched in the same direction, which may be 35 or 50 cars from one yard and 100 to 115 cars from another yard for the same class of locomotive, depending on the ruling grade of the division over which trains are being hauled.

In this connection another primary cause of delay in assembling trains in the classification yard is to be found in the usual number of classifications imposed upon certain yards for the convenience of connecting divisions to meet their requirements for various reasons, but primarily due to inadequate track and switching facilities. So-called "prior classifications" are also a source of yard delay at the point where they are assembled, but the time thus consumed is presumably offset by saving in time at the next yard or terminal point where such trains are kept intact and delivered to the division in advance thereof without reclassifying, which means an actual saving in the aggregate time consumed from shipping point to destination, also in operating expenses. Therefore a considerable portion of yard delay is beyond control, owing to prevailing conditions that cannot be eliminated. However, there is ample opportunity for minimizing yard and road delays to train movement by employing the best operating methods, maintaining sound organization and efficient supervision.

Time consumed assembling tonnage for heavy trains to be hauled by large types of locomotives over comparatively level grades may be viewed by some as a contributory cause of "avoidable waste in cars," but it should be recognized that doing so reduces the number of engine and train crews and locomotives required to haul a large volume of freight, which means economical operation.

C—The Inspection and Repair of Cars by the Maintenance-of-Equipment Department

When trains are hauled over the road certain defects develop, and by the time they reach the terminal of a run a certain portion of the cars, say 3 to 5 per cent, must go to shop for repairs. The cars from the time last inspected until they go to the industries or mines to be loaded and return, develop many defects due to stress and strain of service, and consequently they have to be shopped when reaching the nearest terminal.

There are three distinct classifications for shop cars: light, medium and heavy. When an inspector discovers a defect which he cannot correct, he applies a bad-order card, and places it in a conspicuous location on the car. These cards are placed in one of three positions: vertical, horizontal or at an angle of 45 deg. A card placed in a vertical position indicates light repairs; horizontal, heavy repairs; and at a 45-deg. angle, medium repairs.

After the train is inspected a car marker goes along the train and marks each car with chalk and the date and track number to which each particular car is to be classified.

As already stated, the classification yard consists of a number of tracks for the various classifications; a certain number of these tracks are set aside for shop cars, some tracks for light-repair cars, some for medium, and some for heavy repairs. The shop cars are moved from the classification yard to the car-repair yard by shifting engines, usually at night, and the repair tracks filled up so that when the gang foremen arrive at their places of duty approximately one-half hour in advance of the commencing time for the shop forces, they can prepare their work for the day. It is their duty to see that the work is properly distributed and there is sufficient material on hand to proceed with the repairs.

After they have all the cars written up they start inspecting the work done by the men to determine if it has been properly performed, and that proper charges for material have been made. After this is completed they report out such cars as are ready to go and mark those uncompleted to be set back. The shifting crew then takes out the entire string, returning those not completed. It is the gang foreman's duty to see that any cars not completed are in such shape that they can be moved out with the O. K. cars, as otherwise there would be non-movable cars between two or three cars O. K. for service and this would hold the cars ready for movement an unreasonable length of time.

After the cars are turned out of the repair shop they are returned to the receiving yard and reclassified over the hump to be returned to service.

In order to keep a check on cars undergoing repairs, a report is prepared and sent to the different operating officials. The report

indicates the time the car is shopped, the time it is moved to the shop, the time repairs are completed and the time car is moved out of shop. By checking over this report each morning the master mechanic, superintendent or general officers can determine in a few seconds if there are any cars that are being held an unreasonable length of time.

It is the aim of the operating officials not only to see that all cars are repaired, but to have the cars repaired promptly and returned to service in the most expeditious manner.

Conclusion

The great secret of the entire operation, therefore, lies in coöperation and teamwork, and these can be checked by suitable reports.

The statistics which reach the superintendent's desk giving hourly, daily, weekly and monthly information are many and varied, and originate from numerous sources, but the reports scanned by the author with most interest each day are those which tell where each of the heavy road freight and passenger engines were the day before and what they were doing. There is a maxim, "Take care of the shillings and the pounds will take care of themselves." It seems to apply particularly to the railroads. Take care of the engines and the dividends will take care of themselves. Of course this could not be literally true, but there is so much involved in this "taking care of the engines," embracing as it does the time and inferentially the money spent on locomotive repairs, the quality of back-shop and engine house work performed, the proper tonnage rating, and suitable loading of engines in order to obtain the most economical road speed, the reduction of delays getting into and out of yards, the inspection and repair of car equipment, the efficiency of water stations, coal-, sand- and ash-handling plants, the organization and operation of wreck forces, the handling of local freight and work trains, in fact, almost each and every one of the thousand and one matters that go to make up a successful operation of a division. If any one of the features named above is not functioning properly, as well as others too numerous to mention, the effect will be seen in the slowing down of the road speed or a lowering of the average mileage per serviceable locomotive or a falling off in the loading efficiency. All these must be at their highest possible levels of practical performance, and when they are, a glance of the eye at the daily barometer ought to tell it, and when they are not, a few minutes' inspection of the data ought to tell why and point the remedy. The supervisors must have tracks fit for speed and service; the signal engineer must have communicating systems and signal apparatus in good working order; the road foreman must have engines properly rated and sufficient crews and supervision; the train master must have his yard and road forces properly instructed and disciplined; the division operator must have his train dispatchers and signalmen alert and intelligent; and the master mechanic must produce the power in ample quantity and fit for service. If the division superintendent can be assured that everything is being done that can be done to have every available engine in service that can be put in service, and that every engine dispatched is being loaded to the maximum number of cars it can economically haul, then he is assured of an economical performance and an avoidance of waste in the operation both of locomotives and cars.

APPENDIX NO. 1

Daily Slow Freight-Train Performance Record

The record shown in Fig. 1 is prepared each morning from the train sheets and tonnage records of the previous day. Each dot or circle represents a train, its position vertically indicating on the scale at the left the percentage of the full capacity of the engine utilized, and its position across the sheet, read from the scale of hours at the bottom, shows the time the train crew was on duty. The red dots (shown in Fig. 1 as small circles) represent eastbound trains and the black dots westbound trains. The extreme left-hand dot shows a westbound train which was 99 per cent of the full adjusted-tonnage rating of the engine, and it made the run over the division in 8 hours 12 minutes from the time the crew were called to report for duty until they were relieved from duty at the opposite terminal. It includes initial and final terminal delay and this particular train made an excellent run, well within the overtime limit. The red dot (small circle) slightly above and to the right represents a 100 per cent eastbound train, 8 hours and 18 minutes from called to relieved. The dot to the extreme right shows a westbound 101 per cent train, 14 hours. It is seen at a glance that the lowest loading for that day was 94 per cent and the highest 105 per cent. The spread of the time was from 8 hours and 12 minutes to 14 hours. Fourteen runs were made within the overtime limit (of ten hours and a quarter), and no crews were relieved on account of the 16-hour law. The average of all the red dots (small circles) is shown by the red cross at A and its position shows that the average of all the eastbound trains that day were loaded to 100 per cent and the average time was 10½ hours. The black cross at B shows that the average loading of westbound trains was also 100 per cent and the time just under 11½ hours.

The black characters near the left-hand margin indicate the class of engine hauling the westbound trains, the number of cars being shown on the scale at the right, and the time from called to passing out of the yard being read on the scale of hours at the bottom. From this it can be seen that there were three trains of 100 cars each, 1 hour and 24 minutes, 1 hour and 30 minutes and 1 hour and 42 minutes getting out of the yard. There were nine trains of 115 cars each, varying from 1 hour and 12 minutes to 2 hours and 48 minutes initial terminal time. Other trains are as indicated, the total number completing their runs that day being 20. Similar information is shown for the eastbound trains by the red (dotted-line) characters near the right-hand margin, the final terminal delay being recorded from right to left and read on the scale just above; the number of cars per train varying from 90 to 105, and the time from 36 minutes to 2 hours and 6 minutes. The same sheet is also used to record fast freight trains, but these have been omitted to avoid complication. An explanation can be given on the back of any unusual conditions, undue length of time on the road, reason for relieving crews, etc. A code of symbol letters reduces the need of elaborate descriptions.

After keeping these daily sheets for several months, the location of all the red crosses may be recorded on a sheet of tracing cloth, or a composite of all the red dots (small circles) may be made on one tracing, and through the center of gravity of all the dots a curve may be drawn, and this will show for any point on the curve the average time for the trains corresponding to that tonnage loading. A similar composite of the black dots[1] will show the westbound trains. These curves are shown in Fig. 2 and are the basis of the calculations of the most economical train loading described in Appendix No. 2. Even if most of the dots and circles are concentrated along the lines of full tonnage, there will usually come days when engines are being loaded light to get them to the other end of the division to meet a heavy movement, and there are occasional mistakes of yard clerks which result in underloaded or overloaded trains which are not checked up until the conductor's wheel report is recorded at the end of the run.

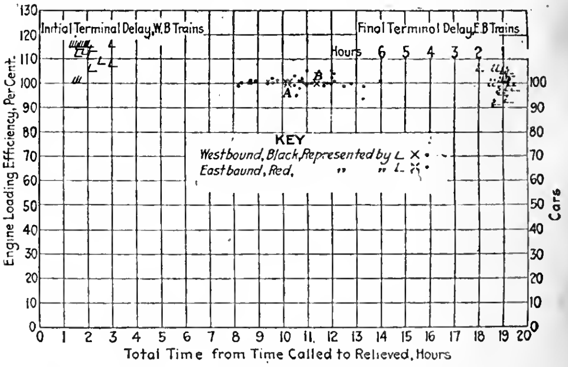


Fig. 1 Daily Slow Freight-Train Performance Record

APPENDIX NO. 2

The Most Economical Train Loading

The curves described in Appendix No. 1 having been prepared, the data shown in Table 1 may be calculated. Column 1 gives the percentage of engine loading, from 120 per cent down to 80 per cent. The average flat tons in the eastbound and westbound trains having been recorded each day on the sheets shown in Fig. 1 and the percentage of the engine loading being also available for each day, a summary may be run up at the end of the month and a comparison drawn as to the number of flat tons per train which would correspond to a 100 per cent tonnage train. A few months of this information will settle the proper figure and this has been shown for the westbound trains at the head of column 2. This amount multiplied by the percentages in column 1 gives the tons per train in column 2. From the load-time curves in Fig. 2 may be read the average time for a westbound train loaded to 120 per cent of the engine rating, etc., and these times recorded in column 3. The summary mentioned above will also show, by extension, the total gross tons moved each day, and the average of this figure is at the top of column 4. The number of trains which it would be

---

[1] It is suggested that black ink be used in making the composite of the red dots and red ink for the black dots. It is much easier to see the opposite color through the thickly clustering dots of the composite, and those below the tracing cloth will not be so readily missed.

TABLE 1 MOST ECONOMICAL TRAIN LOADING

(1) Per cent engine loading W.B.	(2) Tons per train W.B. 2400 × (1)[1]	(3) Time called to relieved, hours W.B., Curve	(4) No. of trains W.B. 48,000 ÷ (2)	(5) Tons per train, E.B. 140,000 ÷ (4)	(6) Per cent engine loading E.B. (5) ÷ 7000	(7) Time called to relieved, hours, E.B., Curve	(8) Time crews on duty 1 R.T., hours (3) + (7)	(9) Total time of engine 1 R.T., hours (8) + 24	(10) Engine hours, total (9) × (4)	(11) No. of engines required (10) ÷ 24	(12) Overtime hr. per train R.T. (8) − 20.5	(13) Punitive overtime, hr. per train R.T. (12) × 1½	(14) Total punitive overtime, hr. per day (13) × (4)	(15) Overtime, total cost per day (14) × 3.975	(16) Straight time, hours per day (4) × 20½	(17) Straight time cost per day (16) × 3.975	(18) Total wages cost per day (15) + (17)	(19) Value of engines at 60 cts. per hour (10) × 0.60	(20) Total engine and wage cost per day (18) + (19)	(21) Per cent engine loading W.B.
120	2880	14.18	16.667	8400	120	12.93	27.11	51.11	851.85	35.49	6.61	9.92	165.34	657.23	341.67	1358.14	2015.36	511.11	2526.47	120
115	2760	13.00	17.391	8050	115	12.11	25.11	49.11	854.07	35.59	4.61	6.92	120.35	478.39	356.56	1417.17	1895.56	512.44	2408.00	115
110	2640	12.13	18.182	7700	110	11.40	23.53	47.53	864.19	36.01	3.03	4.55	82.73	328.85	372.73	1481.60	1810.45	518.51	2328.96	110
105	2520	11.41	19.048	7350	105	10.78	22.19	46.19	879.83	36.66	1.69	2.54	48.38	192.31	390.48	1552.16	1744.47	527.90	2272.37	105
100	2400	10.77	20	7000	100	10.21	20.98	44.98	899.60	37.48	0.48	0.72	14.40	57.21	410.00	1629.75	1686.99	539.76	2226.75	100
95	2280	10.19	21.053	6650	95	9.67	19.86	43.86	923.38	38.47	..	..	....	....	431.59	1715.71	1715.71	554.03	2269.74	95
90	2160	9.67	22.222	6300	90	9.16	18.83	42.83	951.77	39.66	..	..	....	....	455.55	1810.81	1810.81	571.06	2381.87	90
85	2040	9.18	23.529	5950	85	8.70	17.98	41.98	987.75	41.16	..	..	....	....	486.34	1917.31	1917.31	592.65	2509.96	85
80	1920	8.70	25.	5600	80	8.26	16.96	40.96	1024.00	42.67	..	..	....	....	512.50	2037.19	2037.19	614.40	2651.59	80

[1] 2400 × (1) = 2400 multiplied by value in Column 1.

necessary to run to move the average day's business may be found by dividing this number of tons by the proposed tons per train in column 2 and the result recorded in column 4. The same process is followed to obtain the figure at the top of column 5 as explained for column 4 and as there will usually be the same number of eastbound as westbound trains in order to avoid running power and crews light, the tonnage per eastbound train will be found by dividing the total tons to be moved per day by the trains per day shown in column 4 and the results recorded in column 5. The total time on duty for the crews in making a round trip is shown in column 8, and from data obtained on reports described in other appendices, it has been determined that on the division under consideration, engines are off the road and in the hands of the Motive Power Department about 24 hours for every round trip they make. Consequently, 24 hours should be added to the times shown in column 8 to give the total time of an engine for a round trip as in column 9. This number of round trips made in column 4, multiplied by the number of hours per round trip in column 9 will give the total number of engine hours shown in column 10, and these figures, divided by 24 hours in the day, will give the number of engines assigned to the service as recorded in column 11.

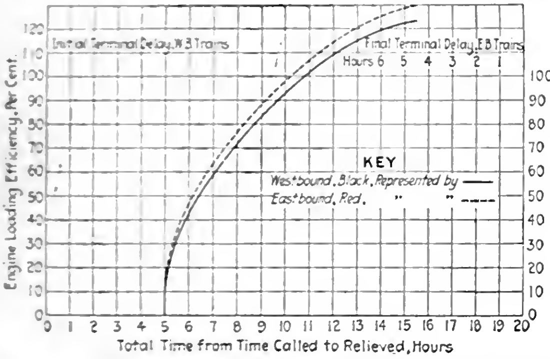


Fig. 2 Type of Curves Used to Show Average Time for Trains of a Given Tonnage Loading

As the average distance run by these trains is 128.2 miles and the overtime speed basis is now 12$^1/_2$ miles per hour, the time per trip is 10$^1/_4$ hours and for the round trip 20$^1/_2$ hours. Consequently, the overtime per round trip is found by subtracting 20$^1/_2$ from the times shown in column 8, and the result entered in column 12. We now pay time and a half for overtime in freight-train service, therefore the number of hours shown in column 12 multiplied by 1$^1/_2$ gives the overtime hours for which we have to pay at the regular hourly rates, and these figures are entered in column 13. Multiplying by the number of trains per day in column 4, we have the total number of punitive overtime hours per day shown in column 14. The total wages paid to the engine and train crews in slow freight service and with the class of engine under discussion now amounts to $3.975 per hour, and the figures in column 14 multiplied by this sum gives the total overtime cost per day as shown in column 15. The straight-time hours per day is the product of the 20$^1/_2$ hours for one round trip times the number of trips in column 4 and is shown in column 16. This at the rate of $3.975 per hour gives the total straight time cost per day shown in column 17, and adding the overtime cost in column 15 gives the total wages cost per day in column 18.

Modern Mikado locomotives of the size under consideration are worth $47,750 apiece, and taking interest at 6 per cent, depreciation at 4 per cent and insurance and taxes together at 1 per cent, we have fixed charges of $5,256 per locomotive per year, or $14.40 per day or 60 cents per hour. Column 19 shows the value of the engine hours in column 10 and the sum of the wages cost in column 18 gives the total engine and wage cost shown in column 20. It will be noted that this cost is a minimum at 100 per cent loading. The limits are rather narrow and an error of 10 per cent in overloading or underloading would cause a loss of $100 per day or $3000 per month on the amount of business handled on the division under consideration.

DISCUSSION AT RAILWAY SESSION

In opening the third session held so far by the Railway Division of the A.S.M.E. on Tuesday, December 6, 1921, Edwin B. Katte, chairman of the Division, called attention to the fact that the keynote of the Annual Meeting, the elimination of waste, was being carried out by the Division in papers relating to waste in connection with the design and operation of railway equipment. He introduced W. H. Winterrowd, chief mechanical engineer of the Canadian Pacific Railway, and now vice-chairman of the A.S.M.E. Division, who presided at the session. The papers presented were Avoidable Waste in the Operation of Locomotives and Cars, by William Elmer; Avoidable Waste of Locomotives as Affected by Their Design, by James Partington; and Avoidable Waste in Car Operation—The Container Car, by Walter C. Sanders.

Discussion of the Paper by William Elmer

Wm. L. Bean[1] opened the discussion of Mr. Elmer's paper, stating that he considered it a splendid exposition of the practical means for overcoming a loss incident to the short and inadequate use of equipment and that it presented a specific method of working out improvements. It had been his experience, he said, that locomotives which were operating satisfactorily to the extent of keeping off the delay sheet, might not be operating with satisfactory fuel economy. He had noticed on the N.Y.N.H. & H.R.R. during 1921 that the consumption of coal on a unit basis in freight service was 10 per cent less than the previous year. Part of this increase in economy was due to equality of loading, as in times of slack business trains could be uniformly loaded more easily than in busy times. He considered overloading of engines worse than underloading. He had found that many roads, in applying the adjustment factor explained by the author, failed to take account of the difference of its application on the level and on grades, as was also true of temperature adjustment, which applied, of course, only to rolling friction.

A. J. Wood[2] spoke of the importance of considering acceleration so essential in heavy passenger traffic. There was a field for development of this problem, he said. He had been interested to find how accurately schedule time can be computed by laying out speed-time curves from ordinary roadbed data.

Mr. Elmer, in closing the discussion, commented on a reference Mr. Bean had made to the importance of fuel economy, saying that he did not wish to imply that he did not consider this of importance. He would not, however, give too much attention to a slight variation in fuel economy if the loading of the locomotive were correct. Acceleration, too, was important, but was as vital in freight traffic as in passenger traffic.

Discussion of the Paper by James Partington

C. C. Trump[3] presented a written discussion in which he called attention to the application of the uniflow engine to locomotives. Prof. Johann Stumpf, by using the energy of exhaust steam with an ejector action, had been able to lower the back pressure in the cylinder by 4 or 5 lb. per sq. in., especially at heavier loads. Thus both the length and diameter of the uniflow cylinder for a given

---

[1] Assistant General Mechanical Superintendent, N.Y.N.H. & H.R.R.
[2] Professor of Railroad M.E., Pa. State College, State College, Pa.
[3] Fuller Lehigh Co., New York, N. Y.

drawbar pull had been reduced. In addition, a steadier draft had been attained. A smaller boiler is required but a larger superheater, because of reduced flue temperatures. Data from Europe indicate that with 700 to 800 lb. pressure in a compound uniflow engine, a well-designed condenser, economizer, etc., the economy and simplicity of a Diesel locomotive might be equaled, with the additional advantage of ability to use a greater variety of fuels.

Mr. Trump presented a translation of a paper by Professor Stumpf dealing with the subject of the uniflow locomotive with single-beat valves and exhaust ejector action.

Wm. H. Wood,[4] offered a written criticism in which he claimed that most of the devices for increasing the economy of locomotives, such as firebrick arches, feedwater heaters and superheaters, did not result in the economy claimed for them but in greater maintenance costs.

John L. Nicholson[5] called attention to the newly developed thermic siphon which had shown an average saving of 15 to 19 per cent in the fuel consumed per drawbar horsepower. If two thermic siphons were to be applied to locomotive No. 50,000, mentioned by the author, they would add approximately 62 sq. ft. to the radiant-heat-absorbing surface of the firebox, and result in an addition of 164 boiler horsepower to the capacity of the locomotive. Allowing for the net additional weight of the siphons, the result in this locomotive would be a reduction in weight per boiler horsepower from 119.6 lb. without the siphons to 113 lb. with the siphons.

W. F. Kiesel, Jr.,[6] called attention to the errors involved in using empirical formulas for steam requirements of locomotives. Thus comparison of the locomotives referred to in the first and second columns of the author's Table 1, which are the Erie No. 50,000 and the Pennsylvania K4S, respectively, show, according to the formulas, that the former is the more economical. Test results, however, are as follows:

	No. 50,000	K4S
Low rate, one test, coal, lb. per i.hp.	2.12	1.52
Low rate, one test, steam, lb. per i.hp.	16.5	14.96
Maximum i.hp.	2216	3184
Weight of locomotive in lb. per maximum i.hp.	121.4	97.0

This shows that the K4S is actually far ahead of the No. 50,000 on every count, instead of being inferior, as the comparison, based on the antiquated empirical formulas, would indicate.

Frans H. C. Coppus[7] wrote that the logical order of locomotive development, as far as combustion is concerned, should be the following:

1 Mechanical induced draft at front end
2 Condensing exhaust steam and returning condensate to tender
3 Pumping the hot water from the tender through a waste-steam and waste-gas heater into the boiler
4 Under-grate forced draft in the ashpan.

His discussion continued with an elaboration of these improvements and an estimate of the savings to be expected from their use. He looked forward, he said, to a reduction of the operating expense of a locomotive equivalent to 50 per cent of the present coal consumption. The suggested improvements, he pointed out, can be attached to all locomotives now in use and at a cost which will pay for them within a year.

John E. Muhlfeld[8] contributed a written discussion in which he developed some ideas in addition to those presented by the author, such as increased boiler pressure and superheat, compounding, reduction of the factor of adhesion, and tender boosters. He also pointed out that it would take a locomotive of considerably increased fuel economy to make worth while the scrapping of many serviceable obsolete locomotives now in use.

Carl J. Mellin[9] said that some of the formulas presented by the author should be accepted only as approximations.

Elmer A. Sperry[10] spoke of the possibilities of economy in railroad operation by the use of Diesel-engine locomotives. The possibility of using bunker oil as fuel in the new compound Diesel engine instead of the high-grade oil which the present Diesel required was going to be greatly in favor of this new type of power. It was possible, he said, that the Diesel locomotive would be combined with electric motors, to obtain the advantages of electric power and economical generation of current.

Oliver C. Cromwell[11] called attention to faulty design in providing sufficient lubrication for the locomotive trucks. He had found less packing used on the locomotive journals than on those of tender and trailer trucks.

Discussion of Paper by Walter C. Sanders

A. E. Ostrander[12] wrote that special containers for use in the transportation of high-grade freight are not new; they have been in successful operation for years. One large company in New York has purchased several lots of containers called "steel lift vans," and their method of operation is to supply one of these vans to a shipper, furnishing him with keys to special locks with which the containers are fitted. The shipper then loads his freight into the container, the lading in this case being high-grade furniture, locks it up and it is then delivered to the railroad for shipment to any part of the world.

The fact that they have continued in business, and, as indicated above, have purchased several orders of the vans, shows that it must have been profitable business for them; therefore it would certainly seem to be more profitable to a railroad to handle strictly high-grade freight in this manner.

In regard to the statement made that the use of the container car saves demurrage on freight cars, this seems unfair to the railroad if no charge is made for demurrage on the containers themselves. In other words, the shipper or the consignee has no more right to use a container as a storage warehouse than he has to hold up a car for the same purpose when he is not in a position to unload his goods.

Verbal discussion of the paper was participated in by V. N. Crocker, Supt. Mail Traffic, N.Y.C.R.R.; C. H. Otis, Asst. Supt. of Car Construction, N.Y.C.R.R.; R. H. R. Newcomb, Asst. to President, B.&M.R.R.; and F. S. Gallagher, Engr. of Rolling Stock, N.Y.C.R.R.; in which the advantages of the container car and experiences with it were brought out.

Bureau of Economic Research

This Bureau was organized for the purpose of finding and placing the facts in regard to economic questions before the public. In order to ensure the impartial and scientific treatment of the data, its Board of Directors is composed of men of widely divergent points of view.

The directors include Edwin F. Gay, President; John P. Frey, Vice-President; W. C. Mitchell, Director of Research. The Research Staff is composed of: Wesley C. Mitchell, Willford I. King, Frederick R. Macaulay, and Oswald W. Knauth.

How large is the National Income? Is it keeping pace with the growth of population? By what industries is it mainly produced? How is it distributed among our income receivers? These are the questions to which an answer is given in the report of the National Bureau of Economic Research of New York entitled "Income in the United States," which is now in press, and to be issued within a few days.

The total National Income increased very greatly between 1910 and 1919 when measured in current dollars; it increased less when calculated in unchanging dollars based on 1913 prices; the per capita income in terms of 1913 dollars increased still less.

The time-honored opinion that America is a nation of spendthrifts is brought into question by the report. The savings of individuals going into extension of plant as represented by new corporate issues of securities; public improvements financed by state and municipal bond issues; and the great number of private houses built each year; all these mount up to a large total.

---

[4] Mechanical and Constructing Engineer, Media, Pa.

[5] President, Locomotive Firebox Co., Chicago, Ill.

[6] Mechanical Engineer, Pa.R.R., Altoona, Pa.

[7] President, Coppus Engineering and Equipment Co., Worcester, Mass.

[8] Consulting Engineer, New York, N. Y.

[9] Consulting Engineer, American Locomotive Co., Schenectady, N. Y.

[10] President, The Sperry Gyroscope Co., Brooklyn, N. Y.

[11] Mechanical Engineer, The B. & O.R.R. Co., Baltimore, Md.

[12] General Mechanical Engineer, Am. Car & Foundry Co., New York, N. Y.

Emergency Fleet Corporation Water-Tube Boilers for Wood Ships

By F. W. Dean,[1] Boston, Mass.

Tests upon the standard four-pass water-tube marine boiler designed by the United States Shipping Board Emergency Fleet Corporation, using coal as fuel, were reported by the present author and Mr. H. Kreisinger in a paper read at the Annual Meeting of the Society in 1919. In consequence of the introduction of oil for fuel on many of the steamships of the United States Shipping Board, it became desirable to ascertain the relative merits on several of the available mechanical atomizing oil burners for boilers. Tests were accordingly run, the boiler used having a heating surface of 2518 sq. ft., a furnace volume of 408 cu. ft., and a commercial horsepower of 435 on the basis of the marine rating of 6 lb. of water to a square foot of heating surface per hour. These tests and the results obtained form the subject of the present paper.

OIL-FUEL EVAPORATIVE TESTS

In the paper presented to this Society in 1919 by the author and Mr. Henry Kreisinger, on coal-fuel tests of Emergency Fleet Corporation water-tube boilers for wood ships,[2] it was stated that oil-fuel tests were being made, and in the present paper the principal results of those tests are given.

In consequence of the introduction of oil for fuel on many of the steamships belonging to the United States Shipping Board it became desirable to ascertain the relative merits of several of the mechanical atomizing oil burners for boilers. The tests were made under the direction of the writer assisted by Mr. Henry Kreisinger, then Fuel Engineer of the Bureau of Mines, and under the critical observation of Lieut-Commander W. R. Purnell and Lieutenant Pennycook from the Philadelphia Fuel Oil Testing Plant of the U. S. Navy. As in the coal-burning tests, assistants for chemical and physical work were furnished by the Bureau of Mines, as well as by the Emergency Fleet Corporation.

The boiler tested was the four-pass boiler illustrated on p. 627 of the former paper and here reproduced as Fig. 1. In the oil tests the bottom of the casing was dropped 12 in., and the furnace on sides and bottom was lined with brickwork about 12 in. thick, there being $2^1/_2$ in. of sil-o-cel brick next to the casing. These were covered by $2^1/_2$ in. of calcined brick. The sides were still further lined with firebrick 6 in. thick and the bottom covered with two courses of standard firebrick laid flat. This formed a very effective insulation, so good, in fact, that the bricks suffered accordingly. However, it was the standard lining of the Emergency Fleet and was very satisfactory in keeping down the temperature of the fire rooms aboard ship, for which purpose it was adopted. This is shown in Fig. 2.

The furnace volume was very small, the distance between the front and back walls was only 6 ft., and the distance from the back wall to the burner tip about 6 ft. 9 in. This short distance, without doubt, prevented the atomizing capacities of the burners from being fully developed. After every series of tests the joints between the bricks opposite each burner required pointing and sometimes the bricks over a small area required replacing.

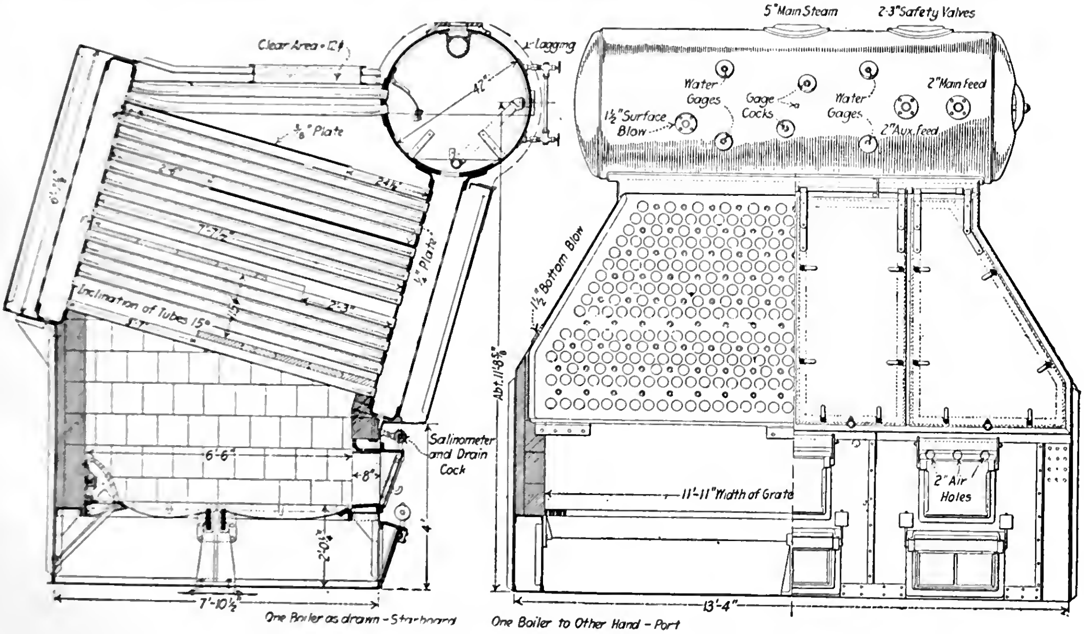


Fig. 1 Four-Pass Standard Water-Tube Marine Boiler for Wood Ships

The following were the dimensions of the firebox below the tubes

Height of furnace at front	5 ft. 0½ in.
Height of furnace at back	6 ft. 9 in.
Width of furnace	11 ft. 6½ in.
Distance between front and back walls	6 ft. 0 in.
Volume of furnace	408 cu. ft.

The boiler was equipped with thermocouples for measuring the temperatures of the gases throughout the passes and in the uptake. At the latter level there were several thermocouples for determining the temperatures at various points, for it had been previously ascertained that the temperatures in the different parts of one horizontal plane of the uptake were not uniform and varied as much as 100 deg. fahr.

Means were provided for sampling the gases at various points throughout the boiler between the vicinity of the burners and the

---

[1] Mfr's Agent, Wheelock, Dean & Bogue, Inc. Mem.Am.Soc.M.E.

Presented at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

[2] Trans. Am.Soc.M.E., vol. 41, p. 623.

uptake. Thus the progression of the process of combustion could be ascertained. Similarly draft gages were arranged to indicate the drafts at various points.

Some of the dimensions of the boiler are given as follows:

Width of casing at floor level	13 ft. 4 in.
Length of casing at floor level	7 ft. 10½ in.
Height of center of steam drum above floor	11 ft. 8⅝ in.
Width of water spaces in headers	8 in.
Outside diameter of tubes	3 in.
Exposed length of tubes between headers	7 ft. 7½ in.
Number of tubes connecting headers	388
Number of tubes between rear header and drum	21
Steam pressure carried	210 lb.

The Oil

Mexican oil was used because it is the only oil that is usually available for steamship fuel. This oil as it comes from the wells is of about 21 gravity Baumé. About 12 per cent to 13 per cent of gasoline is removed, leaving the oil at about 16 gravity Baumé. The heating value per pound is about 18,330 B.t.u.

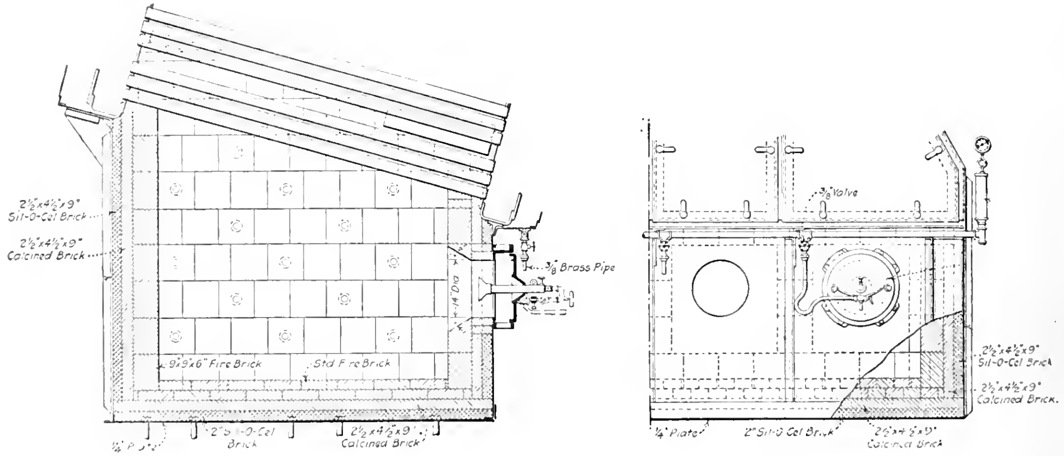


Fig. 2 Arrangement of Furnace of Boiler for Oil Firing

The first sample taken was found by the Bureau of Mines to have the following properties:

Specific gravity at 15 deg. cent	0.960
Gravity, Baumé, modulus 140, at 60 deg. fahr	15.8
Viscosity, Engler, at 65.5 deg. cent	19.21
Calories per gram	10,179
British thermal units per pound	18,323
Water, per cent	0.00
Sulphur, per cent	3.88
Mineral matter, sand, etc., per cent	0.00
Flash point (Pensky-Martens closed tester)	72 deg. cent.
Burning point (Pensky-Martens tester opened)	116 deg. cent.
Solid at	−2 deg. cent.

Other samples, of which many were taken, differed but slightly from this.

The Burners

As stated before, all burners tested were mechanical atomizing. This type is used at sea in order that all steam used in heating the oil may be condensed and saved for feedwater.

Six kinds of burners were used, No. 1 being the U. S. Navy Bureau (of Steam Engineering) Standard Register Burner.

Other Apparatus

The oil was supplied to the burners by either of two horizontal duplex pumps, $5^1/_4$ in. by $3^1/_2$ in. by 5 in. A pair of suction and a pair of discharge oil strainers and an oil heater were loaned by the Schutte and Koerting Company. On the discharge pipe of the oil pumps there was a 6-in. air chamber about eight feet high, which maintained the oil pressure at the burners sufficiently steady for the best results. This chamber was emptied of oil at the beginning of each test and charged with air at 100 lb. pressure.

The oil was heated in the railroad-car tank and forced by air pressure into the weighing tank. From this tank the oil after being weighed was discharged into a tank containing a steam coil, and to this tank the pump suctions were connected. Between the pumps and suction tank the suction strainer was located and the discharge strainer was placed between the pumps and oil heater.

The Navy Bureau Standard Burner

This burner is shown in Fig. 3, and consists of a circular cast-iron register with inclined (not radial) blades around the outside between two thin narrow rings with which they are cast, so formed that the air passes between them somewhat toward the center of the burner, and by them is given rotation.

The register is suitably bolted to the boiler front, but between it and the front there is a conical ring which serves to direct the air toward the oil and counteract the opposite tendency caused by the centrifugal effect of the register.

The oil is forced through a pipe to the so-called tip, which is screwed on the pipe and serves the purpose of delivering the oil to the furnace in a rapidly rotating stream passing through a very small hole. The tip consists of two hardened steel parts, the outer one being called the "nut," and apparent on the drawing. The nut has a conical cavity with the apex toward the furnace and the other part is conical and fits it in firm contact. The latter is provided with tangential grooves fed by small holes and these grooves serve to rotate the oil as above mentioned.

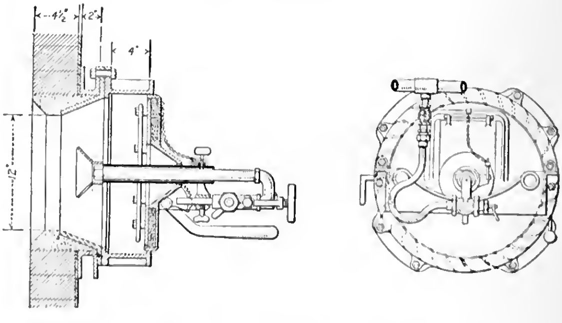


Fig. 3 The Navy Bureau Standard Burner

The centrifugal force derived from the rotation of the oil causes the latter to spread into the form of a thin hollow cone, which is protected from the inrushing air from the register by a cast-iron cone until it reaches an advisable thinness at the edge of the cone, where it is met by the rotating air with which it is thoroughly mixed. Immediately beyond this line of mixture the ignition occurs and the completeness of combustion depends upon the ade-

quacy of the quantity of air, the completeness of the atomization of the oil, and the thoroughness of the mixing.

The other burners have tips that rotate the oil, as this is indispensable in thinning the oil film, but burner No. 4 rotates the air but little, and No. 6 not at all. This demonstrates that the rotation of the air is not necessary, a conclusion that might otherwise have been reached.

THE TESTS

Four burners of each kind were applied to the boiler, and, except the Navy Bureau Standard burner, were placed with their centers 30 in. apart and 20 in. above the furnace floor, leaving 24 in. between the side walls of the furnace and centers of the adjacent burners. In some of the tests the Bureau burners were arranged likewise, but at the beginning they were placed with their centers 36 in. apart and 22 in. above the furnace floor, leaving 15 in. between the side-burner centers and the walls. No advantage in either spacing could be discerned.

The first burner to be used was the Bureau, and on account of inexperience with Mexican oil very poor results were for some time obtained and immense amounts of smoke made. With more experience excellent results were obtained and there was no difficulty in preventing smoke with this or any burner. In general a slight amount of smoke was allowed.

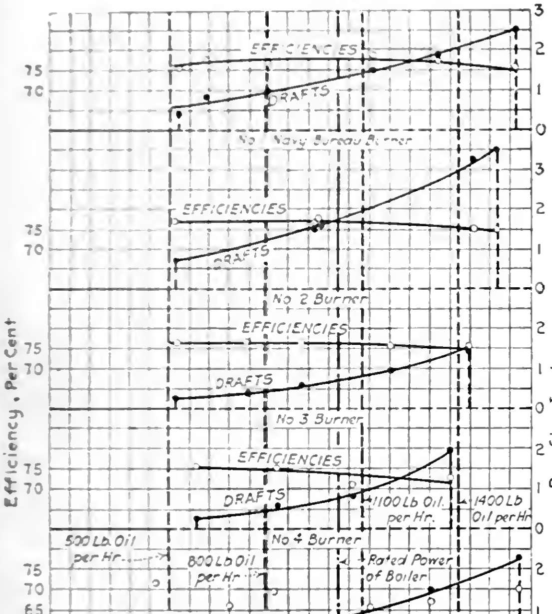


FIG. 4 EFFICIENCIES AND DRAFTS OF SELECTED TESTS

At the beginning there was frequent difficulty from the carbonizing of the oil, but this was gradually overcome.

The criteria by which the merits of a burner can be judged when used with induced draft are its ability to burn the oil to CO_2, to do this with a minimum of draft, to produce little smoke, to produce no carbonization in the burner, and to have sufficient range in oil-burning capacity.

To produce desirable CO_2 the oil atomization must be well performed and the air admitted in such a manner that it will intimately mix with the oil.

A common feature of all the mechanical atomizers tested is the rapid rotation of the oil as it enters the furnace, as in the Bureau burner. This is produced, as in that case, by forcing it at high pressure through small channels of various forms tangential to a small central hole in the burner tip through which it passes to the furnace. As it issues it rotates rapidly and the centrifugal force expands it and forms a thin conical shell of oil. While expanding it is usually protected from the incoming air by a thin cast-iron conical shell of advisable diameter placed in front of it with its base toward the furnace. When the oil reaches the edge of the cone it is swept by the incoming air and the mixing and ignition occur.

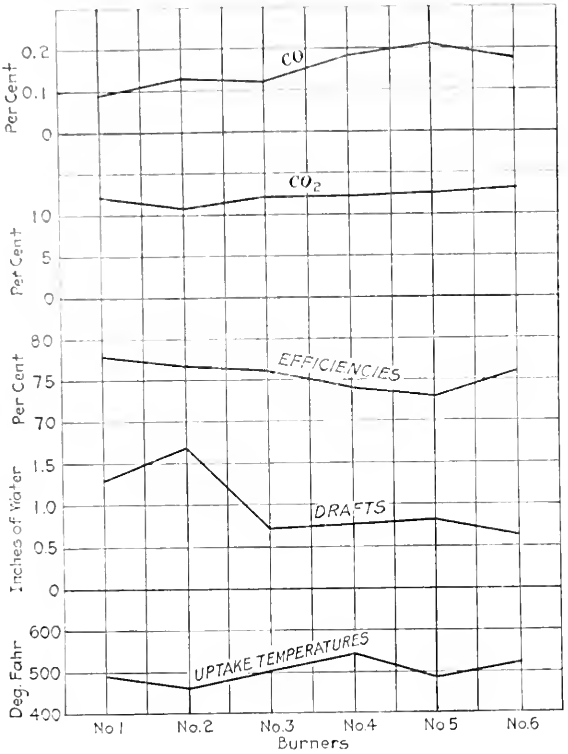


FIG. 5 COMPARISON OF BOILER EFFICIENCIES, DRAFTS, CO_2 AND UPTAKE TEMPERATURES AT RATED POWER OF BOILER WITH DIFFERENT BURNERS, AND AVERAGE CO OF SELECTED TESTS

RESULTS OF THE TESTS

The results of the tests which are considered to be most reliable and to represent the merits of the burners are given in four tables in the complete paper, of which Table 1 is representative. With each burner several preliminary tests were made before sufficient skill was acquired to obtain consistent results, and these are omitted. It may be well to remark here that the representatives of the burners were not able to operate them successfully, which indicates that the efficiencies of boilers with oil fuel are very uncertain.

It was intended with each kind of burner to consume oil at four different hourly rates for four burners collectively, namely, 500 lb., 800 lb., 1100 lb., and 1400 lb., but it was impossible to realize these results with precision.

In judging the merits of a burner by the magnitudes of the CO_2 and CO, a difficulty is encountered from the fact that these constituents are not uniformly distributed throughout the area in which they are determined, whether it is in the uptake or in one of the passes.

Usually, in the boiler tested, the combustion is complete by the time the gases reach the first or lowest pass of the boiler, but if the gases are sampled in this pass they are far from uniform at different

points between the end of the baffle and rear header. The following are examples:

Test No.	CO_2 5 in. from header per cent	CO_2 17 in. from header per cent	CO_2 39 in. from header per cent
41	10.6	10.4	11.1
42	11.9	14.2	14.3
43	10.0	12.3	12.6
44	11.9	13.3	13.6
45	11.6	—	13.6
46	12.6	12.8	12.9

While the above are at different distances from the end of the baffle, the following are at the same distance and at different points in a line parallel to the end of the baffle and 19 in. therefrom:

Test No.	Position C CO_2 per cent	Position D CO_2 per cent	Position E CO_2 per cent
26	11	12	12.3
36	12.9	9.5	11.8

Similarly the other ingredients of the gases vary.

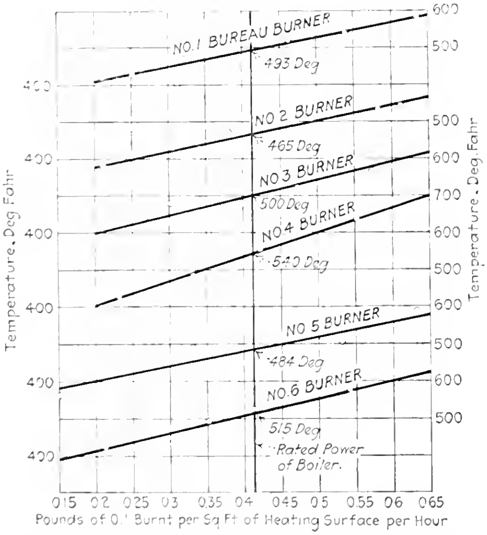


Fig. 6 Temperature Gradients for Different Rates of Oil Consumption with Different Burners

This variation of the gases of combustion renders it difficult to apply the chemical criterion in determining merits of a burner. In operating burners, of course, constant studies of the gas analyses are made, and this is necessary, for if the CO_2 is good at one point it is probable that it is at others. Nevertheless, it is necessary to determine the efficiency of the boiler under the same conditions as a final means of judging of the performance of a burner. It may be found that the maximum boiler efficiency will not correspond with the maximum CO_2, and this is true with these tests.

In the tables of results given the following efficiencies and average CO_2 and CO occur, and are here listed in the order of the burner trials.

Burner	Average efficiencies, per cent	Average CO_2 per cent	Average CO per cent
No. 1	77.02	11.88	0.09
No. 3	75.94	12.16	1.12
No. 4	73.50	12.00	1.18
No. 6	75.10	12.71	0.18

In Fig. 4 the efficiencies and drafts of the various burners are plotted. The Bureau Standard burner required more draft than the others. The reason for this is that it was designed for use on war vessels and made to require a strong draft, or fire-room pressure, in order not to backfire from gun shock.

In Fig. 5 a diagram of comparative uptake temperatures, drafts, efficiencies, CO_2 and CO is given.

In Fig. 6 the uptake temperature gradients of the different burners are shown. It will be noticed that the burner of lowest efficiency gave the steepest gradient. In Figs. 4, 5, and 6 all burners are included.

Burner No. 6 required the least draft and the least adjusting. It was the only burner that did not vibrate; it gave the highest CO_2, but also next to the highest CO. All other burners required constant adjusting to maintain proper CO_2, and the reason for this could not be ascertained.

TABLE 1 RESULTS OF EVAPORATIVE TESTS OF FOUR-PASS BOILER EQUIPPED WITH FOUR NO. 1 OIL BURNERS

Fuel Oil Used: Mexican Petroleum Residuum

1	Test number	37	33	29	38	31	36
2	Date of trial, 1919	Aug. 8	Aug. 1	Jul. 26	Aug. 9	Jul. 30	Aug. 7
3	Duration of trial, hr.	7⅙	6	8	4.88	7	5
4	Barometer, in.	29.4	29.3	29.5	....	29.5	29.14
5	Number of burners used	4	4	4	4	4	4
	DIMENSIONS AND PROPORTIONS						
6	Furnace volume, cu. ft.	408	408	408	408	408	408
7	Heating surface, sq. ft.	2518	2518	2518	2518	2518	2518
8	Ratio of h.s. to f.v.	6.13	6.13	6.13	6.13	6.13	6.13
	AVERAGE PRESSURES						
9	Steam pressure by gage, lb.	200.2	197.0	203.1	196.7	193.60	201.0
10	Atmospheric pressure, lb.	14.46	14.26	14.51	....	14.51	14.34
11	Absolute pressure, lb.	214.66	211.26	217.61	....	208.11	215.34
12	Draft between damper and boiler, in.	0.382	0.774	0.947	1.475	1.902	2.51
	AVERAGE TEMPERATURES						
13	External air, deg. fahr.	72.8	74.6	82.8	70.6	74.6	86.2
14	Fire room, deg. fahr.	74.7	83.6	89.8	79.2	84.9	92.7
15	Feedwater, deg. fahr.	116	90	68.6	85.9	73.7	91.7
16	Escaping gas, deg. fahr.	414	412	465	516	538	583
17	Furnace by optical pyrometer, deg. fahr.	2198	2230	2331	....	2551	2654
	FUEL DATA						
18	Oil consumed per hour, lb.	527	615.5	807.8	1137.8	1341.0	1584.6
19	Oil per hour per sq. ft. heating surf., lb.	0.211	0.246	0.325	0.455	0.537	0.634
20	Oil per hour per cu. ft. of fur. vol., lb.	1.292	1.509	1.98	2.79	3.29	3.882
21	Oil per hour per burner, lb.	131.8	153.9	201.95	284	335.3	396.2
22	Temperature of oil at burners, deg. fahr.	266	264.1	276.5	283.4	260	281
23	Pressure of oil at burners, lb.	146.2	181.9	249.3	167.8	228	236.4
24	Heat value per pound of oil, B.t.u.	18376	18376	18352	18376	18376	18376
25	Moisture in oil, per cent	0.15	0.15	0.05	0.15	0.15	0.15
26	Silt, per cent	0.00	0.00	0.00	0.00	0.00	0.00
27	Specific gravity at 60 deg. fahr.	0.962	0.962	0.96	15° C., 0.962	0.962	0.962
28	Viscosity, deg. Engler at 65.5 deg. cent.	20.39	20.39	......	20.39	......	20.39
29	Flash temperature, deg. fahr.	167	167	158	167	167	167
30	Burning temperature, deg. fahr.	270	270	266	270	270	270
31	Carbon, per cent	84.02	84.02	84.19	84.02	84.02	84.02
32	Hydrogen, per cent	11.00	11.00	11.11	11.00	11.00	11.00
33	Sulphur, per cent	4.04	4.04	4.07	4.04	4.04	4.04
34	Gravity at 60 deg. fahr., Baumé scale	15.50	15.50	15.80	15.53	15.54	15.54
	QUALITY OF STEAM						
35	Moisture in steam, per cent	1.11	1.04	0.91	0.85	0.87	0.93
	EFFICIENCY						
36	Efficiency of boiler and furnace, per cent	75.9	77.7	76.8	78.9	77.0	76.1
	WATER AND EVAPORATION						
37	Water supplied to boiler per hour, lb.	6663	7783	9876	14520	16555	19620
38	Dry steam generated per hour, lb.	6590	7700	9790	14397	16400	19437
39	Factor of evaporation	1.150	1.176	1.198	1.180	1.192	1.174
40	Evap. per hour from and at 212° fahr., lb.	7580	9060	11730	16988	19550	22819
41	Do. per sq. ft. heating surface, lb.	3.03	3.62	4.69	6.80	7.82	9.14
42	Actual evaporation per lb. of oil, lb.	12.50	12.51	12.12	12.65	12.22	12.27
43	Equivalent from and at 212° fahr., lb.	14.38	14.72	14.53	14.93	14.57	14.40
44	Do. per cu. ft. of furnace volume, lb.	18.57	22.20	21.00	41.63	47.93	55.95
	POWER OF BOILER						
45	Land hp. obtained (rated at 250 hp.)	220	263	340	492	567	661
46	Per cent of land rating obtained	88	104	136	197	227	265
47	Equiv. land hp. of marine rating	435	435	435	435	435	435
48	Per cent of marine rating obtained	51	60	78	113	130	152

DISCUSSION

IN the discussion which followed Mr. Dean's paper, Past-President D. S. Jacobus presiding, Joseph Nelis, Jr.,[1] who had been associated with the author in the early part of the tests, said, in reply to questions, that an attempt was made with the standard size adopted to run up to as high a capacity as possible—higher than they would be on shipboard—and that in some of the higher ratings the brickwork melted. The burners employed were all mechanical

(Continued on page 104)

---

[1] Manager, Marine Dept., Power Specialty Co., New York, N. Y. Mem. Am.Soc.M.E.

Motion Pictures of a Stoker Furnace in Operation

By R. SANFORD RILEY,[1] WORCESTER, MASS.

THE moving-picture method of showing furnace operation is the result of about ten years of study and experiment in an effort to show continuously the action of a fuel bed. The opportunity thus offered of studying the fuel bed in operation may suggest new lines of investigation and development. The first intimate contact with a roaring-hot stoker fire usually developed the fact that motion-picture cameras were valuable and must be treated with more respect. A temperature approaching 3000 deg. fahr. presented new problems even to the most versatile motion-picture expert.

These difficulties in the observation of the phenomenon of the combustion of coal were finally overcome by the ingenuity and persistence of F. H. Daniels[2] so it is to him we owe the invention and accomplishment here described.

The camera (Fig. 1) was mounted at the right height on a stand which was arranged to roll up to the door. A heavy asbestos shield was built to protect the front and side of the camera. The shield over the front was made to fit more or less accurately in place of the door, while the shield at the side was made to protect the camera against the hot brick lining of the door when the latter swung open. This arrangement made it convenient to run the camera up into position as soon as the door was opened and maintain the furnace conditions the same as when the door was shut. Fig. 1 shows the operator in position with the door opening closed by the front shield and the hot door lining covered by the side shield shown. Even with these precautions, an electric fan was required to keep the camera safe and the operator less uncomfortable.

Fig. 1 Arrangement of Camera before Furnace Door

Of course, the real problem was the protection of the camera lens during the time it had to be exposed. The hole allowing the camera lens to look through the front screen was normally closed by another asbestos plate. This plate was tripped open by the operator's foot only during the time pictures were to be taken. Note the pedal and pulley connections thereto in Fig. 1.

For protection of the camera lens, a water cell with glass windows was first tried. A forced circulation of water through the cell did not prevent the glass from cracking. This defect was remedied by using special Pyrex glass, but it was found that air bubbles were formed on the side next the fire and even distilled water did not prevent them. These of course spoiled the clearness of the pictures. Finally, the combination of two sheets of heat-resisting glass with a thin sheet of gold between was tried. The gold acted as a mirror and threw back into the furnace approximately 75 per cent of the radiant heat, while it allowed approximately 75 per cent of the light rays to pass through. This protector for the lens was itself protected by two jets of compressed air arranged to impinge and mushroom in front of the opening in the asbestos screen. (See the hose connection in Fig. 1.) This air had to be delivered at approximately 100 lb. pressure in order to get the required cooling effect. Furthermore, it had to be clean and free from all moisture and oil. The trap shown underneath the camera was drained frequently in order to insure clean air.

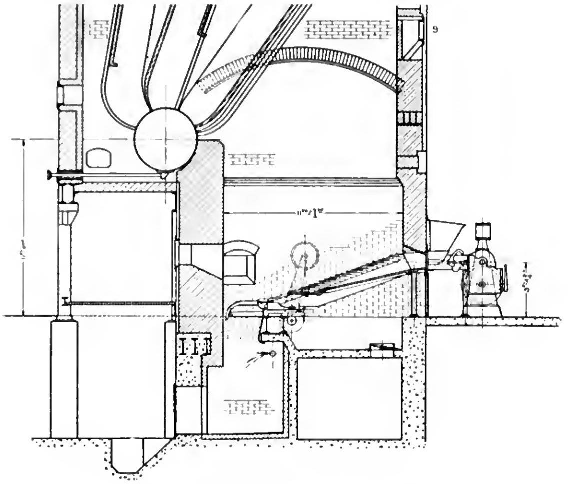


Fig. 2 Cross-Section of Furnace Setting

In addition to the screening effect of the gold leaf, it was found necessary to use what is called a Wrattan filter in order to prevent halations on the film.

At the suggestion of John A. Stevens, Mem.Am.Soc.M.E., a spectrometer was used in the fire and this showed a complete spectrum from reds down to violet and a brilliant yellow sodium line. The blues and purples increase in intensity, depending on the temperature of the fire viewed through the spectrometer. A panchromatic film stock was used to bring out the reds of the spectrum. This combination of gold screen, Wrattan filter and panchromatic film shows the texture of the fire well enough for the purpose.

The pictures were taken at the plant of Bird & Son, Inc., East Walpole, Mass. The boiler is a Stirling, of 822 hp., equipped with a 9-retort extra long Riley underfeed stoker. This installation was made by John A. Stevens, Engineer, of Lowell, Mass. and a cross-section of the furnace setting is shown in Fig. 2. The height of the mud drum being 11 ft. above the floor line allowed the use of the rear door shown in addition to the usual side observation door. Both these doors were used for taking pictures and proved just as convenient for this as they are for observation in everyday use.

Fig. 3 is a typical view through the rear door and Fig. 4 through the side door. Restriction of the view due to limited flare of the brickwork around the doors is a handicap but does not interfere with a study of the limited area seen. It is hoped later to get more extended views through specially flared door openings, but in this

---

[1] President, Sanford Riley Stoker Co. Inc. Mem.Am.Soc.M.E.

[2] General Manager, Sanford Riley Stoker Co., Inc., Asso-Mem.Am.Soc. M.E.

Remarks accompanying presentation of motion pictures, under auspices of the Fuel Division, December 8, 1921, at the Annual Meeting of The American Society of Mechanical Engineers.

case it was necessary to take pictures under usual service conditions. It is also planned to make special studies of side-wall clinker action, and development of clinkers elsewhere in the furnace. The operating conditions were normal during the week these pictures were taken. It took nearly an entire week to get satisfactory motion pictures of the fire alone, and altogether about 2000 ft. of film were used up in order to get the 700 ft. shown. There was no attempt made to have the fire in any special condition. The pictures were taken generally as the apparatus could be prepared for action, and some of the operation shown is better as an example of what not to do.

The pictures taken and reproduced at normal camera speed show nothing much more interesting than the still pictures reproduced in Figs. 3 and 4, except perhaps the pictures of the banked fire and the dumping. The change from banked fire to 300 per cent of rating in six minutes is less monotonous than normal operation and shows quite clearly what happens in breaking up a fire bed that has been standing overnight. The dumping shows what happens if stokers of this type are dumped with a heavy fuel bed.

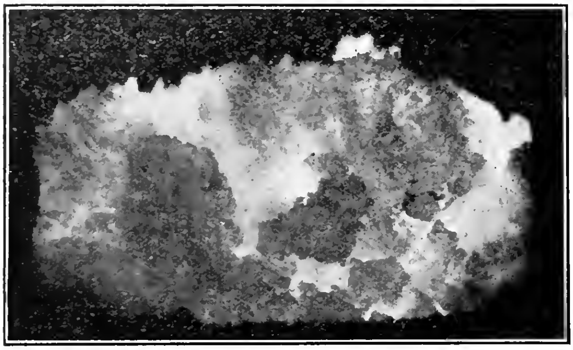


Fig. 3 Typical View through Rear Door of Furnace

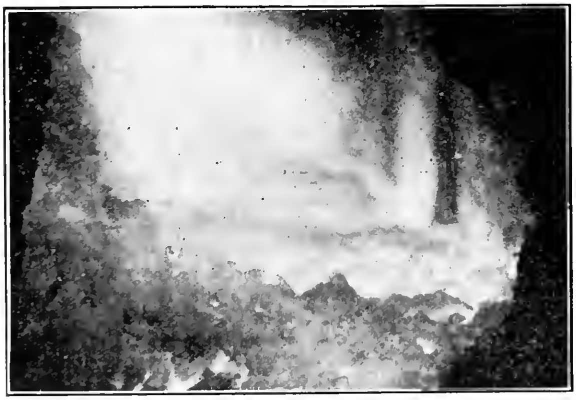


Fig. 4 Typical View through Side Door of Furnace

The most interesting features, and certainly the most dramatic, are those taken at intervals and speeded up like the well-known pictures of a growing plant, though of course no such great magnification of speed was used. Some of the pictures were taken at intervals of six and eight seconds. These show some appreciable change in the fire and when speeded up to normal reproduction rate of sixteen per second, there is an action worth watching. Particular attention will be called to some of these highly speeded-up pictures where the fuel bed appears to be "shimmying" on its way instead of "inching" along at a scarcely perceptible rate. The disintegration and melting away of the fuel is clearly shown as is also the gradual segregation of the non-combustible matter in the form of clinkers on the surface. It is to be regretted that there appears to be no way of getting a cross-section of the fire, although we hope to find a way of making some additional observations below the surface.

DISCUSSION ON E. F. C. WATER-TUBE BOILERS FOR WOOD SHIPS

(Continued from page 102)

atomizing burners, as steam atomizers wasted too much make-up water. Up to the ratings possible in marine work—4.5 to 6 lb. of evaporation per square foot of heating surface—smokeless operation was possible with oil at the proper temperature and pressure.

John A. Stevens[2] gave interesting particulars of the oil-burning installation on the Cunard liner *Mauretania*, describing the periscopes on the uptakes for observing the character of smoke passing, the foamite tanks for use in extinguishing oil fires, etc. The furnaces on the *Mauretania* were somewhat small—46 in. in diameter—and the combustion chamber restricted. The installation made it possible to dispense with 450 firemen and coal trimmers.

F. W. Leahy[3] called attention to the electric-drive vessels of the U. S. Shipping Board, which were provided with oil-burning Scotch boilers and all of the improvements that had been mentioned in connection with the *Mauretania*.

N. E. Lewis[4] gave particulars regarding the dimensions of a 450-hp. water-tube boiler with 4-in. tubes 14 ft. long and equipped for oil burning, as well as of a 2-in.-tube marine-type boiler. The efficiencies reported were perceptibly higher than those given in the paper. Mr. Lewis said that he had noted a statement in the paper that the efficiencies of boilers with oil fuel are very uncertain. He believed that a well-designed mechanical oil burner would give higher efficiencies with less care and manipulation on the part of the operator than any other fuel-burning apparatus. The adjustment of air and oil pressures was practically all that one had to watch, other than seeing that the burners were kept free, and it was not like the coal-fired, gas-fired, or other kind of boiler where several other elements entered into the operation.

Superpower

There are few who understand the superpower plan in detail, but the public does not understand it in general.

Even men in the business regard it as a collection of extra-large power houses and say that the superpower station of yesterday is the ordinary plant of today.

Perhaps they make a difference between the superpower station and the superpower plan, although they mingle them in writing and in conversation.

Look over an industrial city block of a few years ago. There are in it a dozen or twenty separate power plants. On the back street several small industries, each with its boiler and engine, coal carts from different dealers backing up and leaving the fuel, a ton or two at a time. Oil, packing and supplies bought in driblets. No one of them big enough to support a real engineer. On the main street some office buildings with more pretentious and efficient power plants, but the aggregate employing many more men than were needed, burning more fuel and paying more for their supplies than would be necessary in a well-designed and operated plant that could furnish not only power, but light, heat, hot and cold water, compressed air, vacuum, refrigeration, etc., to the entire block.

Extend this idealization to a section of the country instead of to a city block, and you have a conception of the superpower plan.

Only the superpower plan does not contemplate merely building a single immense power station for each industrial block or district and tying them all together. It proposes an intelligent engineering study of the power needs and the available sources of power supply for a district and a combination and coördination that will give to each subdivision of the district a dependable supply of power in the cheapest and most economical way.

It is the organization, the systemizing, the rationalizing of the power resources of the country.

And it is time that somebody began to think of power in that way; to look ahead to the time when the world will have to decide the purposes for which fuel may be burned and power used; to pick the essential industries. This time is already in sight so far as liquid fuels are concerned.—F. R. Low, Mem.Am.Soc.M.E., in *Power*, Jan. 10, 1922.

---

[2] Consulting Engineer, Lowell, Mass. Mem.Am.Soc.M.E.

[3] Marine Manager, Diamond Power Specialty Co., New York, N. Y. Mem.Am.Soc.M.E.

[4] Babcock & Wilcox Co., New York, N. Y. Mem.Am.Soc.M.E.

A Study of the Elastic Properties of Small-Size Wire Cable

By R. R. MOORE,[1] DAYTON, OHIO

In aircraft work use is made of several varieties of small-diameter steel cable, knowledge of the physical characteristics of which is important for efficient design. The present paper gives results of a series of tests carried out at McCook Field, Dayton, Ohio, in which it is shown that the modulus of elasticity of small-sized wire aircraft cable varies from 15,000,000 to 28,000,000, depending upon the size and type of the cable. The maximum difference between moduli of specimens of the same size and type of cable may be as high as 3,000,000.

It was also found that the modulus of elasticity may be raised by loading the cable below the elastic limit, and that resting the cable does not seem to have any definite effect on the modulus. The elastic limit may be raised by loading the cable a little beyond this point, the maximum increase obtained amounting to 63 per cent of the original elastic limit.

THE development of aircraft has brought into use several varieties of small-diameter steel cable, a knowledge of the physical characteristics of which is important for efficient design. Such information becomes vitally important to engineers who are concerned with the development of new types of aircraft and the advancement of the science of aviation in general. This is the case at the Engineering Division of the Air Service, located at McCook Field, Dayton, Ohio. The subject was first brought to the attention of the Material Section by a request from the Design Section for stress-strain curves on various sizes of the 19-wire non-flexible type of aircraft cable. After completing these tests the investigation was extended to cover all the available types of cable used in airplane construction.

Engineering handbooks do not quote any value for the elastic limit of wire cable, and for the modulus of elasticity they give a value of about 12,000,000. This value, however, refers to wire ropes with hemp centers and for sizes greater than $^3/_8$ in. In aircraft work we are mostly concerned with ropes made of high-strength steel wire in sizes less than $^3/_8$ in. and types which have either a wire or wire-strand center. The value for the modulus of this type of cable is considerably greater than 12,000,000.

While the determination of ultimate strength is a comparatively simple matter, the accurate measurement of elongation necessary in determining the elastic limit and modulus of elasticity presents several difficulties. In the first place, the fact that the cable is built up of so many small wires and strands makes it difficult to locate accurately a definite gage point and attach an instrument there without its shifting in position. It is evident that the usual type of extensometer with pointed screws for grips is of no use for this work. In the second place, a cable twists when under load, so that any rigid instrument cannot be used.

Tests were made on a 20,000-lb. Olsen structural-material and airplane-parts testing machine which was previously calibrated and found to be in good adjustment. However, in several cases the measurement of load was obtained from the deflection of an accurately calibrated spring placed on the upper head of the machine and arranged so as to take the load applied to the cable. The deflection of the spring was measured with an Ames dial reading to 0.001 in. It was found that this method gave more consistent results because it was considerably more sensitive to small variations in load than the lever system of the testing machine. In fact, some such arrangement is absolutely necessary in testing the small cables, particularly the $^1/_{32}$, $^1/_{16}$, and $^3/_{32}$-in. sizes, in order to obtain the elastic limit and modulus with any degree of accuracy. To obtain the breaking load, however, the spring must be removed and the load measured on the machine. A view of the complete set-up with extensometer attached is shown in Fig. 1.

The instrument used was very similar to the familar wire-wound dial type of extensometer. The greatest difficulty was in attaching the dial to the cable at the gage point. This was accomplished by attaching the dial to a specially devised clamp as shown in Fig. 2. At the other gage point, a second clamp was attached similar to the one holding the dial. To this clamp one end of a fine magnet wire was attached; the wire extended down the cable and around the brass drum, the loose end having a light weight attached to it. It is clear, then, that as the two gage points moved apart the wire turned the drum and shaft upon which the needle was mounted, thus recording directly on the dial the elongation of the cable.

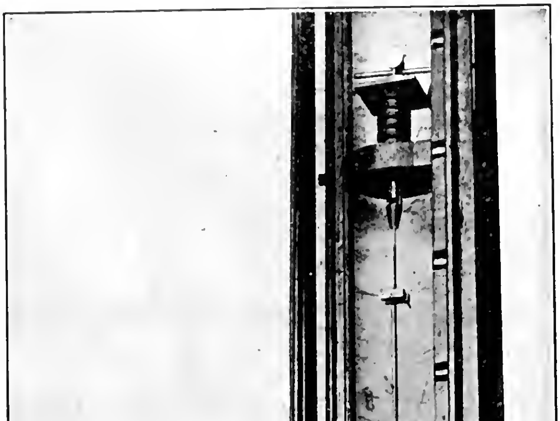


FIG. 1 COMPLETE SET-UP OF APPARATUS WITH EXTENSOMETER ATTACHED

In order to reduce the error occurring from this twisting, the wire was placed as near the cable as possible and hardly exceeded $^1/_2$ in. from the center of the cable at any time. As the maximum twist noted did not exceed 90 deg., the error incurred in the modulus due to this error of elongation is negligible.

Cables of four different types of construction and one made of phosphor-bronze wire were tested, the types and sizes tested being given in Table 1.

A chemical analysis of several wires taken from the phosphor-bronze cable gave the following composition: tin, 3.77; copper,

---

[1] Chief, Physical Testing Branch, Material Section, McCook Field.

Abstract of paper presented at the Annual Meeting, New York, December, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

95.60; zinc, 0.34; phosphorus, 0.28. A chemical analysis of several wires from the steel cables gave the following composition: carbon, 0.64; manganese, 0.55; phosphorus, 0.033; sulphur, 0.033.

In Fig. 3 is shown the arrangement of the wires and strands in the four different types of cables.

Stress-strain curves for computing the modulus and locating the elastic limit were plotted on cross-section paper with a scale of 1 in. equal to 0.01 in. actual elongation in 50 in. The vertical scale was made so as to give the curve a slope of about 45 deg. with the horizontal. This large-scale plotting showed the readings of the extensometer to be very consistent, indicating that the cable was stretching uniformly and also twisting uniformly.

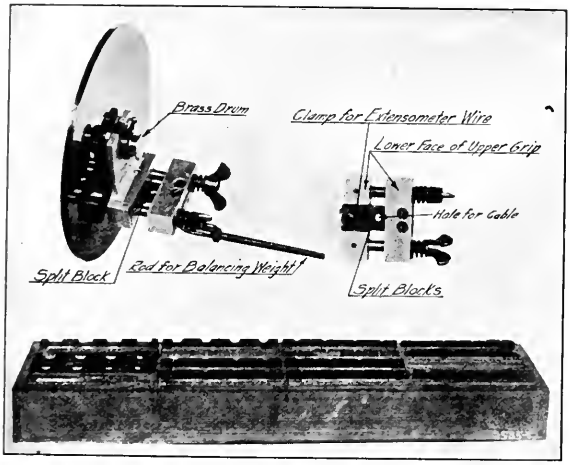


Fig. 2 Extensometer Clamp

The values for elastic limit were obtained by selecting the highest point on the straight-line section of the stress-strain curves. Strictly speaking, this is not the elastic limit but the proportional limit. (American Society for Testing Materials.)

However, as the majority of practical designing engineers use the term "elastic limit" to designate what is actually the proportional limit, we have also used it in that sense in order to avoid confusion.

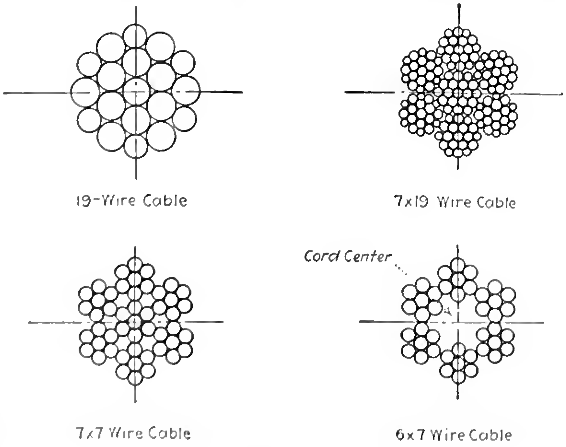


Fig. 3 Types of Cable Construction

There is considerable variation between the modulus of different-sized specimens of the same type. In order to show the comparative modulus values for the different types of cable, Table 2 was prepared, selecting the same size of cable from each type as nearly as it was possible to obtain.

There is in several cases quite a difference between the first-run modulus obtained on different specimens of the same cable. The largest of these differences is in these $^1/_8$-in. 7 by 19 cable, specimens 13 and 14, which show a difference of about 3,200,000; and the 6 by 7 cable, specimens 16 and 40, which show a difference of 2,760,000.

The highest modulus obtained on any cable is 27,793,100. This value was obtained after loading below the elastic limit. It should be remarked here that this value is more than twice as large as the value 12,000,000 which is commonly quoted for wire rope.

The largest increase in modulus is found in the $^1/_8$-in. 7 by 19 cable, which shows an increase of 6,600,000 after loading above the yield point. It is noticeable that this maximum increase occurs on the smallest-sized cable. The phosphor-bronze cable shows the smallest increase in modulus of any of the other cables, even though it is of the same type of construction (7 by 19) as the one which showed the greatest increase.

TABLE 1 TYPES AND SIZES OF CABLES TESTED

Type	Material of Wires	Protective Coating on Wires	Diameter of Cable
19 wire	Steel	Tinned	$^1/_{32}$*, $^1/_{16}$, $^7/_{64}$, $^1/_8$, $^5/_{32}$, $^7/_{32}$
7 by 7	Steel	Zinc-plated	$^1/_{16}$, $^3/_{32}$, $^5/_{32}$
7 by 7	Steel	Tinned	$^3/_{32}$
6 by 7	Steel	Zinc-plated	$^9/_{64}$
7 by 19	Steel	Tinned	$^1/_8$, $^5/_{32}$, $^7/_{32}$, $^9/_{32}$, $^{11}/_{32}$
7 by 19	Phosphor-bronze	None	$^7/_{32}$

* This cable has only 7 wires because of its small size.

TABLE 2 COMPARATIVE MODULUS VALUES FOR DIFFERENT TYPES OF CABLE

Type	Size	Average 1st Run Modulus	Average Modulus after Loading above Yield Point
19 wire	$^5/_{32}$	24, 870, 000	25, 687, 000
7 by 7	$^5/_{32}$	19, 505, 000	22, 985, 000
6 by 7	$^9/_{64}$	17, 989, 000	20, 660, 000
7 by 19	$^5/_{32}$	15, 605, 000	20, 112, 000
7 by 19[1]	$^7/_{32}$	11, 307, 000	11, 953, 000

[1] Phosphor-bronze.

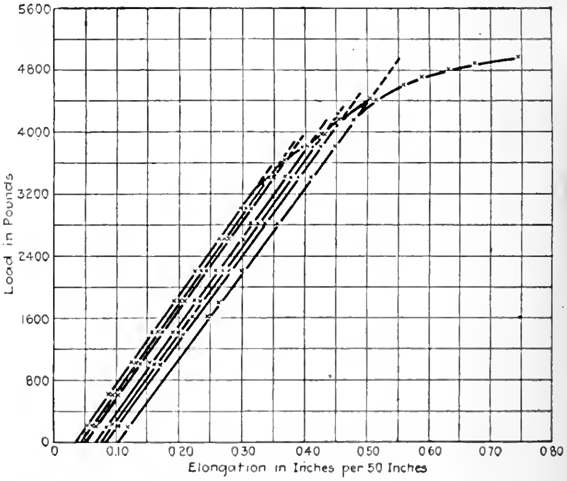


Fig. 4 Rise in Elastic Limit of $^3/_{16}$-in. 19-Wire Non-flexible Steel-wire Cable

While it is true that the modulus is raised a greater amount by loading above the yield point than below the elastic limit, it is to be remembered that a very large part of this increase is due to the loading below the elastic limit. It is evident, then, that the net effect of loading above the yield point is small.

The final object of this investigation was to determine whether it is possible to raise the elastic limit by loading a little beyond this point. The results of one set of runs made to show this are given in Fig. 4. These curves indicate definitely that the elastic limit can be considerably increased.

The amount of increase obtained on the cables tested is as given in Table 3, page 111.

(Continued on page 111)

Air Lines and Some of Their Problems

By R. B. C. NOORDUYN,[1] NEW YORK, N. Y.

To those who are interested in the early and successful development of commercial air lines in this country, this paper will give an index of the problems to be solved, both from the point of view of development of the machine itself, as well as of such important accessory factors as proper landing facilities, ground organizations, legislation, and insurance.

The author gives a detailed account of the progress of commercial aviation in Europe, tracing the development from the time of the post-war experimental work with military machines and fields, to the present successful operation with proper machines and schedules and with Government subsidies.

His ideas are authoritative, and hence valuable, and his presentation of the problems of air lines should do much toward helping to secure the establishment of air travel in this country as a factor of every-day life.

THE air lines in operation in Europe since 1919 have proved a great attraction for Americans who have formed, in fact, a surprisingly large percentage of the passengers carried. The favorable impression which they invariably bring home of the new method of travel encourages the belief that once air lines are running in this country and can promise to equal the performance of those with which the traveler has become familiar abroad, public support will be forthcoming to a greater degree than has been generally anticipated.

In the United States last year, the mileage covered by commercial or privately owned airplanes was estimated by the Manufacturers' Aircraft Association, from reports received from operators all over the country, to be not less than six million miles, in the course of which some 225,000 passengers were carried. The Frenchman, who is accustomed to using a time-table for the next plane for London or Amsterdam, and buying his ticket at the nearest travel bureau looks at these figures and thinks that the air lines in this country must be doing a good business. If this large mileage were actually covered in the operation of scheduled services over fixed routes, instead of in unorganized short flights, we could indeed consider air-travel to be an established factor in every-day life.

As a precursor of regular services the present volume of flying must not be underrated. Its educative value is very great as the passengers carried on short flights now will be the patrons of the air lines of the future. Further, personnel, pilots, and mechanics are being trained, and ground organization, landing fields and service stations are being developed all over the country, although slowly and on a modest scale.

What, then, are the difficulties which have so far stood in the way of rapid development of regular inter-city air lines in this country?

Briefly, the airplane finds itself today in that stage through which many new inventions have passed, and in which the article itself has reached a more advanced state of development than the facilities and accessories necessary for its completely effective use.

The modern commerical airplane has all the qualities requisite to passenger vehicles generally, whether land, sea, or air going, with the addition, naturally, of a few of its own. As for comfort, passengers are seated in chairs similar to those in a Pullman car, in cabins easily entered through full sized doors a step or two from the ground, protected from wind, cold and engine smells. They view the scenery through large windows. The motions of an airplane are far more gentle than those of any other vehicle, while sense of speed and vertigo are entirely absent in straightforward flying and there is no dust or dirt.

Safety and reliability under organized operating conditions are now such as to justify anyone in entrusting life and property to the air; according to the latest time-tables the regular passenger and freight lines in Europe are covering 22,000 miles per day. Table 1, a summary of British Air Ministry weekly reports on the traffic between London and the Continent, shows some interesting figures. On the three routes operated, 3088 flights were started during the first 10 months of 1921, of which $91\frac{1}{2}$ per cent were carried out in good order, which represents a distance of 700,000 miles flown and at least 6200 starts and landings made without one single passenger being hurt seriously. These figures are the more remarkable when taken into consideration with the very unfavorable weather conditions for which the region of the English Channel is notorious.

The United States Air Mail Service, which is operated over a series of route sections somewhat shorter in average length than the European lines, completed 95 per cent of the 6690 flights attempted during the first 9 months of 1921, in the course of which 1,332,000 miles were flown with mail. On the Cleveland-Chicago section the twenty-fifth successive week of 100 per cent performance was recently reported. However, it must be remembered that the Mail Service is supplied with a far greater number of airplanes and engines in proportion to the length of its routes than any private company striving to operate at a profit could afford, and also that, when carrying mail only, flights often can be successfully carried out under conditions which would be incompatible with the safety of passengers. The figures given do not, therefore, provide a satisfactory basis on which to judge the relative merits of equipment and personnel between the U. S. Air Mail and the European passenger lines, as far as regularity of performance is concerned.

TABLE 1 OFFICIAL STATISTICS ON THE AIR LINES BETWEEN LONDON AND THE CONTINENT

From January 1, 1921 to October 30, 1921. Approximate total mileage flown 700,000 miles. Not a single passenger killed or injured.

ROUTE	Distance in Miles	Number of Journeys	Passengers Carried	Journeys Carrying Mail	Journeys Carrying Freight	Journeys Completed to Schedule	Percentage of Journeys Completed	Type of Machines
Paris–London	240	1141	4581	435	787	1021	90	De Haviland Handley-Page Préguet Farman S.P.A.D. Vickers
London–Paris	240	1110	4521	317	407	1033	93	
London–Brussels[1]	210	260	298	148	153	243	93.5	Farman De Havilland
Brussels–London[1]	210	226	353	177	173	201	89	
London–Amsterdam[2]	265	176	200	160	166	167	95	Fokker F-3
Amsterdam–London[2]	265	175	275	164	147	162	93	
Total	...	3088	10228	1401	1830	2827	91.5	=

[1] Service suspended owing to fire at Brussels aerodrome Sept. 28, 1921.
[2] Commenced operations April 14, 1921.

Finally, in judging the present status of the airplane as a means of transportation, the all-important question of operating cost must be considered. The first air lines started operations hopefully, on the assumption that their small first outlay, on the purchase of converted war planes at a fraction of the manufacturing cost, and the supposed imperative demand of modern business for speed above all things, would insure at least a paying business from the beginning. How sadly they were disappointed is clearly shown both by the history of the companies concerned and the rapid, if not yet quite complete, disappearance of these machines from the chief airways of Europe.

Large numbers of 3-seater machines, converted fast day bombers, were in use during the first year or two after the war, which showed a dead financial loss on every trip, even when loaded to full capacity which was by no means always the case. Large twin-engine bombers, capable of carrying about 10 passengers, solemnly ploughed their way daily between London and Paris and London and Brussels, more often than not less than half loaded, and at a prohibitive cost in gasoline and oil for their big engines. The fares charged had to be very high and the vicious circle was complete.

The technical results—mechanical reliability and ability of the pilots to make their way in bad weather in spite of the rather primitive meteorological and other ground services available at that time—were surprisingly good, but the financial results were disastrous and produced a great deal of adverse opinion.

---

[1] Netherlands Aircraft Mfg. Co., New York, N. Y., Fokker representatives in America. A.M.I.Ae.E.

Paper presented at the Annual Meeting, New York, December, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

It was not until the French Government heavily subsidized the French lines and enabled them to make a cut of 40 per cent in their rates, that traffic began to increase; with this assistance, the old war types, uneconomical as they are, took on a further lease of life in France and are still widely used in that country. To enable the British companies to compete, the British Government assisted them by financing the acquisition of modern commercial planes on a repayment basis, and guaranteed a profit. The effect of these steps on the traffic itself is well shown by Table 1. In the meantime the principal constructors had given their serious attention to the problem of increasing the carrying capacity and reducing the running costs and the new machines showed a remarkable improvement in this respect.

It is interesting to note the successive steps toward this realization of the chief commercial requirement, the carriage of greater loads at less expense. Just before the dissolution of the pioneer concern—The Aircraft Travel & Transport Co.—a desperate effort was made to improve matters in this respect. Operations were placed in the hands of traffic experts pure and simple, who, quite justifiably, at once tried to increase the service obtained per week from the equipment in hand, such as it was. Undoubtedly this effort provided a vast amount of data on constructional details such as accessibility of engine installations, ease of repair and all matters which would become especially prominent as more work in a given time was demanded of each airplane as a unit. The results only emphasized more respects in which the coming commercial designs had to show improvement over the converted war types, aside from carrying capacity and load space.

The requirements having thus become clearly established, the designers set out to fulfill them. After the 360-hp. DH16, really a converted DH4, carrying four passengers in very cramped quarters, and subsequently the BAT, FK26, which carries a slightly greater load with the same horsepower in a good-sized cabin, this progress in design was very marked in the 450-hp. DH18, carrying eight passengers which was very soon followed by the Fokker monoplane with five passengers for 185 hp. With these the useful load carried per horsepower had advanced from 4 lb. to 8 lb., or an improvement in commercial performance of 100 per cent. The internally braced monoplane, in which the airplane finds itself practically reduced to its essential parts, lifting surface, body, chassis and controlling organs comprising the entire structure of the machine, has opened up fields of study in the matter of wing design which promise still further progress in this direction. Within recent months several new designs on this principle have appeared and are in successful operation, which again show an advance in carrying capacity. Notable among these are the new DH29 and the new Fokker F4, which carry from ten to twelve passengers and considerable baggage with engines of 400–450 hp., the useful load carried per hp. thus having now advanced to 9 lb. Roughly, this means that such airplanes can carry a load of more than one ton in passengers and freight a distance of 600 miles in 6 hours at a fuel cost of $48, or $^3/_4$ of a cent per passenger mile.

The few figures given go to show that the airplane, even in its present state of development, is by no means a hopelessly costly means of transportation, provided that facilities for its exploitation are developed to a sufficient extent so as not to entail the addition of entirely disproportionate overhead charges to the actual running cost, charges of a character with which no other form of transportation has to contend or is able to bear. In the following paragraphs a few of the factors governing these charges are discussed.

The Selection of Routes

What has been said gives an indication of the airplane's present capacities and also of the trend of development in the near future. The next question is, obviously, where can it be put into regular service with a reasonable expectation that that service will become truly a public utility and receive sufficient support to thrive as a commercial venture?

It may be argued that eventually air traffic will have its place in the scheme of things alongside the older and slower means of transit, wherever traffic of any kind—or at least long distance traffic—exists. However, it is obvious that in choosing the routes to be operated during the introductory period very great care will have to be taken to select those on which the air lines are likely to justify their existence within a reasonably short time. Such routes may be fairly clearly divided into two categories. First, there is the route between commercially or politically important points, of which the development has been so rapid that transportation facilities have been unable to develop proportionately. The new world is full of such opportunities for the airplane, the only vehicle which is practically independent of geographical obstacles and does not entail the laying down of a permanent right of way.

Second, there are routes on which terrestrial tranportation facilities are very highly developed and the volume of traffic very great, but where at the same time communication is retarded by natural obstacles which do not affect the airplane to any considerable extent. Chief among these are mountains and intervening stretches of water entailing either transshipment or circuitous routes.

In either case, the decision that the establishment of air communications is a justifiable venture can only be made after careful study of existing transportation facilities and local conditions. The full support of the foremost industrial and business interests in and around the terminal cities must be obtained; and extensive preliminary canvassing and propaganda work are essential with a view to enlisting coöperation by the community in the establishment of air terminals and other facilities analogous to those provided for shipping as well as to insure patronage once the air line is in operation.

The public has to be taught how to use the airways; even with air lines in full operation a great deal of publicity work and effective advertising will be necessary to show the business man just how to combine the new transport facilities with the older ones in order to take full advantage of the airplane's speed. This is especially the case as long as night flying is not practicable, or rather, not organized and regularly carried out, thereby necessitating the coördination of train- and air-service schedules for long-distance transportation.

Especially in the early days, the European lines suffered from lack of appreciation of the value of this educative publicity, a fact which contributed immeasurably to their difficulties in obtaining satisfactory loads. Both by this example and the far greater development of the science of advertising in this country, the coming American lines should have a considerable advantage over the European pioneers in this respect.

In the establishment of the first lines many similarities to the early days of railroading will be found, but many of the trials of the latter, both technical and financial, may be avoided. Compared with the railroad, the capital outlay involved in the air line is fractional; the non-requirement of permanent tracks involving the possession of immense tracts of land, will always be among the chief advantages the airplane possesses over any other means of overland transportation.

Ground Organization

Nevertheless, real estate values effect the increasing commerical use of the airplane to a considerable extent. There is probably no other single factor which has been so effective in retarding the general use of aircraft in this country as the lack of landing fields. Such privately owned flying fields as there are, are in only too many cases small, with obstructed surroundings and inadequate for highly loaded commerical craft. The military fields, which in Europe form the backbone of the airways, are few in the U. S., even including those abandoned after the war; also they are generally located just where the ground happened to be naturally suited for training in flying, far removed from large cities. In Europe important centers were liable to attack by enemy airplanes and defensive squadrons had to be stationed close at hand. Even in the case of the European capitals, however, the air ports now established on these old military fields are in most cases much further away from the cities than is desirable for commercial flying. If two hours have to be spent in transportation to and from the airports, in order to make a $2^1/_2$-hour journey by airplane, the saving of time over the railroad, at least where the latter provides an efficient and direct service, is practically lost, and the air line is not likely to flourish.

This problem is admittedly in most cases difficult of solution. The nearer the center of a town, the more valuable land becomes;

however well financed, the cost of such land suitable as an air port is not one which a new transportation company, which has yet to develop a popular demand for its service, can be reasonably expected to bear. The analogy with docks and harbors, of which the initial cost is borne by the city treasury, is obvious, but it is also demanding much from a city's foresight and enterprise to expect it to lock up a great amount of capital in reserving large tracts of valuable land near the business center, of which—especially at first—very scant use will seem to be made. As traffic develops, increased landing fees, hangar rents and other dues will improve the immediate financial aspect, until the time, which may not be so far distant as to be visionary, that long distance airliners will land on platforms covering the stations, yards and part of the tracks of the local railroad lines or even several city blocks.

To a layman, it would seem that in this question of reserving centrally located tracts of land as airports for a number of years there may be much to interest real estate manipulators.

The arrangement of emergency landing fields at short distances apart, along the routes, should not present any difficulties. Their preparation may involve the removal of a few trees and other obstructions and the erection of suitable markings as a guide for pilots when in difficulties due to weather or mechanical trouble, but otherwise they can retain their normal functions if meadow land is selected.

A most important part of the ground organization is the provision of a specialized and adequate meteorological service. A considerable development of the existing Government meteorological institutions or weather bureaus will be necessary, since the information obtainable at the present time is of very little use for air navigation. In Europe, government weather experts and radio services are installed on the principal airports, and reports are obtainable hourly. In England it was so well recognized that air navigation was bound to develop the knowledge and organization of meteorological work, that shortly after the war the existing government meteorological office was placed completely under the control of the Air Ministry.

Such further auxiliary services as directional radio and beaconing the airways by night, will eventually all have to be recognized as a public service and undertaken by the Government; the pooling of facilities by different railroad companies may be a matter of private arrangement and not the concern of the public, but the following of organized airways and the picking up of radio signals will automatically become a public right.

Legislation and Insurance

As is the case with any form of transportation, the perfection of organization, mechanical reliability and standing of personnel ought to be reflected clearly in the terms on which equipment passengers and freight are accepted for insurance by the large companies, and it may be fairly regarded as illustrative of the condition of commercial flying in this country that the state of affairs in aircraft insurance is far from satisfactory.

At present the position of an insurance company called upon to quote on aircraft risks is not enviable. The entire absence of any legislation to place responsibility for even the most elementary consideration of public safety, by controlling the efficiency of aircraft and ground organization, combined with the scarcity of such ground organization in the form of landing fields and auxiliary services, would induce any company to keep clear of taking aviation risks for the present, were it not for the necessity of obtaining experience and statistics as a basis for the business which the development of air transportation on a large scale will eventually offer. As it is, the present state of the aircraft insurance market may justifiably be described as chaotic. Again, risks have been accepted which should never even have been considered, and the consequent losses duly paid, while on the other hand premiums have been quoted which must have been based on a considerable "factor of ignorance," being, apparently, out of all proportion to results already been obtained elsewhere under conditions sufficiently similar to those involved in the proposal.

The institution of a system of registration and inspection of aircraft and pilots by the Insurance Underwriters Laboratories is a great step in the right direction. To make the system fully effective, it is to be hoped that legal confirmation of the powers of that body will soon follow. The assignment of such technical duties to a semi-public institution, instead of to a Government department—which principle has a strong precedent in the case of shipping in Lloyds—is in many respects preferable. The rapid development both of the airplane and its application, may necessitate frequent and urgent changes in existing regulations, with which necessity it will be difficult to keep pace if technical details are incorporated in Federal laws.

The effect which proper legislation will have on the financial stabilization of air transportation in general, both through the creation of reasonable insurance facilities, and through the definition of the legal status of the airplane and that of its operators, is well illustrated in the case of passenger liability. When legal liability for the safety of passengers and third parties is determined, insurance against these risks will become possible. At the present time the risk cannot be determined. Possibly claims on one accident are limited to the value of the machine to which it hapened, as under Admiralty Law (which presumably already applies to seaplanes); possibly they are not. The operators of aircraft can only print a strong cover against liability on their tickets, or perhaps incorporate each plane as a separate company, and find comfort in the safety statistics. It is to be noted that the latter have already led the English insurance companies to strike the clause refusing flying risks from the ordinary life policies.

With the development of the air lines, the insurance rates will undoubtedly always serve as an excellent index on the effectiveness of whatever legislation or regulation there may be and of the soundness of air transportation as a public service and a business.

A Few General Conclusions

In reviewing the possibilities of an early and successful development of air lines in this country it is imperative that the European pioneering in this sort of traffic be closely watched and that the greatest possible use be made of the experience and statistics it has provided. Except as regards purely technical matters, however, these should be applied to American projects and prospects with great circumspection and the difference in political and economic conditions be kept clearly in view. The case of direct government subsidies is a striking one, these having been largely responsible for the development of traffic in Europe, while they are practically unthinkable in this country. What is wanted from the Government here is what may justifiably be looked upon as its natural obligations, that is, the provision of facilities of all kinds, as outlined above. That direct financial assistance ever fosters true progress and new developments no one believes. Human nature being as it is, the tendency is inevitable to regard official aid as manna from Heaven and let things take care of themselves; not to speak of the countless opportunities for favoritism, intrigue and worse, that it entails. Abroad, conditions are different in that respect. It should not be forgotten that most European trunklines are international in character and that national pride and political expediency are potent factors in matters of this kind. Also that the various governments have a much greater interest in the maintenance of a commercial air-fleet as well as a ground organization that can be requisitioned at short notice in case of need, than will ever be the case in this country.

Apart from their questionable desirability on the grounds touched upon above, direct subsidies should not be *necessary*. The variety of geographical and economic situations which the United States offers within its own boundaries will provide plenty of scope for financially successful commercial flying operations, if properly taken in hand with proper equipment. The moment that air transportation shows its inherent advantages to the business men of America it will be used on a scale which will leave European traffic figures far behind from the very start. The history of the automobile is a good example.

The amount of traffic, both in passengers and express matter from which the air lines will be able to draw their share, is great. The "magnificent distances" to which President Harding alluded in his recent message on this subject automatically insure the saving in time that makes air travel pay.

But the first steps are always the hardest and official support in some practical form for operators and builders of commercial

(*Continued on page 111*)

The Strength of Airplane Rib Forms

Description of An Investigation to Determine the Strength of Plywood Webs, with Lightening Holes Arranged as in Airplane Ribs

By D. T. BROWN,[1] PHILADELPHIA, PA. and R. J. DIEFENBACH,[2] BUFFALO, N. Y.

As illustrating the problem of the strength of materials entering into airplane construction and the degree of research necessary for their proper solution, the following report of an investigation carried out at the United States Forest Products Laboratory will be of interest. In the design of airplane ribs the prime requisite is to obtain the maximum strength with minimum weight of rib. Two factors enter into the problem: the form or design of the rib and the method of its construction in relation to the grain of the material. It will be seen that the investigation reported was conducted in a very complete manner and that conclusions of great value in the design of this essential part of the airplane are brought out.

THE great difference in the strength properties of wood along and across the grain has long been recognized as one of the features restricting its use in structures. Tests made by the U. S. Forest Products Laboratory show that the approximate ratios of the strength properties in these two directions are: The modulus of elasticity across the grain is one-fifteenth of that along the grain; the tensile strength across the grain is one-twentieth of that along the grain. These ratios do not apply exactly to any individual species, since different species vary largely in this respect.

A very material reduction in the differences along and across the grain is obtained in ply-wood construction by gluing together successive sheets of veneer with the directions of the grain at right angles, and varying the proportion of grain and number of plies in the two directions.

In the design of airplane ribs the prime requisite is to obtain the maximum strength with minimum weight of rib. This series of tests has been made to find the strongest form of rib, taking into account the two factors above mentioned by placing the grain of the veneer 45 deg. to the vertical. In modern practice the face grains are vertical and the core horizontal. Most of these tests, however, were made with the face grains parallel and at 45 deg. to the vertical with one core at 90 deg. to the face grain.

DESCRIPTION OF THE MATERIALS USED

Birch veneer $^{1}/_{28}$ in. thick was used. In order to obtain a fair comparison in the tests, all of the veneer used in making up the ply-wood was cut from one log. The veneer used consisted entirely of heart wood, the log being sufficiently large to eliminate the need of using any sap wood. No pieces containing knots or checks were used. The veneer had been in store for some time and was well seasoned.

The veneer was glued together into three-ply ply-wood by the Theodore Schwamb Company, which specializes in such work. The ply-wood was cut into specimens $4^{1}/_{2}$ in. wide by 18 in. long. As already noted, the face grains were parallel and in most of the tests at 45 deg. to the vertical, and the core was placed at 90 deg. to the face grains. One of the chief objects of these experiments was to determine the effect of making the web of a rib from plywood with the grain at 45 deg. to the chord, so that the grain runs parallel to the directions of the principal stresses at the neutral axis of the web.

The ply-wood now used in practice in airplane ribs is made up with the face grains parallel and usually vertical and the core horizontal. This method has proved generally stronger than if the reverse disposition is used, that is with the face grains parallel and horizontal and the core vertical.

In order to prove the superiority of the method suggested in this paper some specimens were made according to modern practice and tested under like conditions.

THE METHODS OF TESTING EMPLOYED

In all cases the specimens were tested as cantilevers at a 15 in. arm. Spruce flanges $^{1}/_{4}$-in. square were glued on the sides of the specimens to prevent lateral collapse as a whole. In order to insure a definite length of cantilever arm and also for holding purposes, a hardwood block, $^{1}/_{4}$-in. by $3^{1}/_{2}$-in. square was glued on each side at one end of the specimen. The specimens were held in a wide-jawed vise; knurled jaws were used to avoid slippage. The load was applied by a smooth-acting screw jack, and the force was measured by placing the screw jack on a small platform scale which could be read accurately to one pound. Upon the head of the screw jack, a round steel bar was placed. This insured a concentrated load at the end of the cantilever.

THE RESULTS OBTAINED

In the rectangular type of lightening hole with constant web thickness and variable fillet radius, it was found that below $^{3}/_{4}$ in. radius the fillet was of but little use.

The specimens for the tests made in the next group, were made with variable radius of fillet using lattice construction. A maximum of 283 lb. was reached in this group. Since 181 lb. was the maximum force applied at the end of a 15-in. cantilever with vertical grain and rectangular holes, and since it has generally been found that lattice design with triangular holes is little, if any, stronger than that involving amply filleted rectangular holes, if vertical or horizontal face grain is used in both cases[1] the advantage of diagonal-grain design for the lattice form appears to be clear. The comparison between the best case with diagonal grain and lattice design and the best arrangement of rectangular lightening holes with vertical grain expressed in percentage change from the second to the first is as follows:

Radius of fillet, in.	Increase or decrease of area not cut out (change of web weight, per cent)	Increase or decrease of force applied to produce failure, per cent
$^{1}/_{4}$	−29	+12
$^{1}/_{2}$	−2	+29
$^{3}/_{4}$	+2	+56

The advantage of the lattice construction is obvious. Inspection of Table 1, where the ratio of strength to area of web is given, indicates that that ratio is little affected by radius of fillet, the smaller radii having a slight advantage.

TABLE 1 RATIO OF STRENGTH TO AREA OF WEB

Type of Construction	Variable	Width of Vertical or Diagonal Web Members, in.	Radius of Fillet, in.	Character of Failure	Distance between Center of Cross	Per cent of total Area Cut Out	Per cent of Area Remaining	Force Applied at end of 15-in. Cantilever, lb.	Force ÷ Per cent of Area Remaining
Rectangular lightening holes	Radius of fillet	$^{1}/_{2}$	0	Shear	....	76.1	23.9	50	2.09
		$^{1}/_{2}$	$^{3}/_{4}$	Shear	....	73.1	26.9	55	2.04
		$^{1}/_{2}$	1	Shear	....	70.7	29.3	64	2.18
		$^{1}/_{2}$	$1^{1}/_{4}$	Shear	....	67.7	32.3	97	3.00
		$^{1}/_{2}$	$1^{1}/_{2}$	Shear	....	63.9	36.1	134	3.71
Lattice	Radius of fillet	$^{5}/_{16}$	$^{1}/_{4}$	Compression	....	74.6	25.4	202	7.95
		$^{5}/_{16}$	$^{1}/_{2}$	Compression	....	70.3	29.7	233	7.85
		$^{5}/_{16}$	$^{3}/_{4}$	Compression	....	63.3	36.7	283	7.71
Lattice	Thickness of web	$^{5}/_{16}$	$^{1}/_{4}$	Compression	....	74.6	25.4	202	7.95
		$^{3}/_{8}$	$^{1}/_{4}$	Compression	....	73.0	27.0	238	8.82
		$^{7}/_{16}$	$^{1}/_{4}$	Compression	....	71.5	28.5	256	8.98
		$^{1}/_{2}$	$^{1}/_{4}$	Tension	....	69.9	30.1	278	9.24
Crossed lattice	Distance between center of cross	$^{1}/_{4}$	$^{1}/_{4}$	Compression	7 in.	70.9	29.1	201	6.90
		$^{1}/_{4}$	$^{1}/_{4}$	Compression	6 in.	69.3	30.7	230	7.49
		$^{1}/_{4}$	$^{1}/_{4}$	Compression	5 in.	67.2	32.8	280	8.54
		$^{1}/_{4}$	$^{1}/_{4}$	Flange	4.5 in.	65.7	34.3	295	8.60

The ratio of strength to weight is steadily improved by increasing the width of the diagonals, although the improvement is slow for widths of $^{3}/_{8}$ in. or more.

A crossed-lattice arrangement with a spacing between the crosses

---

[1] Sales Dept, American Radiator Co.

[2] Student Sales Engineer, Worthington Pump & Machy. Corpn. Jun-Mem.Am.Soc.M.E.

Abstract of paper presented at the Annual Meeting, New York, December, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

[1] Bulletin Airplane Engineering Division, U. S. Army, September, 1918.

of 1.5 times the depth of the lightening hole appears to be approximately equal to the best straight-lattice arrangement. It is difficult to make a satisfactory direct comparison, as the required depth of the horizontal portions of the web, above and below the lightening holes, varies with the distance between lattice members. With due allowance for this fact, a very close spacing of the crosses seems to be best.

With forces in excess of 300 lb. the flange fails by shearing. In the crossed-lattice construction true shear failure of the diagonals never occurred. The compression members are supported by the tension members in such a way as to decrease the free length of the column under compression.

In connection with this crossed-lattice group some specimens were tested with the compression member left out in every other cross. This arrangement is palpably inferior to the straight-lattice or continuous crossed-lattice. It was found that the crossed-lattice type did not stand up so well relatively with web thickness of $^{3}/_{16}$ in.

A continuous cross lattice spaced at 3 in. with vertical grain, carried 214 lb. Even this design is far better than that with rectangular holes.

Finally a test was made with no area cut out and it failed by buckling of the flange at 325 lb.

It was observed in the tests made that there was but little deflection with both the straight lattice and cross-lattice type. The deflection with the rectangular type was much more pronounced.

PROGRESS IN FLYING DISCUSSED

PRACTICALLY all of the discussion at the session was on the commercial aspects of aviation. Mr. Joseph A. Steinmetz, chairman of the Executive Committee of the Aeronautic Division, discussed the present status of aerial development, describing the progress in Europe from first hand observation this summer, and the progress in this country, especially in the South, where commercial lines are about to be inaugurated. In the construction and development of aviation throughout the world, he saw tremendous possibilities for the art within the next few years.

Prof. E. P. Warner, Massachusetts Institute of Technology, who presided at the session considered that our fundamental purpose is the development of commercial flying, which has ceased to be a problem of design and construction, and has become one of publicity.

Lieutenant E. E. Aldrin, secretary of the Division in the discussion of Mr. Noorduyn's paper, detailed his experiences on the London to Paris Air-Line this summer. He said there was no question of the advantage of commercial flying, if only from the point of saving time.

Commercial flying in Europe is now developed to the point that the passenger uses a time-table just as he does for a railroad train.

Then again, the comforts of the air journeys are a favorable consideration.

Mr. Foster Russell[1] asked a number of questions regarding the cost of carrying mail and Major Lent answered him, pointing out also that there was much greater promise of commercial success in carrying goods, such as mail, than in the transportation of passengers. A study had been made of the profits to be derived. The commercial companies acknowledged that they were after express business and other high class matter, and would be glad to avoid the risk of carrying passengers.

Mr. Noorduyn answered a question of Mr. Russell's that the Government would gladly turn over the carriage of mail to private transportation companies provided that they could show satisfactory prospects of rendering good service, but that the Congressional appropriations would not allow the payment of a higher rate for air-line transportation than by any other means.

There was considerable discussion of the possibilities of aircraft landing fields, and Mr. Steinmetz related his experience in getting such fields. He said the way to do it was to get a City Plan Conference to set aside a big fair ground, or a county exposition field, and then get an engineer to go over the layout with them and put in an aircraft landing field. Later on they could be shown their great wisdom and foresight in providing for an air port for world traffic.

Mr. Russell, thought the main problem of commercial flying was the provision of a machine which could be made and sold very much like a Ford automobile is sold, something that could be sold to farmers. He also gave his experiences with landing fields, reciting some of the cases encountered in trying to get such fields. He thought the best thing to do was to get airplanes in the air and the landing fields would come.

Several of the speakers present discussed the feature of safety in commercial flying, and there was a general agreement that great publicity should be given to the relatively small amount of risk, added to the extreme pleasure of this form of transportation.

Among those who took part in the discussion was Mr. Charles Manly, past president of the Society of Automotive Engineers, and a well-known figure in the practice of aviation. Mr. Manly outlined in great detail the things that would have to be done to make commercial flying popular with the public, and to make possible the development of commercial aviation companies on a profitable basis, without which there could be no commercial flying. The only other thing to be met was that a machine should be provided which could be bought for a reasonable price.

---

[1] Spokane, Wash. Jun-Mem.Am.Soc.M.E.

ELASTIC PROPERTIES OF SMALL-SIZE WIRE CABLE

(Continued from page 106)

TABLE 3 AMOUNT OF INCREASE IN ELASTIC LIMIT OBTAINED ON THE CABLES TESTED

Type	Size	Increase in Elastic Limit, Lb.	Per Cent Increase over Original Elastic Limit
19	$^{7}/_{32}$	2000	62
	$^{3}/_{16}$	1000	33
7 by 7	$^{3}/_{32}$	250	63
6 by 7	$^{9}/_{64}$	210	30
7 by 19	$^{1}/_{8}$	400	36
	$^{11}/_{32}$	2000	33

CONCLUSIONS

The modulus of elasticity of small-size wire aircraft cable varies from 15,000,000 to 28,000,000, depending upon the size and types of the cable. The 19-wire cable has undoubtedly the highest modulus and the 7 by 19 cable probably the lowest. The maximum difference between moduli of specimens of the same size and type of cable may be as high as 3,000,000.

The modulus of elasticity may be raised by loading the cable below the elastic limit. The greatest increase is obtained on the 7 by 19 type and may amount to 6,500,000.

Resting the cable did not seem to have any definite effect on the modulus.

The elastic limit may be raised by loading the cable a little beyond this point. The maximum increase obtained amounted to 63 per cent of the original elastic limit.

The complete paper contains curves of all the runs in the different sizes, also complete logs of the tests.

AIR LINES AND SOME OF THEIR PROBLEMS

(Continued from page 109)

aircraft would do much to ease the situation. Contracts for the carriage of mail at rates, commensurate with the increased rapidity of delivery, could be given to reputable air transport concerns whose facilities for carrying out their engagements would bear investigation. Congress can make this possible as it did when mail coach and couriers were replaced by the railroad.

Another valuable form of subsidy would be the development of all purely war-types of machines in the shops of commercial builders and a system of awarding to designing firms paying production contracts for their own original products. Thereby would the aeronautical industry regain a good deal of the confidence which apparently it has lost. And the blending of the newest ideas in aeronautical warfare or defense with the most modern developments in efficiency and reliability would go a long way, in the writer's opinion, toward the reëstablishment in this country of supremacy in the air.

A Session on Fuel Economy

Discussion of Four Papers at A.S.M.E. Annual Meeting Brings Out Many Experiences in Economic Boiler and Furnace Operation, Leading to Great Fuel Savings

THE Fuel Waste Session of the Annual Meeting of The American Society of Mechanical Engineers, held Thursday morning, December 8, 1921, attracted a large audience and a voluminous discussion on account of the popular interest in the subject. Prof. L. P. Breckenridge, Chairman of the Fuels Division, presided at the meeting. The papers presented were, Boiler Plant Efficiency, by Victor J. Azbe: Boiler and Furnace Economy, by D. S. Jacobus; Fuel Saving in Relation to Capital Necessary, by Joseph Harrington; and Fuel Saving in Modern Gas Producers and Industrial Furnaces, by W. B. Chapman. All these papers have already been published in MECHANICAL ENGINEERING.

ALL CONCEDE MR. AZBE'S STATEMENTS SOUND

J. M. Spitzglass[1] quoted the following paragraph which, he said, he believed to be the keynote of Mr. Azbe's paper:

> Nowhere is there such an opportunity for good return on the investment as in the boiler house, where a few dollars properly applied can perform wonders. But there are also properly designed plants that are wasteful, due to human inefficiency, and to such beliefs as that stokers are a failure, high CO_2 harmful, economizers a poor investment, superheated steam impractical, etc. It is the man who designs or operates who is at fault, rather than the equipment. The fireman is more important than the stoker and a good fireman will obtain good results from a poor stoker. But since good firemen are scarce, it is preferable to purchase equipment which is as nearly foolproof as possible.

Wm. S. Aldrich[2] wrote suggesting that in grading combustion performance, a percentage scale with maximum possible CO_2 as 100 per cent be used.

John Clinton Parker[3] spoke in commendation of the paper. He pointed out the necessity for honorable design, honorable testing and honorable operation in the engineering world.

R. Sanford Riley[4] considered the paper absolutely sound, saying that nothing sounder had been expressed before the Society than the author's ideas on differences in conditions of operation.

D. S. Jacobus[5] said he wished to add that, in getting the most out of a boiler plant, more must be considered than the efficiency of the boiler and the efficiency of the plant in general. Much of the saving to be made in boiler plants is often not in improvements in the boilers themselves, although many times such improvements can be made, but by such means as changing the system of heating feedwater, or of providing hot air, or of adjusting the heating system.

David Moffat Myers,[6] speaking in the spirit of Dr. Jacobus's remarks, told of making a saving of 15 per cent in a plant without making a single change. The firemen, conscious of his presence, had paid better attention to their jobs, with the resulting saving. In other plants he had found that merely by requiring simple records kept, economy was improved through the psychological effect on the firemen. He also spoke of the necessity of providing the firemen with an incentive for good work. Efficiency in a plant, he said, was a combination of the efficiency of the men and the efficiency of the machine.

C. H. Smoot[7] asked who was responsible for low efficiency in boiler plants—the manufacturer of the boiler, the manufacturer of the stoker, the operator, or the fireman? If it is possible to increase the efficiency of boilers from 50 to 80 per cent, as stated by the author, it seemed to him that such an organization as the Society should see to it that such savings were made.

C. Harold Berry[8] assumed that most of the statements of the author's paper referred to small plants, and not to central stations. He also pointed out that the tests reported in Table 3 of the paper were made at different ratings, which might account for some change in the efficiency. The author's statement that most stations had too many boilers did not apply to central stations.

In reply to Mr. Berry, the author pointed out that the tests referred to were run in each case at maximum capacity, showing that improved conditions resulted in increased capacity as well as increased efficiency.

DR. JACOBUS' PAPER CHARACTERIZED AS FILLED WITH WISDOM

W. F. M. Goss[9] characterized the paper as a concise statement of significant facts and a monument to the industry and scientific skill of its author. He has long had a part in the development of this field of engineering research, and much that is common knowledge today, has come through the painstaking processes which he has inspired and promoted. Underlying this paper therefore are activities incident to his fruitful life.

Edward N. Trump[10] wrote congratulating the Society on having received such an able paper as that of Dr. Jacobus, saying that it was full of the wisdom of long experience. A survey made by the Fuel Administration during the war had shown that the average efficiency of plants in the State of New York, even including the large plants operating at 80 per cent efficiency, would not be greater than 50 per cent.

While we should study the investment factor, he said, in determining whether or not to replace an inefficient plant, we must remember that the supply of coal in this country is not inexhaustible and will always increase in cost, and we owe something to posterity. We should be content to take a low rate of return on our capital, expecting other advantages which are more difficult to calculate.

He dealt with such questions as economizers, corrosion, high boiler setting, operation of boilers at high rating, furnace volume, and form of furnace as affecting the economy of operation.

Alex D. Bailey[11] wrote in reference to a statement of the author that air heaters are of special advantage where low-grade fuels are burned. While this may be true as stated, he said, it is equally true, particularly in the case of coal, that on account of the sulphur content, air heaters might operate at the greatest disadvantage.

So far as the personnel of boiler plants is concerned, probably the greatest need for education and missionary work is with managers and chief engineers who do not appreciate the importance of this part of power-plant operation.

Automatic systems for combustion control will never take the place of brains, and while these may function fairly successfully if left alone, their ultimate success would be improved by proper supervision and care.

To attract the right kind of men the conditions in the boiler room must be made attractive, and to get the best results proper equipment must be provided, so that the men with proper education and training can get the desired results.

R. Sanford Riley[12] wrote that we all agree that combustion should be completed within the furnace chamber. This requires volume and proper opportunity for mixing of the gases. He could not see, however, that efficiency is increased by the maintenance of a high temperature in the furnace between the fuel bed and the boiler. The maximum temperature due to combustion of the fuel will be obtained when there is high percentage of CO_2 without CO, or in other words, when there is a minimum of excess air accom-

---

[1] Cons. Engr., Republic Flow Meters Co., Chicago, Ill. Mem.Am.Soc. M.E.

[2] Gary, Ind. Mem.Am.Soc.M.E.

[3] Editor, *Lefax*, Sheridan Bldg., Philadelphia, Pa. Mem.Am.Soc.M.E.

[4] Pres., Sanford Riley Stoker Co., Worcester, Mass. Mem.Am.Soc. M.E.

[5] Advis. Engr., The Babcock & Wilcox Co., New York, N. Y. Mem. Am.Soc.M.E.

[6] Cons. Engr., Griggs and Myers, New York, N. Y. Mem.Am.Soc. M.E.

[7] Engr. & V. P., Rateau, Battu Smoot Co., New York, N. Y. Mem. Am.Soc.M.E.

[8] Research Engr., The Detroit Edison Co., Detroit, Mich. Mem.Am. Soc.M.E.

[9] Pres., Ry. Car Manufacturers Assn., New York, N. Y. Mem.Am. Soc.M.E.

[10] V. P., The Solvay Process Co., Syracuse, N. Y. Mem.Am.Soc.M.E.

[11] Chief Engr., Stas. 1 & 2, Commonwealth Edison Co., Chicago, Ill. Mem.Am.Soc.M.E.

[12] Pres., Sanford Riley Stoker Co., Inc., Worcester, Mass. Mem.Am. Soc.M.E.

panied by complete combustion. The above condition represents, of course, the highest combustion efficiency and if Dr. Jacobus means "temperature of combustion" or "fuel bed temperature" when he says "furnace temperature," he could certainly agree with his statement. The temperature within the furnace chamber, however, need not be as high as this maximum temperature of combustion.

Elsewhere in the paper Dr. Jacobus mentions the large utilization of radiant heat, and he was much impressed with the statement that B & W boilers may absorb as much as 60 per cent of the total heat by radiation. It seemed to him that this large absorption by radiation is all to the good, and the consequent lowering of furnace temperature is one reason why it is so good. No compromise is necessary in this respect, except to secure ignition. With underfeed stokers there is no need to make any compromise whatever, and the best practice seems to be to expose the maximum area of tubes to radiant heat and thus hold down the furnace temperature. This transfer of heat by radiation is the direct route "from maker to user." There is then no middleman like brickwork to take toll and cause trouble. Convection can also be considered a middleman but does not require much attention or cause any trouble.

He suggested the theory that all boiler-furnace construction should utilize radiation to the maximum, and so hold furnace temperature down to the minimum. This theory has nothing to do with the temperature of combustion in the fuel bed, which of course should be the highest possible to correspond with the minimum of excess air.

E. L. Hopping[13] presented a written discussion referring to the design of furnaces for 1500-hp. Stirling boilers, with integral economizers, at the Delaware station of the Philadelphia Electric Co. Two considerations were kept in mind;

a That the furnace be made sufficiently large to allow for efficient operation at high rating without detriment to furnace walls or stoker parts

b That in case it was found desirable, after installation of the boiler, to change to some other type of fuel burning, the cost of such a change would not be prohibitive and that conditions would be such as to produce the highest economies.

The furnace as finally designed and built has a volume of 4.8 cu. ft. per rated boiler horsepower, or about $1^1/_2$ cu. ft. per maximum developed horsepower, which is a rather high rating for stoker-fired boilers. These boilers were designed to operate at maximum capacities of about 300 per cent normal rating.

The results obtained in operation of these boilers have been very satisfactory and one condition which was not looked for has been secured. This is the practical elimination of the cinder nuisance at this plant.

Edwin B. Ricketts[14] discussed the subject of deformation temperature of furnace brickwork and methods of decreasing it by currents of steam or air or by circulating water through pipes in the brickwork. He also spoke of the lack of uniformity of size of furnace brick and methods of overcoming the difficulty.

A. A. Cary[15] pointed out the difficulty of separating the efficiency of the boiler from the combined efficiency of boiler and furnace. Notwithstanding the difficulties involved, he had found it desirable to determine individual efficiencies for boiler and furnace, and he explained his method. Dr. Jacobus' statements concerning firebrick he considered important, and he discussed carefully the problem involved in the design of the furnace, the selection of the material and the character of the clays used.

David Moffatt Myers urged the necessity of taking the matter of fuel conservation out of the hands of the individual, who will always be wasteful, and placing it with an authority powerful enough to insist upon economical utilization of this valuable natural resource, and suggested means by which this might be accomplished.

Wm. S. Aldrich offered some data covering experiences with a vertical water-tube boiler, installed originally as a waste-heat boiler and hence heated almost entirely by convection. The boiler was subsequently used with oil and with coal fuel, experiments showing that the conclusions of Dr. Jacobus were correct. This discussion spoke also of difficulties with brickwork at high temperature.

F. F. Uehling[16] wrote in amplification of Dr. Jacobus' statements regarding the presence of a small amount of CO with a high percentage of CO_2. Since the relation which the percentage of CO in the products of combustion bears to the loss up the chimney is a very interesting one, it occurred to him that a few curves showing chimney losses for different percentages of CO and CO_2 might prove not only interesting but also of value to engineers when the importance of CO content in flue gases is given their consideration. The curves were shown on the screen.

One of the most striking facts brought out in the curves is that there is not only a *loss* due to the presence of CO but *also a gain*, and the net magnitude of the CO loss is their difference. In other words, the effect of CO on chimney loss is twofold, one positive and the other negative, and the resultant actual CO loss can be determined by their algebraic summation. Furthermore the net effect of CO on the chimney loss may be plus, minus or zero, depending upon the conditions obtaining.

What actually takes place when CO is present is:

First, a loss results due to the unliberated heat in the CO itself, that is to say, the additional heat that would be available if the CO in the products of combustion had been oxidized.

Second, a gain occurs due to the fact that the more CO there is in the products of combustion for any given percentage of CO_2 the less will be the weight of the products of combustion per pound of carbon burned, and consequently the less will be the sensible heat dissipated by the flue gases as they leave the boiler.

John A. Stevens[17] spoke of the arrangements at the new central power station at Paris for preheating the combustion air to 190 deg. fahr. Another system has been devised for preheating to 170 deg. The proper temperature seems to be between 170 and 190 deg. fahr. The preheaters consist of a series of plates beyond the economizer, through which the air for combustion travels in one direction and the exhaust gases in another. The heater can be easily cleaned, both inside and outside.

Dr. Jacobus submitted additional matter after the meeting in which he said that the statements in his paper respecting the influence of the amount of boiler heating surface exposed to direct radiant heat from the fire on the efficiencies should be amplified. Where some portions of the fuel bed are much hotter than others a higher efficiency may be obtained by absorbing the maximum amount of radiant heat directly from the fuel bed rather than by mingling the gases within the furnace and afterwards passing them to the boiler. In general, however, the higher the furnace temperature the higher the efficiency. This part will be more fully covered in his closure.

Mr. Harrington's Subject a Public Affair

Walter N. Polakov[18] opened the discussion of Mr. Harrington's paper by emphasizing the fact that the conservation of our resources is in reality a public affair. Machinery, boilers and stokers, furnaces, instruments in the boiler room are of little importance unless the human element is back of them, and unless the intelligence is present to make use of what is available. The fact that daily performance does not equal test performance is due, he said, to four things: First, monotony, which is absent from test conditions; second, stimulation always present under test conditions; third, lack of coördinated brain and manual effort, as is essential in tests; and fourth, the close watch on all conditions which must be maintained during the test. It is important to increase the interest of the power-plant personnel in the use of instruments and to train them properly to observe the indications of these instruments. Whatever instruments are necessary, he said, usually pay for themselves within a short time.

T. A. Marsh[19] called attention to some changes made in the

(*Continued on page 118*)

---

[13] M. E., Philadelphia Electric Co., Philadelphia, Pa. Mem.Am.Soc. M.E.

[14] Asst. to Ch. Oper. Engr., New York Edison Co., New York, N. Y. Mem.Am.Soc.M.E.

[15] Cons. M.E., 95 Liberty St., New York N. Y. Mem.Am.Soc.M.E.

[16] General Mgr., Uehling Instrument Co., New York, N. Y. Mem.Am. Soc.M.E.

[17] Cons. Engr., Lowell, Mass. Mem.Am.Soc.M.E.

[18] Cons. Engr., New York, N. Y. Mem.Am.Soc.M.E.

[19] Ch. Engr., Green Engrg. Co., East Chicago, Ind. Mem.Am.Soc.M.E.

National Research Council to Coördinate Research Throughout Country

With Assistance of All Research Agencies, Complete List of Investigations to be Kept—A.S.M.E., in First Annual Research Conference, Considers Means of Covering Mechanical Engineering Field

A MECHANICAL Engineering Advisory Committee for the Division of Engineering of the National Research Council has been formed within the organization of The American Society of Mechanical Engineers, with the Society's Standing Committee on Research as a basis. The contemplated program is described in the following article by Alfred D. Flinn, chairman of the Division of Engineering, who detailed the plan at the Annual Meeting of The American Society of Mechanical Engineers, at a Research Conference held on the morning of Thursday, December 8, 1921.

MECHANICAL ENGINEERING ADVISORY COMMITTEE FOR DIVISION OF ENGINEERING

By ALFRED D. FLINN, NEW YORK, N. Y.

MECHANICAL engineers make use, in some measure, at some time, directly or indirectly of many results of scientific research. There are, however, certain problems requiring scientific and engineering investigation which fall within the field regarded as peculiarly that of mechanical engineers. Among these, by way of example, may be mentioned problems relating to heat transfer, fatigue or progressive failure of metals, lubrication, cutting of metals, heat treatment of metals, welding, fuel economy and properties of steam.

Fields requiring research related to engineering are numerous and broad; the corresponding fields of application are occupied by the societies represented on the Division of Engineering. These societies have close contact with practicing engineers and the industries. The Division consequently came to the conclusion last Spring, that it could render best service and most wisely select and control its activities if it had the guidance of an advisory committee, or board, in each broad field of engineering. Such committees or boards are therefore being organized or have been organized in civil, mining and metallurgical, mechanical, electrical, highway, and welding fields. In some cases two or more societies having kindred interests have joined in one advisory committee.

Of course, the Division can proceed no faster in the development of these advisory committees than the societies are disposed to progress, or the committees themselves are willing to go.

Functions which the Mechanical Advisory Committee is expected to perform in its several fields are:

1 To act as clearing-house, steering committee and coördinating agency, in an advisory capacity
2 To advise the Division in selecting the most promising and feasible researches and in organizing the research committees
3 To propose researches which would be of especial interest to the A.S.M.E. and the societies associated with it in the Advisory Committee
4 To consider ways and means suggested by the Division for the conduct of the selected researches
5 To serve as the connecting link between the Division and the Society or the group represented by the Advisory Committee.

The form and degree of organization may be adjusted to the desires of the Advisory Committee. The American Bureau of Welding is an example of complete and close organization. The committee representing the A.S.M.E., at its first meeting, held December 8, 1921, preferred informal organization, leaving organizational development to be made as needs become apparent. The functions in such a field may be performed in general through sub-committees, by correspondence. It will hardly be feasible to hold meetings of the whole Advisory Committee oftener than once a year, in conjunction with the annual meetings of the Society. It may be that in the future one session of each annual meeting will be given over to a program of papers, reports and discussions on research topics under the auspices of the Research Committee.

Sub-committes may be suggested by the Division from time to time as needs arise. The interests of the Advisory Committee will suggest others. Initiative on the part of the Advisory Committee is much desired by the Division. Permit the suggestion also of an interim committee of a few members to conduct the business of the Advisory Committee between meetings of the latter.

The National Research Council has thirteen divisions. Six are devoted to general relations—Federal, Foreign, States, Educational, Research Extension, Research Information. Seven divisions are devoted to technical research, including engineering, agriculture, medicine, and the mathematical, physical and biological sciences. The Division of Engineering is made up of representatives of ten societies, including all four national engineering societies, and a number of members chosen because of their interest and their prominence in engineering.

The Division of Engineering is a switchboard, or telephone exchange, or clearing house, to bring together from one extreme the man in industry who wants to see practical results and who is loath to put money into research even then, and the man at the other end, who is called the pure scientist, and the various grades between them. One great advantage of the Research Council is that in its many committees it is able to assemble these many points of view of pure research men and the "practical" industrial men, by personal contact and by correspondence. It often happens that information or a suggestion is picked up from committee associates which is very valuable—information in the different branches of chemistry, biology, physics, geology, engineering, medicine. This feature of the work of the Research Council deserves emphasis—the bringing together of minds in many lines of scientific and industrial pursuits and the possibility of getting one man to help another, often incidentally, even though the connection of their problems at first thought seems remote.

The Division (and the Research Council as a whole) needs close contact with the various main groups of engineers in order to know how it can serve them most effectively and most acceptably. Small groups of men working in the Research Council's offices, or in committees closely connected with those offices, cannot get the various points of view which are needed except from a large group like the Advisory Committee. But if a group like this exists and can be readily reached through its chairman and its sub-committees, problems can be referred to it and sound advice can be obtained on the willingness to support a given project, or reasons for modifying or declining the proposal. At least the Division can get the suggestions of men who have been working on that line, whatever it may be, or who are prepared in their establishments to undertake to advantage the investigation selected.

At the Grosslichterfelde Laboratory, near Berlin, there is a wonderful card catalog. It is reported to have been claimed that of all the questions that came to this laboratory, eighty per cent were answered by the card index. Some one in Germany or elsewhere had worked on the subject in question and those cards showed where the information was. Be it noted that the questions sent to this laboratory were supposed to require original research work. That is the value of having information or keys to information available and concentrated at one place. In its field the Division of Engineering seeks to become useful in that way for the various branches of engineering and allied industries. Much more broadly the Research Information Service at the Washington office of the Research Council is endeavoring to build up such a collection of keys to scientific information and research personnel for the scien-

tists and engineers of the country. It will require the aid of many men who are leaders in technology and science. Engineering Societies Library is coöperating.

Interesting reports, papers or discussions presented to the Division of Engineering are offered for publication to the member society most likely to be interested. Occasionally such statements are issued as bulletins of the National Research Council.

Not a few research projects have phases which interest more than one society. Fatigue of metals has both metallurgical and mechanical aspects and concerns the civil engineer besides. Welding enters the fields of mechanical, electrical, civil and mining engineering, in addition to being a metallurgical and physical problem and interesting the welders as specialists. Heat transfer affects all branches of engineering, but especially the mechanical, the heating and ventilating, the refrigerating and the automotive societies. Highway research concerns particularly the civil, automotive and mechanical engineers. These few incompletely stated examples but indicate and emphasize the need for such a clearinghouse as the Division of Engineering.

Through the generous coöperation of the Engineering Foundation, the Division of Engineering has offices in Engineering Societies Building, 29 West 39th Street, New York, the focus of American engineering. The headquarters of the National Research Council is in Washington. Information in further detail will gladly be given in response to inquiries addressed to the office of the Division of Engineering.

PROCEEDINGS OF RESEARCH CONFERENCE

To those who heard Mr. Flinn's plea for the coöperation of The American Society of Mechanical Engineers with the National Research Council in the attempt of the latter to place on file all the information available on research, and who also heard the discussions at the conference, there came the mental reaction that an enormous amount of research along parallel lines must be going on at any time and that there is really a lack of general information as to what research is really in progress. For in the comparatively small group—about fifty—gathered at the conference, men engaged in important work learned practically for the first time of the details or work with many similarities being conducted by others sitting almost beside them.

This fact must have impressed the chairman of the A.S.M.E. Research Committee, Prof. A. M. Greene, Jr., who conducted the conference, when he made the remark that "a Research Conference such as this should be held at least once a year. Today is only a starter. Our Standing Research Committee of five is not able to do this kind of work; the committee is at present busy on such subjects as lubrication, bearing metals, flow of fluids, heat transfer, steam constants, permanency and accuracy of engineering instruments, vibration of shafting, torsional stress, vibration stress, friction of glass. These subjects represent particular phases only, though the whole field of mechanical engineering is open to the committee and the Society.

"The National Research Council feels that the Society ought to be available to furnish information on any branch of the subject, but only by a much larger committee organization than the present can this be done. Therefore the suggestion was that there should be a committee of about thirty-five, which would be a kind of subcommittee of the Research Committee, and an advisory committee to the National Research Council."

Throughout the proceedings of the conference there was no objection in principle to this kind of organization. It was felt, however, that the organization should be more or less informal and flexible, and formed with the idea that it could be made available to the National Research Council at any time upon its request.

Papers Presented and Discussed

To confine the discussion at the conference to definite subjects it had been arranged that four topics should be introduced. Two of these were technical papers: Elimination of Waste in Industry Through Research, by F. A. Wardenburg;[1] and Research in Leather Manufacture, by Arthur W. Thomas.[2] The other two were, respectively, Report of the Research Sub-Committee on Lubrication, and Discussion of Steam Table Research. While a number of valuable ideas were brought out in the discussions by the research specialists present, the account here given of the remarks made is confined as far as possible to the two things necessary for a successful liaison with the National Research Council: An indication of (1) the extent to which important work is being more or less duplicated in some other place; and (2) the probable degree of general publicity about research work in progress. The papers by Messrs. Wardenburg and Thomas are both condensed considerably to fit within the space of this special account of the Conference.

ELIMINATION OF WASTE IN INDUSTRY THROUGH RESEARCH

By F. A. WARDENBURG, WILMINGTON, DEL.

The prime object of business is the making of money, and if research work is to maintain its proper place in business, it must be conducted so that it will more than pay its way.

Perhaps in no other work is it more difficult to foresee the difficulties liable to be encountered, and research work is always approached in a spirit of optimism. As a consequence, the cost is almost certain to be underestimated, not infrequently as much as 50 per cent, and the saving is very liable to be overestimated. As the work progresses the solution of the problem seems always just "around the corner," and more and more expenditure is incurred until the final cost may be greater than the saving effected. This is particularly true of the development of new machines or processes, but to almost as great an extent with an improvement to something existing. The result may be that the research, instead of decreasing waste, adds to it.

From the standpoint of the permanent success of research work, every possible means should be adopted at the inception of a problem and at all times during its progress to make the proposition a commercial success.

As one of the methods of assisting in this, the following plan of a large corporation is outlined:

1 When it is desired that a research problem be undertaken, it is required that there be filled out an "Experimental Request Form" giving

- *a* Title of research problem
- *b* Process affected and plants to which applicable
- *c* Reasons for conducting research
- *d* Description of process or machine in use which research work is to improve or replace
- *e* Description of proposed improvement and how to be obtained
- *f* Estimated cost of research work
- *g* Estimated savings or other advantages, given in detail to show clearly how saving has been figured and estimated capital expenditure necessary to put results into production
- *h* Name of persons making suggestion or contributing major ideas
- *i* Necessary approvals by executives authorizing the work.

It is surprising the many research problems which seem very promising when discussed in abstract, but which fail to pass the test insured by the filling out of the above form.

2 The man having charge of the research is required once a month to make a complete review of the problem, stating:

- *a* Object of the investigation
- *b* Work accomplished during past month
- *c* Status of problem to date
- *d* Probability of successful outcome and any new developments having a bearing on the application of the work commercially, if successful
- *e* Further work proposed in immediate future.

---

[1] Asst. Chief Engr., E. I. du Pont de Nemours & Co., Wilmington, Del. Mem.Am.Soc.M.E.

[2] Asst. Prof. Food Chemistry, Columbia University, New York, N. Y.

3 Where it is apparent that the cost of conducting a research problem may be greater than the appropriation, an additional appropriation must be secured, at which time the commercial status of the entire subject is reconsidered by the executives to determine whether the expenditure of the additional money is justified. If not, the study is discontinued.

4 At the conclusion of a research problem, a complete report is made, in which is included the estimated figure on capital expenditure necessary and the savings and other advantages to be gained by the application of the results obtained to regular production so that, if justified, the research work may be turned to profit as soon as possible.

This plan of conducting research work lays continual stress on the *commercial* outcome. At every angle the question is asked, "Is the cost of this particular step justified by the results to be obtained from it?"

Suggested Coöperative Plan

Many companies in different lines are carrying on research work, each on problems in its own line. There are, however, many problems which should be studied but which are not receiving the attention they deserve because they do not present sufficient probability of making a satisfactory monetary return to justify any one company proceeding with the work.

Much research now done by manufacturing companies has to do only with that part of the subject which is of direct interest, frequently the effect of one or more of the variables is not determined, and frequently also, the study is only conducted to obtain a part of the curve. Further, there is a great deal of research work, of great importance to industry, but which is not done because it is seldom that any one company can justify conducting an abstract scientific reseach with the hope that the result of that research can be profitably applied to its business in some way.

True, a great deal of such work is being done by the universities or similar institutions, and some of it by the Bureau of Standards and other departments of the Government. The governmental departments, however, cannot be altogether depended upon because of the difficulty of securing the necessary appropriations. This kind of research work in the universities must necessarily show slow progress because it must be carried on during the spare time of the member of the faculty who is working on it, and it is difficult for a man engaged in university work to have the perspective necessary to obtain the results in the way most suitable for commercial use. Further, the problem selected to be worked upon depends upon the desires of the man who happens to have the opportunity and desire for research work, and is not determined as it should be from a broad viewpoint to insure that the most important subject receives earliest attention.

How much better it would be if a fund could be collected by subscription from manufacturing companies and others interested, and this fund placed under the control of some central body, such as the Research Committee of The American Society of Mechanical Engineers, which would fix a program of research work to be conducted, the place where the work should be done, and the methods to be followed in doing it.

With such a plan, information very necessary to industry would be obtained many years sooner than under the haphazard plan now followed. More complete and scientifically accurate information would be obtained, and the results would be much more widely distributed and made available for industry. As is quite important also, the total cost to industry would be very much less than where many concerns duplicate effort, as is now being done. To accomplish the best results, such a fund should be a continuing one, so that a program could be adopted for several years' work.

The American Society of Heating and Ventilating Engineers has had such a plan in effect for the past two years, with subscriptions amounting to $25,000 per year for five years. The coöperation of the U. S. Bureau of Mines was secured, and the Bureau loaned excellent laboratory facilities in the fuel-testing station at Pittsburgh. This latter is equivalent to approximately $20,000 per year, so that the equivalent of $225,000 is available altogether in this instance. An excellent technical staff is employed and good progress has been made. The work is directed by the Research Bureau of the Heating and Ventilating Society.

With the wide field covered by the A.S.M.E., no difficulty should be experienced in raising a similar fund, ample to carry on an ambitious research program and secure data of inestimable value to industry. Some of this research would be carried on in a laboratory to be financed and controlled by the committee directing this fund, and some of it at universities, the necessary financial assistance being provided from the fund. This would also increase the scope of the research work which the universities could carry on, as the necessary financial support would be easier to secure.

RESEARCH IN LEATHER MANUFACTURE

By ARTHUR W. THOMAS, NEW YORK, N. Y.

The art of leather manufacture is a glaring example of the need for scientific research, and if conditions in some other industries are comparable with those of the tanning industry, it is time that attention is given to publicizing the research which has been done, if only to show the small amount of accurate scientific data upon which these industries are based.

In the average tannery the majority of the operations conducted in transforming rawhide into finished leather are conducted in essentially the same manner chemically as they were centuries ago. Frightful "formulae" similar to "shot-gun prescriptions" of the old-school physicians have been jealously guarded in the tanneries and have been handed down from generation to generation.

The point of view is usually that since good leather was being made in 1000 B.C. or 1776 A.D., why bother about scientific research? This impedance in the leather industry will soon be overcome by competition.

To give an example, the foul practice of bating with dungs is still to be found in many tanneries, though it has been found that artificial bates can be prepared with the necessary proteolytic enzyme in the dungs—and even the value of the presence of pancreatic enzyme is now questioned.

Fundamental advances in the science of leather formation have been made in the last few years, and he who can understand the new chemical thermodynamic theory of Proctor and his students, notably Wilson, can safely discard all his old rule-of-thumb methods and feel sure in advance just what is going to happen in his processes.

Many other examples might be given. Stasny's studies of limings have proved that the old idea of necessity for the presence of ammonia in lime liquors was unfounded, and that the factors which count are regulation of alkalinity and proportions of sulphide.

Studies of the combination of chrome and collagen have prevented the running of tons of chrome into the sewers because of lack of knowledge of the reaction forming the insoluble impurtrescible chrome-collagen compound. And so on.

Instances in which mechanical engineering has improved the efficiency of leather manufacture are numerous.

The designing of extractors and vacuum evaporators has made possible the manufacture of concentrated vegetable extracts permitting quicker tanning and eliminating the expense of freight on barks.

Machinery for unhairing, fleshing and shaving hides have eliminated much hand labor, although there has not as yet been invented a machine which will completely dehair.

Large mechanical rocking systems have improved the liming operation.

Since animals are raised primarily for their meat and wool, tanners are obliged to use a by-product as their raw material, often under great handicaps. Disease in the animal, admittedly fatal in the meat industry, is also a serious factor to the tanner.

The warble fly problem has been acute. This insect deposits its larvae in the hide of the animal, which becomes filled with holes. The only preventive so far is to watch the live cattle and remove the pest by hand.

To summarize, there is a great field in the tanning industry, by the prosecution of scientific research, to eliminate the unnecessary wastes due to lack of knowledge of the reactions and hence waste of time and materials. Further, publication of the knowledge already available will do much to produce a better product, and make it available at a better price, restoring leather to the point at which it can successfully compete with other materials.

RESEARCH PROBLEMS DISCUSSED

THE first paper to be discussed was that by Mr. Wardenburg. The idea that the DuPont Company insisted on the promise of profit before it gave approval to research, was a surprise to M. C. Stuart,[1] and he thought it would be to others. On the other hand, C. E. Lucke[2] thought that this was the most important paper of its kind he had ever heard. Whether it expresses the correct ideal or not, he did not think as important, as the fact that it could be expected that the maximum research would be done by business corporations.

Dr. Lucke thought that one of the most valuable contributions a Research Conference can make is a classification of research. In such a classification the most important kind is that of improving commercial products.

Albert Kingsbury[3] thought that too close a scrutiny of research subjects sometimes hid things which would otherwise come to light. Further, things set forth as objects in research are often not obtained, but on the other hand, by-products sometimes turn up of a value often exceeding the primary object.

L. F. Lyne, Jr.,[4] continued on the line of Mr. Kingsbury's remarks, and added from his personal experience with lubricants.

F. A. Wardenburg, in closing this part of the discussion, said that most firms finding it necessary to earn a maximum return on their capital were not carrying on research. However, he felt that such concerns would be glad to contribute to some coöperative program, carried out under proper auspices and including subjects in which they were interested.

A Familiar Research Discussed

To bring out ideas of value to the conference, the chairman called on Prof. H. F. Moore, of the University of Illinois, well known in connection with the investigation there of fatigue of metals, or, as Professor Moore put it, "progressive failure of metals under continuous stress."

In describing the scope of the problem, Professor Moore characterized it as "involving much indefinite research into first principles, whose outcome could not be seen."

The National Research Council first saw the problem, and secured a large grant of funds to carry on the investigation. The Engineering Experiment Station at Illinois contributed the laboratory apparatus and also Professor Moore's time. One large commercial company found the apparatus and organization could be effectively utilized for certain work it wanted done.

The work therefore represented a measure of coöperation between the National Research Council, the Engineering Foundation which supplied the money, the Experiment Station at Illinois, and one commercial company.

The Research was carried out under a definite agreement, and the University charged a price. An interesting part of the agreement was that the data of the entire investigation should be open at any time to any interested party.

To his mind, this research pointed out the value of coöperative investigation between quite widely different interests. He saw no reason why such an arrangement should not be duplicated elsewhere.

Both Mr. Flinn and Dean C. R. Richards[5] called attention to the fact that though this investigation has been completed, the apparatus is still available to any industries which might want to use it. Dean Richards put it that it would be unfortunate if this laboratory, now brought to a proper degree of efficiency, were disbanded before it had gathered in the knowledge not only of ferrous, but of non-ferrous, metals. Dean Richards called attention to one fundamental condition—that the obligations of the University to the public compel it to own and control the first right of publication. He thought it a great mistake when such institutions keep their results secret.

Dean Richards thought that in the long run the more complete our knowledge of science in its application to industry, the greater the confidence of the people in using the products of industry. So that the idea that research must be kept for a secret use, and to keep competitors from meeting competition, is entirely wrong.

A Small Beginning Develops Into Big Work

Dean Richards also cited the research at Illinois, in connection with the National Warm Air Heating and Ventilating Association, into house-heating furnaces. In the beginning, while the members of the association thought the research would be good, especially good, advertising, they had no conception of the results to be obtained. Now, as the work has gone on for four years, their attitude is entirely changed, and they want it continued until nothing more is to be gotten out of it.

Secrecy of Experiments Undesirable

An interesting sidelight on secrecy was exposed by E. J. Prindle,[6] who said that not only was it an altruistic thing to reveal secrets of research, but it was a dangerous thing not to reveal them from the standpoint of the Patent Law. The law sustains the man who first discloses the discovery, and not the man who first makes it. The object of the Patent Law is to help the man who not only makes an invention, but who discloses it to the world so that it may become public property after a given period of protection to the inventor.

L. F. Lyne, Jr., gave an example of costly duplication of effort resulting from violation of the principle which Mr. Prindle pointed out. One concern had spent $300,000 in developing a certain product and putting it on the market, while another concern located not very far away was carrying on exactly the same investigation.

The product was a lubricant, and apart from the number of commercial concerns there are at least four societies—all represented at the conference—giving their attention to lubricants. As he understood it, one of the purposes of the National Research Council is to bring together such interests as these.

Mr. Flinn replied to Mr. Lyne that such was one of the functions of the Council. He could give good examples of such service in the iron and steel industry, the welding industry and others.

Work of the A.S.H. & V.E. Described

Dean Anderson, research director of the American Society of Heating and Ventilating Engineers, showed how in research starting out for one thing often led to searching for others. Their work at the Bureau of Mines Laboratories in Pittsburgh started out with the goal of finding the relationship between air temperature and humidity and air motion—a thermodynamic problem. Soon it developed into research on some fundamental laws of the cooling powers of vapors. The effort on the human body turned the problem into a physiological one and brought in the Bureau of Health.

Primarily the work of the laboratory has been to take the numerous problems presented by the manufacturers, and from them determine the fundamental relationships.

With regard to publicity, he expected that we were doing things today that the Chinese did two thousand years ago—doing them again because the Chinese left no record of how they were done. With this experience, there is a tendency now for no one to keep from the scientific world anything he may find out.

Advocates a National Laboratory

In calling attention to the amount now spent by the A.S.M.E. annually for research, Dean Anderson asked if more money could not be appropriated. He thought the Society should establish a research laboratory like those at Illinois University or Pittsburgh. He regarded such a plan as the foundation of the Society—not to collect data about the isolated pieces of research going on about the country, but to have a real research laboratory for the general sciences.

---

[1] Prof. Mechanical and Marine Engineering, Naval Post-Graduate School, Annapolis, Md. Mem.Am.Soc.M.E.

[2] Consulting Mechanical Engineer, New York, N. Y. Mem.Am.Soc. M.E.

[3] Kingsbury Machine Works, Frankford, Philadelphia, Pa. Mem.Am. Soc.M.E.

[4] Pres. and General Manager, Oil Specialties & Supply Co., New York, N. Y. Assoc-Mem.Am.Soc.M.E.

[5] Dean, College of Engineering, and Director Engineering Experiment Station, University of Illinois, Urbana, Ill. Mem.Am.Soc.M.E.

[6] Patent Attorney, Prindle, Wright and Small, New York, N. Y. Mem. Am.Soc.M.E.

Professor Matthews and Dean P. F. Walker both endorsed the laboratory idea. Dean Walker said that the discussion had taken a turn which had been in his mind for years, especially in connection with oils and lubrication. He happened to be a member of the A.S.T.M. Committee on Lubrication, and seeing the report of the A.S.M.E. Committee on Lubrication on the program, he wondered whether there were any connection between the two organizations.

This was a cue for the presentation of the Report of the Sub-Committee on Lubrication, and Professor Greene therefore called for it.

A.S.M.E. WORK IN LUBRICATION

In presenting this report, Albert Kingsbury said that it was simply one of progress for the past year. The committee was organized five or six years ago, and at that time, from a general survey of the situation it was decided for the present to deal with the absolute fundamentals of the subject only.

Practically everything we know about lubrication has been evolved in the last forty years, and one problem—that of the conditions existing in the ordinary bearing under normal conditions—had practically monopolized all activity in this line.

The ideal condition in a bearing is one in which the film of lubrication should be of measureable thickness, and should separate the component parts of the bearing so that the frictional resistance is transferred from the metal and becomes entirely fluid friction.

It has been known for a number of years that the ideal condition is subject to treatment by theory, and definite formulas have been evolved so that fairly accurate predictions can be made.

It is well understood that the property of a lubricant maintaining its function is viscosity. Another important property is "oiliness," which for some reason unknown so far seems to be greater in the organic than in the mineral oils.

The work of the committee has been devoted to carrying on experiments on oils under high pressures, up to 44,000 lb. per sq. in., and the results so far justify going to still higher pressures. Having obtained some indication as to what happens at 3000 atmospheres the committee is anxious to find the conditions at 30,000 atmospheres, and hopes to do so later on.

PROGRESS IN STEAM-TABLE RESEARCH DESCRIBED

By a fortunate coincidence there were brought together at the conference Mr. George A. Orrok, who induced the A.S.M.E. to accept the administration of a fund subscribed by the industries to make a research into the upper limits of the steam tables and establish fundamental constants, Professor Greene, under the auspices of whose Research Committee the technical work was being done, Dr. S. W. Stratton, Director of the Bureau of Standards, which has carried out some of the investigations, and Dr. H. N. Davis, of Harvard University, in whose laboratory another part of the experimental work is being done.

From the information given by these four gentlemen the meeting obtained a very good idea about how this work was being financed and how administered, how far the experimental work had proceeded, and what were some of the difficulties.

Doctor Davis gave a popular conception of what it meant to "try and get something on the Thomson-Joule effect." Then he turned to Dr. Stratton and told the meeting what it meant to "try to get something out of the Bureau of Standards"—how the Bureau would reply to letters and say that "progress was being made," whereas detailed inquiry would reveal that the Bureau had had several of its best men on the job for some time.

Doctor Davis thought that all in all, the probability of completing this fundamental piece of research work was "very hopeful."

A. D. Risteen[1] endorsed Doctor Davis' experiences of the difficulties of doing this kind of work. He also congratulated the Society for having taken it up, characterizing it as a "public scandal" that this one fundamental thing in the whole subject of accurate thermal work had not been done before. A full account of this research has already been published in Mechanical Engineering. Mr. Orrok then detailed the progress in collecting the funds.

Mr. Rice, the Secretary, here suggested the organization of a permanent committee to devote itself especially to this particular piece of research, and this was accepted, the Committee to be appointed by the Council of the Society on the recommendation of the Research Committee.

A SESSION ON FUEL ECONOMY

(Continued from page 113)

equipment of certain installations referred to by the author but not mentioned by him. While the conclusions drawn were correct, he said, all the facts should be known.

Edward N. Trump said that he had had the unique experience of buying boilers from the same company for forty years, which had given him an opportunity of seeing whether or not it paid to economize. By replacing at a cost of about one million dollars an equipment of boilers of from 12,000 to 15,000 horsepower with which an efficiency of 70 per cent was obtainable with an equipment capable of 80 per cent efficiency, the cost of the investment was saved in five years.

David Moffat Myers gave some actual figures of savings with the investment costs involved which has come under his observation.

R. L. Beers[20] presented a written discussion of the savings to be made with the use of stokers applied to small hand-fired boilers.

Gas Producer Problems Discussed

Walter W. Oakley[21] said that the greatest problem in the operation of the producer is labor turnover. Mechanical producers are a help, but even mechanical producers require an attendant. Costs for gasifying a ton of coal in a hand-poked producer are about one dollar, while in a mechanical producer they are about 15 cents these figures being for labor charges. The costs of the mechanical producer can be equaled with hand-poked producers if it is possible to keep trained men on the job.

Earle E. Adams[22] spoke of the use of tar extractors and the returning of the tar to the producer to be gasified. He thought the Fuels Division should give more thought to the use of gas, while J. H. Taussig[23] said he thought the Division should give more attention to the use of fuel for industrial purposes.

Edward N. Trump said that the paper had not considered the recovery of sulphate of ammonia and other products from coal. He had built a plant consuming about 100 tons of coal in which 80 lb. of sulphate of ammonia was obtained per ton of coal.

Jas. H. Matherson[24] presented a written and illustrated discussion on improvements in gas equalizers and soot collectors for gas producers, installed in the tube works of the Reading Iron Co., Reading, Pa. The advantages claimed as a result of these improvements are a saving in fuel of 20 to 25 per cent, an increased product of improved quality, a saving in gas valves, brickwork, labor, machine-shop repairs and cleaning out of soot, more continuous operation of furnaces and more contented workmen.

J. Frank Rogers,[25] in a written discussion, set forth sixteen requirements for a gas producer.

A Correction

In Mr. A. L. De Leeuw's discussion of Mr. Polakov's paper, on page 17 of the January issue, second column, eighth line, the word "demoralization" should have been "democratization". The error was unfortunate, as it was possible to publish only a brief mention of Mr. De Leeuw's comprehensive and meritorious discussion, and quite a misleading conception of his ideas was conveyed.

---

[1] Director Technical Research and Safety Publication Work, Travelers Ins. Co. & Travelers Indemnity Co., Hartford, Conn. Mem.Am.Soc.M.E.

[20] Engrg. Dept., Under-Feed Stoker Co., Detroit, Mich. Mem.Am.Soc. M.E.

[21] Asst. Engr., Corning Glass Wks., Corning, N. Y. Mem.Am.Soc. M.E.

[22] Sales Engr., The Smith Gas Engrg. Co., Dayton, O. Mem.Am.Soc. M.E.

[23] Engr. of Design, The United Gas Improvement Co., Philadelphia, Pa. Mem.Am.Soc.M.E.

[24] Reading, Pa.

[25] Engr., Gas Producer Dept., The Wellman-Seaver-Morgan Co., Cleveland, O. Mem.Am.Soc.M.E.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

The Flow of Air and Steam in Nozzles

Note on the Flow of Air and Steam in Nozzles, Gerald Stoney and Norman Elce. It is now generally recognized that steam when expanded rapidly, as in turbine nozzles, becomes supersaturated provided that the initial superheat is not so high that the steam remains superheated throughout the expansion. Whether any condensation takes place before the nozzle throat is not so definitely known, but some evidence on this point is afforded by the following note on discharge coefficients.

If the theory of supersaturation be correct, the expansion of steam through a nozzle is so rapid that condensation cannot take place down to a pressure below the critical pressure, so that down to the throat the steam expands as a perfect gas. The law of expansion is then:

$$p\,(V-b)^{\gamma} = \text{a constant} \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where γ = 1.3
p = absolute pressure
V = specific volume
b = co-volume, taken as the specific volume of water at 32 deg. fahr.

The co-volume b is only 1 per cent of the specific volume V at pressure $p = 300$ lb. per sq. in. and neglecting this the maximum theoretical discharge of steam through a nozzle may be shown to be

$$q_{\text{max.}} = 0.3155 a_t \sqrt{\frac{p_1}{V_1}} \text{ lb. per sec} \ldots\ldots\ldots [2]$$

where

$q_{\max}$ = maximum theoretical discharge, lb. per sec.
a_t = nozzle throat area sq. in.
p_1 = initial pressure, lb. per sq. in.
V_1 = initial volume, cu. ft. per lb.

The effect of the small term b neglected here is only 0.274 per cent of the discharge at a pressure $p_1 = 300$ lb. per sq. in. abs. The value of V_1 to be inserted in Equation [2] is in each case the specific volume of the steam at inlet, whether superheated or wet.

For saturated steam, Equation [2] may be written in the convenient form:

$$Q_{\text{max.}} = M_1 a_t p_1 \text{ lb. per hr} \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

where:

$Q_{\max}$ = maximum theoretical discharge, lb. per hr.
M_1 = a constant depending upon p_1 and upon the index in the adiabatic equation, which is here taken as 1.3, the value for dry steam.

Rateau (Réchérches experimentales sur l'ecoulement de la vapeur d'eau) measured the discharge of saturated steam through convergent nozzles, and found the empirical equation:

$$Q_{\text{max.}} = 3600\,(15.26 - 0.96 \log p_1)\, a_t p_1 \text{ gm. per hr.} \ldots [4]$$

where

a_t = sq. cm.
p_1 = kg. per sq. cm.

In English units this becomes:

$$Q_{\text{max.}} = 3.456\,(17.05 - \log p_1)\, a_t p_1 \text{ lb. per hr.} \ldots\ldots [5]$$

$$= M_2 a_t p_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [6]$$

where

a_t = sq. in.
p_1 = lb. per sq. in.
M_2 = a constant depending upon p_1.

Table 1 shows values of M_1 for $\gamma = 1.3$ (the index for dry steam) and $\gamma = 1.135$ (the index for saturated steam), and of M_2 for various values of p_1.

If the limit of the supersaturation condition is such that no condensation occurs before the throat, the ratio $\dfrac{M_2}{M_1(\text{for } \gamma = 1.3)}$ is the coefficient of discharge C_d for saturated steam in Rateau's convergent nozzles, and this should then be of the same order in this case as for any perfect gas, such as air or highly superheated steam, through similar nozzles.

Table 2 shows the comparison of the coefficient $\dfrac{M_2}{M_1\,(\text{for } \gamma = 1.3)}$ with

1 The coefficient of discharge of air through a convergent nozzle from the experiments of T. B. Morley (Proc. I.Mech.E., January, 1916).

2 The coefficient of discharge of highly superheated steam through a convergent nozzle from the experiments of A. L. Mellanby and W. Kerr (Trans. Inst. Engineers and Shipbuilders of Scotland, December, 1920).

TABLE 1

p_1	300	250	200	150	100	50	14.689	10	5	1
M_1 $\gamma = 1.3$	52.12	52.39	52.73	53.16	53.83	55.02	57.25	57.93	59.46	62.34
M_1 $\gamma = 1.135$	49.64	49.91	50.22	50.63	51.23	52.41	54.54	55.22	56.64	59.33
M_2	50.37	50.65	50.98	51.42	52.02	53.06	54.90	55.49	56.52	58.93

TABLE 2

			Initial Pressure, Pounds per Square Inch Absolute.						
Medium	Reference		150	100	75	50	25	10	1
Saturated steam	Rateau	C_d	0.967	0.966	0.965	0.964	0.962	0.958	0.945
Steam at 250 deg. fahr. superheat	Mellanby	C_d	...	...	0.975	...	...	...	...
Air	Morley	C_d	...	...	0.97	0.97	0.97	...	...

It is thus seen that the coefficient of discharge for saturated steam is, according to Rateau's tests, slightly less than that for air and superheated steam, which are about the same. On the other hand, Rateau's nozzles were not all so well shaped as those tested by Mellanby and Morley, so that the evidence, although not quite conclusive, is that there is little or no condensation in the expansion of saturated steam in a nozzle down to the critical pressure ratio. It would be an interesting investigation to determine the coefficients of discharge for steam initially wet, saturated and superheated, and for air, through the same nozzle, and thus determine whether there is any condensation before the throat with wet or saturated steam. So far as the above evidence goes, there is no such condensation and saturated steam acts down to the throat as a perfect gas with an adiabatic index of 1.3. (*Engineering*, vol. 112, no. 2918, Dec. 2, 1921, pp. 750–751, *tA*)

Short Abstracts of the Month

AERONAUTICS (See also Internal-Combustion Engineering)

Bristol Gas Starter for Aero Engines. Description of a starter made by the British Aeroplane Co. in England for the Jupiter aero engine, but applicable to many other makes. This starter, the Bristol, consists of a small two-stroke, air-cooled, single-cylinder gasoline engine whose crankcase is mounted on to a pumping cylinder. The latter draws a combustible mixture from the carburetor, supplies the power cylinder, and pumps the mixture under pressure to the main-engine cylinders. Interposed between the pumping cylinder and the main-engine cylinder is a

small disk-valve distributor driven at half engine speed from the main engine, which passes the compressed explosive mixture to the main-engine cylinders in the proper sequence. The mixture is admitted on the firing stroke and also on part of the induction stroke. In order to avoid loss of pressure through the open inlet valves on the induction stroke, the port in the distributor which is in communication at this period is controlled by a spring-loaded ball valve arranged to open at a pressure of about 40 lb. The gas cylinder is fitted with a two-cylinder magneto from which one ignition lead is taken to the spark plug of the two-stroke upper cylinder, while a second is taken to the central terminal of the distributor on one of the main-engine magnetos. When the two-stroke engine is started, explosive mixture is supplied to the main-engine cylinders under pressure, and the main engine begins to turn. At the same time gas is admitted to the cylinders so that after one complete revolution of the main engine the entire induction system is filled with gas which is drawn in on the next induction stroke.

If, now, the short-circuit switch between the starter and magneto and the main-engine magneto is opened, the engine will begin to fire and pick up on its own carburetors. The gas-starter throttle supplies both gas and ignition to the main engine for starting, and, in addition to its function as a starter, can be used for driving wireless generators, etc.

It is stated that the Bristol starter has started a Jupiter engine from cold in 17 sec., and when hot in 2 to 3 sec. It has turned over a 500-hp. engine cold at 12 to 15 r.p.m., and has maintained a gas pressure of 140 lb. per sq. in.: it weighs complete 40 lb. The article does not give specific data as to how in actual service the starter is controlled from the aviator's seat. As the normal power of the Jupiter engine is 345 hp., the weight of the starter is only a little in excess of 0.1 lb. per hp. (*Flight*, vol. 13, no. 48/675, Dec. 8, 1921, pp. 802–803, 2 figs., *dA*)

AIR ENGINEERING (See Steam Engineering)

CORROSION

Colloidal Theory of Rust, Dr. Newton Friend. Abstract of a lecture before the Birmingham Metallurgical Society on Recent Progress in the Study of Corrosion. The author is head of the Chemistry Department of the Birmingham (England) Municipal Technical School.

After examining various theories to account for the phenomena attendant upon corrosion, Dr. Friend directed attention to the "colloidal theory" which had been formulated by himself, and which, he said, reasonably accounted for the facts. If moving water was increased to a velocity of eight miles per hour, no corrosion of immersed metal took place. According to the colloidal theory, corrosion of iron in a neutral solution of water was entirely distinct from corrosion in acid. Iron first passed into solution through the presence of electrolytes, gradually developing a solution of ferrous hydroxide, which eventually produced oxidation. The solution, however, could be removed by rapidly flowing water, thus inhibiting corrosion. The same retardation could be effected if the colloid was coagulated either by physical or chemical precipitants.

Particulars were given of various experiments made to test the theory. Solutions containing alcohol reduced rust relatively to the increase in alcohol.

On the question of the effect of temperature on the rate of corrosion, practically nothing was known. But experiments had shown that at 80 deg. cent. iron corrodes nearly ten times as rapidly as at 0 deg. The effect of light was very remarkable. Light was shown to accelerate corrosion very markedly, even after the temperature effects had been removed. Corrosion was clearly affected by barometric variation. The subject was very complex, and the results were not always the same, even when experiments were carried out under what appeared to be exactly identical conditions. The lecturer expressed the hope that further experiments would indicate the bearing of the colloidal theory upon the corrosion of ferrous alloys and non-ferrous metals. (*The Iron and Coal Trades Review*, vol. 103, no. 2805, Dec. 2, 1921, p. 793, *t*)

ENGINEERING MATERIALS (See also Corrosion)

New Etching Mediums for Steel. Dr. A. Fry described in a German periodical *Stahl und Eisen*, Aug. 11, 1921, a new etching method consisting essentially of a strong acid solution of copper chloride over a properly prepared steel.

The new medium reveals in details the strain lines in a low-carbon steel as distinct from the actual crystalline pearlitic or other structure. In other words, it permits locating alterations in the body of steel caused by stress. In this connection mention is made of an experiment recently conducted by a large eastern railroad, the results of which are in good accord with those obtained by the German method. Thin strips of highly polished low-carbon steel were laid on the surface of the rail, over which the locomotive wheel was allowed to press gently. It was found that there resulted in the strips a distinct set of lines entirely different from anything encountered previously. It is now found that these lines bear a close resemblance to the strain lines brought out in one of the pieces of German steel. (Editorial in *Iron Age*, vol. 108, no. 23, Dec. 8, 1921, pp. 1488–1489, *g*)

Plastic Wood. A new material manufactured by a British concern, namely, a collodion preparation made with very fine wood meal, and as supplied ready for use of the consistency of soft putty.

This material will probably be of most interest in connection with patternmaking and molding, for it can be used for ordinary filling and stopping work in wood patterns and for fillets. It adheres firmly to wood and can be applied and smoothed down by the thumb or a tool. It is claimed to be waterproof, to set quite hard, and can be cut with an ordinary tool like wood and turned in the lathe. It can also be finished with sandpaper. It shrinks slightly in drying but the hardened material is not brittle and nails can be driven firmly into it without cracking it. A solvent is also available to soften the material. (*Engineering*, vol. 112, no. 2919, Dec. 9, 1921, p. 785, *d*)

Wire Cables and Weathering. Taking advantage of the rewrapping of the cables of the Williamsburg bridge over the East River at New York City now in progress, Edward A. Byrne, chief engineer of the Department of Plants and Structures of the City, has been carrying on an examination of the condition of four $18^5/_8$-in. cables of the structure. The sections inspected had the interspaces between wires fairly filled with slushing oil supplied when the cables were constructed (1901–1902) and no signs of corrosion were visible, except for a few spots of discoloration on the outer layer of wires. In the main span, rust discoloration on the outer wires was found at a number of places.

On the Manhattan bridge the cable bands have given some trouble from slipping. This defect has been remedied by modification of details of the cable bands. When slipping occurred the wrapping wire covering the cable between the bands became disarranged and the cable wire was exposed, making prompt replacement of the bands necessary. In such replacement the band is set back to its proper position and a short section of the wire wrapping to either side of the band is renewed. Before this is done, however, the cable wires are wedged apart and the interior examined.

Still better conditions have been found in the wire-wrapped cables of the Manhattan and Brooklyn bridges. There the wires which are galvanized have in no cases shown any rust. The condition of the structural steel of the Williamsburg and Manhattan bridges was also examined and found to be surprisingly good. Although repainting has been done at intervals of as much as eight or nine years, no structural parts of either bridge have suffered from rust. Except for thin metal in some railings and floor grills, the steel work of both structures is considered to be in perfect condition. (*Engineering News-Record*, vol. 87, no. 23, Dec. 8, 1921, p. 939, *dg*)

Krupp Rustproof Steels, Fritz Huth. At the technical exhibition in Leipzig were shown some so-called "rustproof" steels made at the Krupp Works. These have been developed as a result of investigations carried out at that establishment during the

years 1909 to 1914 on the corrosion of steel, and belong to the class of chrome-nickel steels.

These steels may be divided into two classses. To the first class belong steels of high mechanical strength, while to the other belong steels characterized by high resistance to corrosion and wear. According to a paper by Dr. B. Strauss (*Krupp Monatshefte*, Aug., 1921) the first class of steel contains from 10 to 15 per cent chromium and from 6 to 10 per cent nickel. The steels of the first class belong to the type of self-hardening steels, while the second, if heated to 1100 or 1200 deg. cent. and slowly cooled down, are machinable and tough. Steels of the first class are magnetic and those of the second non-magnetic. In order to produce these steels a carbon-free chromium must be used. It may be obtained either by the aluminothermic process or produced from chromium refined in an electric furnace. Such chromium is, however, expensive, which makes the corresponding type of steel also quite costly, namely, 12 to 15 times as high as ordinary steel. (*Metall-Technik*, vol. 47, no. 17, Nov. 1, 1921, p. 123, *d*)

Tensile Properties of Some Structural Alloy Steels at High Temperatures, H. J. French. The report gives results of determination of tensile strength proportional limit, elongation, reduction of area and strength at fracture throughout the range 20 to 550 deg. cent. for four steels containing about 0.38 per cent carbon, as follows: (*a*) plain carbon steel; (*b*) $3^1/_2$ per cent nickel steel; (*c*) 3 per cent nickel, 1 per cent chromium steel; and (*d*) 1 per cent chromium, 0.2 per cent vanadium steel.

Brief reference is made to the type of fractures obtained in testing steels at various temperatures and particular attention is paid to comparison of the tensile properties of these alloys at 550 deg. cent. in the neighborhood of which various parts of converters are subjected to stresses in production of ammonia by the Haber process.

Of the four steels tested in normalized condition it appears that the two alloys containing chromium show greater resistance to weakening by increase in temperature to about 550 deg. cent. than either the plain carbon or $3^1/_2$ per cent nickel steels, and at this high temperature the chromium-vanadium steel is to be preferred from the standpoint of high tensile strength and limit of proportionality.

The carbon and $3^1/_2$ per cent nickel steels behave alike with rise in temperature above that of the room, and at about 550 deg. cent. the addition of $3^1/_2$ per cent of nickel appears to have little or no effect on the tensile properties of the carbon steel. (Abstract of *Technologic Paper of the Bureau of Standards*, No. 205, *e*)

Cutting Fluids

Cutting Fluids, Eugene C. Bingham. Machinists have long recognized lard oil as being wellnigh indispensable in certain cutting operations, whereas for the majority of operations in the machine shop much cheaper oils may be used to advantage. The reasons for the superiority of lard oil have not been clearly understood but they turn out to be closely related to the general theory of lubrication, and with the development of fast-moving machines this theory is of vast economic importance.

Theory. One function of a cutting fluid is to cool the work, and for this purpose water with its high specific heat is suited. But since water tends to rust the machines, alkaline substances are added such as soda or soap.

In difficult cutting operations, the chip is apt to "seize" the tool, causing dulling of the tool, roughness of the work, etc., hence it is inferred that in such cases a good lubricant is required and therefore water is out of place.

The experiments of Tower led many to the erroneous belief that two oils of the same viscosity would have the same lubricating value. Consequently the cheaper mineral oils have been regarded as equivalent in every respect to the fatty oils which they once supplanted. There are certain operations in the machine shop such as the threading of micrometer screws, parting off mild steel, threading and tapping wrought iron, boring gun barrels, in which no mineral oil, regardless of its viscosity, will produce the excellent results obtained with lard or other fixed oils. With lard oil, the surface obtained is smoother, the chip is less serrated and longer and the tool lasts longer; further, the production is increased, there is less heating, and, finally, the machine runs steadier.

It appears that whenever two *clean* surfaces of metal are brought together they tend to seize. Many examples prove that a quite invisible layer of impurity will prevent seizure. The clean metal of the chip moving over the face of the tool under great pressure affords a peculiary difficult problem in lubrication. Lard oil has a much higher *adhesion* for metal than have the pure mineral oils. It is drawn in between the chip and the tool and forms a strong film which prevents the chip from adhering to the tool and forming a 'bead." Other oils containing fatty acids, or groups of atoms with "residual affinities," such as sperm oil, castor oil, rape oil, etc., have in large measure the advantage of lard oil.

It seems readily possible to improve mineral oils as cutting fluids and as lubricants by adding liquids of high adhesion such as oleic acid, pine oil and fixed oils. Methods are suggested for the measurement of adhesion. While this paper was in course of preparation, the Deeley friction-testing machine and the Lanchester worm-gear machine were being developed in Great Britain, which demonstrate the superiority of the fixed oils as lubricants and the advantage of adding fatty oils of their acids to mineral oils to be used as lubricants.

Practice. Correspondence with the large machine shops in America with regard to their practice in the use of cutting fluids elicited information worthy of record.

The purposes of cutting fluids are to cool the work, lubricate, lessen wear, insure a good finish with accurate dimensions, wash away chips, and prevent the formation of dust. The materials used may be classified as (*a*) oils, (*b*) air, (*c*) aqueous solutions and water, and (*d*) emulsions.

Oils may be animal oils, fish oils, vegetable oils, mineral oils or compound oils. The edible animal oils are too expensive to use as a lubricant hence only the inferior grades are used for this purpose. Fish oils are objectionable unless deodorized, vegetable oils tend to gum, and mineral oils are low in adhesion and are therefore poor lubricants. Compound oils are largely used, containing a large percentage of mineral oil with a smaller percentage of vegetable or animal oil, or a mixture of both. Air is used merely to remove chips.

Water alone is used to some extent, but on account of the tendency to rust, soda, sodium silicate, sodium resinate or other soap are usually added.

Emulsions have the advantage of cheapness while possessing much better lubricating properties than the aqueous solutions. They are of three types. Mineral oil compounded with neutralized sulphonated oil will form a permanent emulsion when mixed with various proportions of water. Mineral oils are also compounded with an alcoholic solution of soap. A third variant is marketed as a paste, it being a thick soap solution with mineral oil added. The second type is the most desirable and the third the least so.

As to the choice of a cutting fluid for a given operation, the character of the operation performed has more to do with the choice of cutting fluid than the character of the metal. For drilling, reaming, milling, planing and sawing emulsions are generally satisfactory. For tapping and threading and parting off compound oils and lard oil are often resorted to. Compound oils are used with automatic screw-cutting machines.

The material cut is also of importance. There is a general consensus of opinion that soft steel and wrought iron are difficult metals on which to get a good surface without lard or sperm oils. They are called "draggy" metals. Cast iron, on the other hand, being brittle, does not adhere to the tool and no lubricant is required. Contrariwise, on a hard brittle steel, lard oil merely produces a "glaze" and turpentine is used with success.

The formulas of cutting oils used by large and successful users are given.

In the search for the true explanation of the remarkable "oiliness" exhibited by lard oil, the surface tension, specific gravity, and specific heat of several oils were studied by A. W. C. Menzies. The question of fluidity was studied by W. G. Kleinspehn. (Abstract of *Technologic Paper of the Bureau of Standards*, No. 204, *ep*)

FUELS AND FIRING

Powdered-Coal Burners and Dust Filters

Burning Powdered Coal in Arizona. Description of the plant of the United Verde Copper Co. at Clarkdale, Ariz., where it has been found that it costs less to burn powdered coal than fuel oil (per B.t.u.). In the dust separators muslin tube filters were used at first. The results obtained in keeping the plant free from dust and preventing dust losses from the main vent were highly satisfactory, but several fires occurred and burned out the muslin filter tubes. After this individual filters were placed over each auxiliary collector. These filters consisted of stacks with baffles and water sprays, the dust caught being washed into a pipe line carrying it back into the main coal-storage plant. This system eliminated fires, but allowed considerable dust to escape into the atmosphere. The losses are not, however, of especially great importance.

The original article gives a complete table of costs of preparing powdered coal for fuel, in which 98 cents is stated to be the operating cost per ton, and from 32 cents to $1.88 (depending on the size of production) the fixed charges.

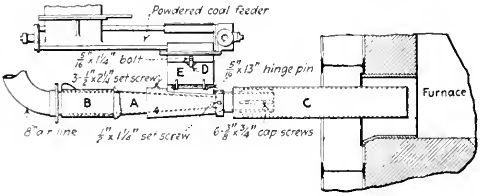


Fig. 1 Powdered-Fuel Burner Used at the Clarkdale Plant, United Verde Copper Co., Ariz.

The powdered-coal burners developed at Clarkdale are shown in Fig. 1. Blower air is delivered through an 8-in. (20.3 cm.) duct to each burner. Coal dust is fed from the 4-in. (10 cm.) screw overhead through the vertical chute *E* on to the first air nozzle *A*. The first stage of induced air is drawn in around this nozzle and regulated by means of sleeve *B*, which slides back and forth over the pipe The second stage is induced in the burner pipe *C* after the coal dust has been fed into the air current. The burner pipe contains a fair mixture of powdered fuel and air which is introduced into the furnace through cast-iron burner ports. This mixture acts as a fluid and is under a pressure varying from 3 to 6 oz. per sq. in., (13 to 26 grams per sq. cm.) and contains approximately 85 per cent of the total air necessary for complete combustion. The remainder of the required air is drawn into the furnace through the furnace walls, burner ports, and other openings. (*Electrical World*, vol. 78, no. 23, Dec. 3, 1921, pp. 1121–1123, 1 fig., *dp*)

FOUNDRY

New Side-Blown Bessemer Converter

Side-Blown Bessemer Converters, T. Levoz. Very interesting historical account of the development of the side-blown bessemer converter, with criticism of the various types based largely on the personal experience with them of the writer, who was for many years chief engineer of a steel company in France.

From his many years of experience with converters, the author developed the one shown in Fig. 2, where *A* is the vertical and *B* the horizontal section of the converter. In the vertical section 1 shows the bottom of the reverse trunk shape, while 2 is the blast chamber proper *V* with the tuyere box *P*. As a matter of fact there are two tuyere boxes, *P′* and *P″*, which can be used alternately in order to permit the renewal of the air-drying material, such as pumice stone impregnated with sulphuric acid. *S* is a tap hole for removing slag as it forms during the period of elimination of silicon. The upper part 3 forms a dome, this particular shape being given to it in order that pieces thrown up from the bath shall collect there and return to the bath. The horizontal section shows the two bearings for tilting the converter. One of the shafts *T* is hollow to admit the air at the maximum pressure of the blower. A chamber *C* causes the air to go through a filter *F*, *F′*, containing dehydrating materials and hence to the tuyeres.

As regards the conditions of operation which would give a maximum of efficiency, it is stated that air from the blower issuing under a pressure of 40 to 50 cm. of mercury goes through the hollow shaft *T* directly into the air box, from there, on account of the presence of damper *C*, through the filters *F*, *F′*, and finally into the tuyeres, where its pressure (around 30 cm. mercury) is so regulated as to avoid an excess of oxidation of iron. This latter is kept particularly low, because of the tangential direction of the tuyeres combined with the truncated shape of the bottom which assures a gyratory movement to the bath of molten pig iron. The dimensions of the bottom of the converter have to be calculated in such a manner that the level of the pig-iron bath should be 5 to 6 cm. (2 to 2.4 in.) above the axis of the tuyeres when the apparatus is in a vertical position and the elimination of silica is going on right. This is essential in order to make certain the discharge of slags through the tap hole *S*.

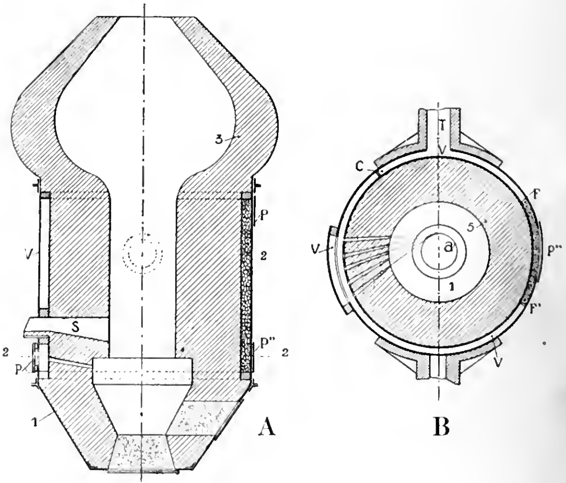


Fig. 2 Levoz Side-Blown Bessemer Converter

It is claimed that because of the lack of excessive oxidation of iron in decarburization goes on without excessive boiling and such material as may be thrown off by the bath is collected in the dome and returned to the bath again. Other advantages are claimed for this type of converter. (*La Fonderie Moderne*, no. 10, Oct., 1921, pp. 284–290, 3 figs., *dh*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics)

Tests of the 450-Horsepower Bristol Jupiter Engine. It is a remarkable fact that out of the three aeronautical engines which satisfied the rigid conditions laid down for the British Air Ministry test, one, the Bristol Jupiter, is of the air-cooled radial type. It is also lighter per horsepower than either of the two other makes which passed the test.

The present article, which is an abstract from the Report of the British Air Ministry, gives some data of these tests, which included a 50-hr. endurance test, slow-running test, high-speed test and high-power test. The average oil and gasoline consumptions throughout the tests were: oil, 0.094 pint per hp-hr; gasoline, 0.594 pint per hp-hr.; which are quite remarkable for an air-cooled engine.

On the full throttle test (with a special cam sleeve) the engine developed a maximum brake horsepower of 462 with a gasoline consumption of 0.566 pint per hp-hr.

One of the most interesting tests was the one-hour test with three cylinders cut out. The engine was set to run at 90 per cent

of normal full power, viz., 345 hp. at 1575 r.p.m. The gasoline from one carburetor was cut off, allowing the engine to run on six cylinders only. The engine was run one hour non-stop under these conditions. Naturally there was a certain amount of vibration, but it was not excessive.

At the end of the hour, gasoline was turned on, and the engine picked up to full load at once. The operation was generally satisfactory and there was no oiling up of plugs. The results obtained on six cylinders were as follows:

B.hp.	193
R.p.m.	1250
Oil consumption, pints per hp-hr.	0.0413
Gasoline consumption, pints per hp-hr.	0.685

The official weight of the engine complete but without exhaust pipes and intakes is 729.25 lb. (*Aviation and Aircraft Journal*, vol. 11, no. 24, Dec. 12, 1921, pp. 685–686, 2 figs., *e*)

Rotary-Valve Motor-Car Engine

Bournonville Rotary-Valve Engine. The valve consists of two hollow cylinders exactly alike and located end to end, which are driven at one-sixth crankshaft speed. It is located within the cylindrical casting which also forms the cylinder head but is referred to as a valve head. In this valve head the combustion chamber is formed in the casting in such a way that it can be easily machined. Mixture from the carburetor is delivered into the passage at the end of the valve and flows then through the passages of the two halves of the valve to both ends of the valve and then enters a passage called "inlet passage" cored in the valve head. This passage extends the whole length of the valve head and mixture can enter it from both ends. It is in communication successively with the different cylinder ports by pockets in the valve. Each half of the valve has three sets of three such pockets, each set being in line with the cylinder port of one cylinder, and the same pockets in the valve which serve for the inlet also serve for the exhaust.

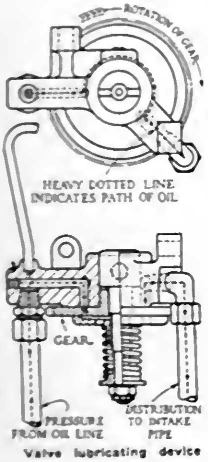


Fig. 3 Lubricating Device of the Bournonville Rotary Valve

The outstanding advantage claimed for the rotary valve is its absolutely silent operation; further, owing to the absence of top rods and valves at the side of the cylinder block, the accessories can be located close to the cylinders and the engine made quite narrow.

An interesting feature is the special feeding device by which one drop of oil is fed into the inlet pipe between the carburetor and valve head for every twelve revolutions of the crankshaft. This device, Fig. 3, is mounted on the gear case at the upper end of the vertical shaft on the forward end of the engine. It consists essentially of a spur gear which meshes with a spur pinion on the upper end of the vertical shaft. This spur gear is provided with an oil pocket which fills up with oil every time it comes into register with the oil inlet passage (communicating with the regular pressure lubricating system of the engine). After a motion of a little more than half a turn the pocket in the spur gear comes into register with the delivery port communicating with the charge inlet pipe, and the oil is then subject to the suction in the inlet port and is drawn into the charge stream therein, together with which it enters the inside of the rotary valve. Here the oil tends to separate out, owing to its greater inertia than that of the gaseous charge which asserts itself every time there is a change in the direction of motion, and to collect in eight internal circumferential oil grooves, four in each half of the valve. From these grooves radial holes are drilled to the outside of the valve. Through these holes the oil is gradually fed at several points to the bearing surface of the valve. (*Automotive Industries*, vol. 45, no. 22, Dec. 1, 1921, pp. 1065–66, 3 figs., *d*)

Two-Stroke Compound Engine

Silent Snow Two-Stroke-Cycle Engine. This engine, of unconventional design, is of the air-cooled type but has the mixture forced to the cylinders by a slow-speed pump. It is so arranged that a very large piston having a short stroke (31 mm.) pumps the charge into the combustion cylinder, in which is a working piston of the type ordinarily used in two-stroke-cycle engines. The inlet ports in the head of the cylinder are sealed by a speed ring somewhat like a very wide piston ring during the compression and working strokes, but are uncovered when the piston opens the exhaust ports by the fact that this ring contracts and thereby leaves its seat.

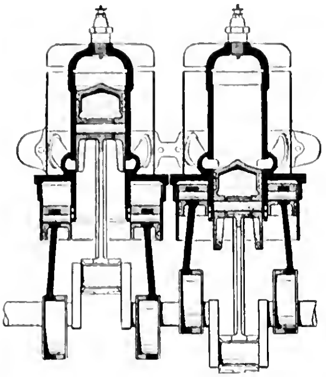


Fig. 4 Silent Snow Two-Stroke-Cycle Engine with Pumps Feeding Mixture to the Working Cylinders

The pump itself is concentric with the working cylinder. It lies within the crankcase. The pump piston is of very large diameter and annular shape so that the spigot of the working cylinder passes through the center, which necessitates an extra set of rings on the working-cylinder spigot.

The working piston is coupled to the crankpin by a connecting rod, while the pump piston is oscillated by eccentrics, straps and short connecting rods, the eccentrics being a part of the crankshaft (Fig. 4). The cycle of operations is as follows:

Immediately after the charge has been fired the working piston is driven down until the exhaust ports are uncovered. As soon as the pressure in the working cylinder falls as the gas is exhausted, the ring valve opens and at the same moment the pump piston forces mixture through the ports in the top of the cylinder, which gives good filling and scavenging. (*The Autocar*, vol. 49, no. 1362, pp. 1129–1130, 3 figs., *d*)

Superinduced-Engine Motor Car

Motor Car with Superinduced Engines, R. Krueger. It is claimed that speed-change gears not only constitute an expensive part of motor-car design but that their frequent use is both annoying and entails other disadvantages. Various methods are considered to eliminate them or reduce their use, the chief of which is the employment of the superinduction principle by equipping the motor with some kind of an air pump.

Among the apparatus described are the Roots (British) and Daimler (German) cars.

The Daimler apparatus is shown in Fig. 5. The motor *a* drives through a coupling *b* and a speed-change box *c*, which has, however, only very few speeds. The flywheel of the motor is surrounded by housing *d* and acts as an air compressor, the housing *d* being connected through pipe *f* with the carburetor *g* of the motor. The pipe *f* is provided with valve for cutting in and out the air precompressor.

The car may be operated with the aid of the speed-change drive with the precompressor *d* cut out, in which case the carburetor gets its air from the free atmosphere; or the precompressor may be cut in, in which case a further regulation may be obtained by

varying the pressure of the air supplied from the housing *d* to the carburetor *g*.

Furthermore, the speed-change-gear variations may be combined with the operation of the motor on precompressed air, all of this permitting a wide range of conditions of motor operation and power output. (*Der Motorwagen*, vol. 24, no. 30, Oct. 31, 1921, pp. 663–665, 4 figs., *d*)

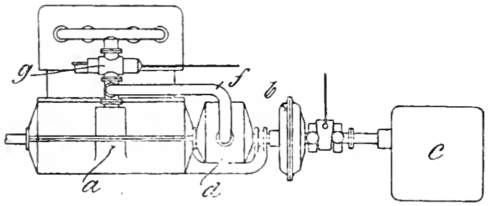


Fig. 5 Daimler Automobile Motor with Superinduction

MACHINE DESIGN (See also Mechanics)

Double Helical or Herringbone Gears, Howard H. Talbot. Discussion of the elements of design, such as tooth strength, friction of tooth surfaces, changes with degrees in spiral angle, tooth pressures, etc. The question of the use of long addenda in the pinion and short addenda in the driving gear to increase the "follow through" is discussed in particular.

As regards the tooth strength, it is recommended as safe to consider a helical tooth approximately one and a half times as strong as a spur tooth of the same tooth section.

The article is not generally suitable for abstracting, notwithstanding its interest.

The general conclusion to which the author arrives is that it is impractical to attempt any standard design of herringbone gears giving interchangeability as we have in the involute spur-gear system. (*The Iron Age*, vol. 108, no. 23 and 24, Dec. 8 and 15, 1921, pp. 1469–1473 and 1531–1533, 17 figs., *tpA*)

Simplified Approximations of Critical Speeds, G. Arrowsmith. This article shows a simple approximate method which may be applied to most cases which occur in practice without having to construct bending-moment and deflection diagrams. In the calculation of critical speeds of shafts extreme accuracy is not necessary, as experience has shown that for satisfactory running it is advisable to adopt a rotor of such proportions that the critical speed is removed by from 25 per cent to 35 per cent from the running speed.

Furthermore, a large proportion of cases which occur in practice deals with shafts freely supported at the ends. In such cases the error involved in accepting as a basis of calculation statical deflection as compared with the deflection due to the centrifugal loading is no greater than the error which may occur because of variations in the elastic modulus E of the shaft material.

The writer divides all rotors into two broad classes:

Where the shaft is comparatively flexible throughout its span (class A). For those cases where the ratio d/D (in a stepped shaft, ratio of diameter of smaller section to diameter of large section) is not less than 0.6, the critical speeds can be calculated in terms of weight, diameter, and length of span of shaft from

$$R_k = \frac{K \times 10^6 D^2}{\sqrt{W L^3}}$$

where R_k is critical speed; K is a constant the value of which varies from 1.57 for a centrally loaded shaft to 2.23 for uniform distribution of load; D is the diameter of shaft in inches; W the total weight of shaft between points of support in pounds, and L length of shaft between points of support in inches.

For values of d/D of less than 0.6 the shaft becomes more or less of class B, where the center of portion of shaft is of such dimensions as to render it practically inflexible as compared with the end portion of the shaft. In that case other equations given in the original article can be used, for example, equation $R_k = 187/\sqrt{Y_a + Y_b}$. Where Y_a is the static deflection of the shaft in inches and Y_b the extra deflection due to the flexure of the center portion.

Where d/D is considerably less than 0.6 the flexure of the center portion of shaft is negligible and simplified equations given in the original article may be used.

Illustrations of the applications of the process are given in the original article. (*Engineering*, vol. 112, no. 2917, Nov. 25, 1921, pp. 717–720, 8 figs., *mp*)

Steel Belts

Steel Bands for Power-Transmitting and Conveying Purposes, Bernard Kruger. In competition with ropes, leather and textile belts, metal bands have made great headway during the past few years in Europe, where it is stated that over 1000 steel-band conveyors are used and close to 1,000,000 hp. is being transmitted by steel bands.

The fundamental rule in the design of these bands or belts is based on the researches of Woehler, who found that a tension constantly varying from zero value to a maximum and frequently applied to a body will cause its destruction, provided the maximum tension is more than half the breaking stress of the material. With this in mind it is always possible to design a belt that will stand up at given stresses by giving it proper dimensions. The belts are made from carefully hardened and tempered carbon steel, rough rolled at red heat and then brought down to standard thickness and width by cold working.

The tensile strength of the finished material is about 95 tons per sq. in. The edges are rounded and so finished that the bands can be safely handled even when running at high velocity. Table 1 gives the approximate weights of belts of various kinds.

TABLE 1 APPROXIMATE WEIGHTS AND DRIVING WIDTHS OF LEATHER BELT, COTTON ROPES, POWER CHAIN, AND STEEL BAND FOR TRANSMITTING 200 HP. AT ABOUT 3000 FT. PER MIN.

System	Weight per foot, lb.	Driving width, in.
Double leather belt	6	24
Five 2-in. ropes	7	15
Three-inch pitch chain	43	7
Steel band	15	8

Owing to the high modulus of elasticity of steel it is very necessary to determine the length of a driving band with considerable accuracy, for a slight extension made necessary by cutting the band too short in the first instance will set up very serious stresses. An ingenious device has accordingly been invented for determining the exact length necessary to obtain a truly correct working tension, allowance being made for the sagging of the band. In this device a measuring band of small breadth and of definite section is mounted on to the pulleys on which the operating band will subsequently be required to run, and the ends fitted into a tension frame. By means of a helical spring and calibrated nut, by the compression of which the arms of the tension frame approach one another, the total tension equaling the desired initial stress per square millimeter in the driving band is read off on a scale provided for the purpose. One of the pulleys around which the band is placed (or also both pulleys in opposite directions) is now slowly rotated so that the friction of the pulley causes a rise in tension in that branch of the band in which the tension apparatus is placed, without, however, the band being driven by the pulley. The tension indicated by the apparatus is noted, the pulley or pulleys are then rotated in the reverse direction, so that the branch under test is slackened to a certain extent; the tension then indicated by the apparatus is again read, and it is ascertained whether the arithmetical mean of the two tensions which has been read corresponds to the desired fundamental tension. The overlaps of the ends of the measuring band are now cut off, and, the tension being released, the remaining length is the correct measurement to which the driving band unstrained must be cut.

In order that metal shall not run to metal and to prevent any possible slip, a friction coating consisting of a layer of canvas, to which are glued thin sheets of cork, is placed over the pulley rim, and to avoid stripping under variable load the pulley rim is first serrated by means of a rough file. A special cement is available for use in very damp situations

In steel-band transmission it is necessary that the pulley face shall be flat; this is owing to the fact that if the pulley is crowned the centers of gravity of the joint clip will be raised slightly from the pulley every time the clip runs on to the latter, thus causing

a blow to be struck which is greater the smaller the pulley diameter and the higher the belt speed. The stress caused by such a blow will be thrown mainly on to the middle of the band and this will cause gradual deterioration of the material at this point and ultimate fracture. As power for power the steel band is only one-third the width of an equivalent leather belt, the use of specially narrow and correspondingly stronger pulleys enables considerable saving in weight to be made, particularly in large diameters, at the same time considerably reducing the cost.

Assuming from a millwright's point of view that the shafts and bearings are properly proportioned and fixed and that the amount of power to be transmitted has already been determined, the necessary calculations are then made for the size and length of the belt to be used. These are based upon carefully worked-out formulas, and as the material is practically static (the maximum and minimum contraction and expansion being only $^1/_{32}$ in. to the yard), the tension necessary for any particular power or width is exactly determined. Thus it will be readily understood that when once the belt has been mounted in the manner previously described it requires no further adjustment.

In many cases, particularly for short conveyors and for certain classes of material, the upper strand of the steel band can slide on a timber support instead of being carried on rollers.

The only variations in length of the band to be taken into consideration are those due to changes in temperature. For short conveyors the tension of the band is adjusted by means of movable bearings of the driven terminal pulley. For conveyors 130 ft. or more in length as well as for conveyors handling warm material, the driven terminal pulley is fitted on a tension frame supplied with counterweights or steel springs to obtain the necessary stretching force.

Various other practical points are discussed, among them applications of the conveyor with steel bands not hitherto considered possible. (*Journal of the Western Society of Engineers*, vol. 26, no. 12, Dec. 1921, pp. 428–432. In this connection attention is called to the paper and experimental investigation of steel belting by F. G. Hampton, C. F. Leh and W. E. Helmick, MECHANICAL ENGINEERING, vol. 42, no. 7, July, 1920, pp. 369–378, 13 figs., to which a short bibliography on the subject is appended)

MACHINE SHOP (See Engineering Materials)

MECHANICS

Simplified Calculation of Rigid Frames

A NEW PROCESS DEVISED BY H. BRONNECK FOR CALCULATING RIGID FRAMES, Professor Marx. An abstract of a chapter from a book by H. Bronneck which has just been published in Berlin, the interest of which lies in the fact that a method is provided for computing the most complicated frame shapes directly and without the use of tables.

Bronneck starts from the fundamental equations laid down in the works of Mueller-Breslau and Moersch. The case of a simple rectangular double-articulated frame may be used to illustrate the process. For this case the shear may be computed from the following equation:

$$x = \frac{\frac{J_c}{J_0}\int_0^h M_0\, y\, dy + \frac{J_c}{J_1}.\, h\int_0^l M_1.\, dx + \frac{J_c}{J_0}\int_0^h M_2\, y\, dy}{\frac{J_c}{J_0}.\,\frac{2}{3}h^2 + \frac{J_c}{J_1}.\, l.\, h^2\frac{J_c}{F_1}.\, l}$$

Here M_0, M_1 and M_2 are the bending moments at points 0, 1 and 2 (Fig. 6) induced by external load with the frame statically determined in some manner: J_0 and J_1 are respectively the moments of inertia of the rods and traverses, while J_c is any moment of inertia whatsoever. If, now, to every part dy of the rods be added elastic weight $\frac{J_c}{J_0}.\, dy$, the first two members in the numerator of the above equation become nothing else but the moments of inertia of the entire frame refer to axis A-B denoted henceforth as T_a. The member $\frac{J_c}{F_1}.\, l$ is produced by the action of the longitudinal forces

The expression $\frac{J_c}{J_0}\int_0^h M_0.\, y.\, dy = \int_0^h M_0\left(\frac{J_c}{J_0}.\, dy\right)y$ represents the static moment of the surface of moments located over the rod AC referring to the AB and hence

$$\int_0^h M_0\left(\frac{J_c}{J_0}.\, dy\right).\, y = \left(\frac{J_c}{J_0}.\, f_0\right).\, y_{so}$$

Here f_o is the area of the surface of moments and y_{so} the distance of the center of gravity of the surface from AB. The two other expressions in the numerator of X may be determined in a similar manner. If, now, we denote the sum of all these expressions by S_a we obtain for the shear on the frame the very simple expression:

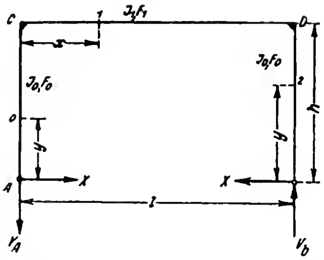


FIG. 6 DIAGRAM OF FORCES ACTING ON A DOUBLE-ARTICULATED FRAME

$$X = \frac{S_a}{T_a\,\frac{T_c}{F_a}.\, l}$$

By means of this formula the shear may be computed for all possible cases of loading, and the influence of heat variations can be very well taken into consideration in this formula which applies to all cases of double-articulated frames, no matter what their shape may be.

From this Bronneck proceeds to the determination of an equation for the influence lines for S_a for various frame shapes and types of loading.

Such equations for the influence lines can be derived now by means individual for each frame shape. Bronneck has, however, succeeded in deriving an equation of the third degree for computing this statically undetermined magnitude, this equation being $y = a + bx + cx^2 + dx^3$. Here a, b, c and d are constants which depend only on the shape and dimensions of the frame, while x is the variable distance of the single load (1) from a predetermined origin of coördinates. The equation permits, therefore, of immediate numerical computation. (*Dinglers Polytechnisches Journal*, vol. 336, no. 21, Oct. 22, 1921, pp. 301–302, 2 figs. *mA*)

THE EXPONENTIAL METHOD IN THE ANALYSIS OF THE BALANCE OF RECIPROCATING MASSES, P. Cormack. (A mathematical article not suitable for abstracting.) A method is developed from the usual formula for inertia resistance of a reciprocating piston mass expressed by a rapidly convergent series. The author converts this series into an exponential series which is made the basis for his calculation. This calculation is applied to such cases as that of seven-crank engines, offset cylinder engines, radial engines and rotating-cylinder engines; and, among other things, shows that the angular accelerations of the connecting rods are identical in the radial and rotary types. (*Engineering*, vol. 112, no. 2919, Dec. 9, 1921, pp. 778–780, 1 fig., *m*)

MARINE ENGINEERING (See Steam Engineering)

MOTOR-CAR ENGINEERING (See also Internal-Combustion Engineering)

Maybach Powerplus-Cylinder Gearless Car. During the war aeroplane engines were developed working on the so-called "powerplus" idea, that is, the cylinders were made considerably larger than corresponded to the dimensions of the driving parts. The powerplus-cylinder aeroplane engine was intended to work at part throttle on the ground and at full throttle at high elevations, thus developing practically the same power at varying altitudes. The same principle with slight changes has been applied in the new Maybach engine. This engine is fitted with six cylinders 95 mm. (3.75 in.) in diameter by 135 mm. (5.32 in.) stroke. At 900 revolutions it develops 36 hp. and at 2200 revolutions, that is, with full throttle open, 72 hp., this power output being so great as to make speed-change gear unnecessary, except on unusually heavy grades. For use on exceptionally heavy inclines a reducing gear is connected between the engine and the driving shaft. The drive backward is achieved by means of an electric starter, no reversing gear being used.

In this connection the statement is made that the Daimler Motor Co. has provided an arrangement for temporarily increasing the torque by 50 to 100 per cent in their new car. Steel-cylinder engines are used and the device presumably consists in an arrangement for increasing the pressure of the charge drawn into the cylinder, but nothing has been divulged as to its details. (*Engineering Progress*, vol. 7, no. 11, Nov., 1921, pp. 242–243, 1 fig., *d*.—The abstract refers to part of an article entitled The German Automobile Exhibition 1921, pp. 241–246, 9 figs.)

POWER-PLANT ENGINEERING (See also Steam Engineering)

Temperatures and Gas Velocities in Boiler Settings, A. W. Binns and C. E. Joos. Results of tests on a 1000-hp. Stirling boiler with a temperature chart taken by a recording Brown pyrometer. The results are given in tables and curves. (*Power Plant Engineering*, vol. 25, no. 23, Dec. 1, 1921, pp. 1138–1139, 3 figs., *l*)

South Meadow Plant of the Hartford, (Conn.) Electric Light Company. The plant is laid out so as to give an ultimate capacity of 130,000 kw. in five units, with enough ground available to extend this rating to 260,000 kw. The design of the plant is such as to make it readily adaptable to superpower service and has been controlled by the idea of providing twofold service—local and regional.

One of the many interesting features of the plant is the provision of a room for auxiliary and combustion-control equipment, with indicating and recording instruments for measuring pressures, temperatures, steam flow, gas analysis and power output. By this arrangement one man is in a position to maintain proper conditions throughout the plant at all times.

Several other features such as methods of fuel handling, boiler rooms, and the somewhat unusual system of piping, are described in the original article. (*Electrical World*, vol. 78, no. 24, Dec. 10, 1921, pp. 1163–1166, *d*)

RAILROAD ENGINEERING

The "Meteor" Track Torpedo. A new type of track torpedo officially adopted on all lines of the Canadian Pacific Railway. It appeals to all three senses, namely, hearing, seeing and smelling, and on detonation produces not only a loud report but simultaneously a brilliant flash and pungent smell. It is called "meteor" and is fastened to the tracks by means of two spring rail clips made of tempered steel or spring brass. In this way a firm gripping of the rail head is assured and at the same time a prompt application of the torpedo is made possible.

It is completely waterproof, will stand any atmospheric conditions of heat, moisture and frost. It has been subjected to one hundred hours' immersion, and one hour in moist steam at 120 deg. fahr., without deterioration, and has been used where the temperature was many degrees below zero with complete success. Special tests have been carried out to ascertain its holding power when placed in position on the rail, and for flying particles likely to cause injury to bystanders. These have all been carried out with satisfactory results. (*Canadian Machinery*, vol. 26, no. 22, Dec. 1, 1921, p. 51, *d*)

SPECIAL PROCESSES

Rotary-Type Gas Filter

Rotary Filter Process of Cleaning Gases and Vapors. A description of a process intended to be used for removing dust, tar, oil and similar impurities from gases and vapors developed by Freytag-Metzler and tested by E. Stach and Doctor Alexi. The principle of this device is illustrated in Fig. 7 and is based on a continuous renewal of the filter material placed in a slowly rotating filter casing surrounding coaxially a high-speed fan wheel. The filter casing consists of a wrought-iron hollow ring of rectangular cross-section divided into several chambers by intervening walls and rolling on bearings in the lateral covers of the general housing. Between the fan wheel and the filter casing there is a clearance of predetermined width. The material used for filling the filter chambers depends on the impurities that have to be handled.

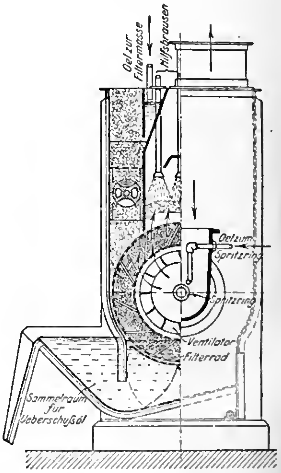


Fig. 7 Freytag-Metzler Gas Filter

(*Oel zur Filtermasse* = oil flow to filter mass; *Hilfsbrausen* = Auxiliary sprinkler; *Oel zum Spritzring* = oil flow to spray ring; *Spritzring* = apray ring; *Ventilator* = fan; *Filterrad* = filter wheel; *Sammelraum fuer Ueberschussoel* = sump for oil overflow)

Thus, for example, for cleaning gases from blast furnaces, copper, zinc and tin smelting furnaces and ceramic kilns, water is used as the cooling and washing liquid, while the filter body is made up of metal, fiber and steel shavings. A small amount of water is sprayed into the fan wheel, while a generous spray is provided from on top. The atomization of water in the fan wheel and its mixing with the gas assists the filter action materially. In order to prevent the filter mass from getting stuffed up by the clinkering of the impurities, which is particularly likely to happen with blast-furnace and cement-kiln gas, the ring constituting the filter housing is placed well away from the fan wheel and the water spray comes between the filter proper and the fan wheel.

The rotary filter can be used for taking oil out of steam and also has an absorption device. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 49, Dec. 3, 1921, pp. 1265–1267, 7 figs., *d*)

STEAM ENGINEERING

Low-Pressure-Turbine Blade Failures in Destroyers, Lt-Com. D. F. Ducey, U. S. N. The investigation was undertaken to determine the causes of certain failures of low-pressure-turbine blading which occurred in the late summer of 1919 on vessels built during the war. From this investigation the following facts were established: Seventeen of the failures occurred in the port low-pressure turbines and five in the starboard low-pressure turbines. The reason for the greater number of failures in the port turbine has not been established and is a subject for further investigation. A theory involving vibration and the greater length of the port lineshafting has been advanced, but this can remain an open problem for the present.

The primary failure, as far as could be ascertained, involved but one or two blades in a single stage. In instances from one to fifteen blades in a single stage were found stripped, but indications were that the failing of one or two blades was the cause of the others going. In no case was there any indication of a general failing of

the blades, the damage usually being confined to the blades being held by a single section of shrouding.

Practically all of the blades ruptured across the root section, although in certain instances where there was a tearing action by the shroud band and loose blades, the rupture occurred higher up on the blade.

In only one instance, that of the 280, did serious vibration exist previous to the blades failing.

Sometimes, when the failure occurred in the earlier stages, the ruptured blade or blades, in going through the following stages, tore blades out of these stages; in other instances the ruptured blade or blades went through as many as three stages and the intervening diaphragm nozzles, without tearing loose other blades. It would be expected that in such cases one would find the blades in the stages intervening between the stripped section and exhaust space badly chewed up, but such was not always the case. The "chewing-up" was usually of minor importance and in one case but five or six blades per stage were involved. As a rule the diaphragm nozzles were easily straightened and but one case of extensive renewals being necessary can be recalled. Incidentally this speaks well for the ruggedness of the turbine design.

Certain imperfections of manufacturing have been discovered, but neither defective material nor excessively bad workmanship has been found to be present.

The material was tested in various ways and chemical analyses and a metallurgical investigation made.

The tests have served to give evidence of the possibility of inducting brittleness in the chrome-nickel steel used for the blading. Furthermore, the design of the type of turbine blade used is such that a sudden change of section occurs between the root and the blade body. This section is the one of maximum bending moment and the maximum stress under bending would be considerably greater even than the theoretical stress. In tests, some of the specimens broke badly or showed cracks.

The general conclusion arrived at, therefore, is that the cause of trouble lay largely in the design of the turbine blade, which was such as to be very poorly fitted for undergoing plastic deformation when bent, without the formation of cracks at the junction of root and blade. This is particularly so, as in some cases there was a tendency to brittleness in the material due to improper microstructure or other causes.

A number of practical recommendations are made. (*Journal of the American Society of Naval Engineers*, vol. 33, no. 3, Aug., 1921, pp. 512-540, numerous illustrations, *deA*)

TESTING AND MEASUREMENTS (See Engineering Materials)

TRANSPORTATION

System of Handling L. C. L. Freight in St. Louis, Mo. In St. Louis the Columbia Terminals Co. handles practically all of the less-than-carload freight lots interchanged between the western lines terminating in St. Louis and the eastern lines with depots in East St. Louis, Ill., across the Mississippi River. It also carries to its own warehouses on either side of the river shipments that arrive over different lines for St. Louis or East St. Louis points. From there the consignee can gather in at the same time all of the articles that may have been shipped from a dozen different points and over a dozen different railroads.

The Columbia Terminals Co. which does this work is paid not by the shipper or consignee but by the railroads themselves, who, by the way, make no additional charge for this service. They are enabled to do this because of the fact that it costs them less to handle this kind of freight by truck than by rail. The Columbia Terminals Co. handles only L. C. L. freight, the transfer of carload shipments from eastern to western lines and for local deliveries being in the hands of the Terminal Railroad Association. All the work of hauling is done by 170 horse-drawn vehicles, 75 motor trucks and 35 tractors drawing 150 Lapeer steam trailers.

It is claimed that through its use of trucks and trailers the company handles freight in from 24 to 72 hours less time than it takes to do so in most of the other great gateways of the United States.

The company has a tariff on the same principle as the railroads but no contract with the roads. (*The Commercial Vehicle*, vol. 25, no. 10, Dec. 15, 1921, p. 7-11, 9 figs., *dA*)

VARIA

The Open Price Association Decision of the U. S. Supreme Court. The American Hardwood Manufacturers Association for some time has maintained a statistical service to its members by which they have been informed of prices at which sales were closed and of impending changes in prices. The U. S. Supreme Court has declared this practice illegal and the dicision has already attracted considerable attention in trade circles. The *Iron Age* (vol. 108 no. 25, Dec. 22, 1921, pp. 1612-1613), believes that this decision will have far reaching effects on all business organizations which seek directly or indirectly to stabilize prices. On the other hand, however, it considers it improbable that the decision will render it impossible for industrial groups to study their respective economic problems.

The *Engineering News-Record* goes into the subject far more extensively but does not believe that the decision in the Hardwood Manufacturers' case finally determines the scope of activities of open-price associations. It considers it final only as to one activity viz., advising on future action.

From the decision in this case it does not appear that mere exchange of information regarding production, stocks and shipments, as well as prices on closed transactions is illegal; support for this opinion is found in the decision of the U. S. District Court of the Northern District of Illinois in the case of the linseed-oil crushers. The Hardwood Manufacturers, however, have gone a step too far.

Passing, however, from the consideration of purely legal aspects of the case, the *Engineering News-Record* expresses the belief that while exchange of information upon closed transactions confined strictly to the membership of an association may be lawful, it is not good policy, as the public, kept in ignorance of these practices but keenly realizing the power that such an exchange gives trade associations, becomes suspicious. The only way to establish confidence in such exchange of information is to follow the practices of stock exchanges and make this information available not only to the sellers, but also to the buyers.

As an instance of the displeasure caused by lack of frankness in giving out price information, the *Engineering News-Record* cites the cement industry. Notwithstanding the many efforts of that journal to obtain from the cement associations statistics on production (not prices), this could not be brought about. The feeling among consumers of cement is so strong in this regard that an influential group of consumers discussed means by which an open cement exchange could be established, in the direction in which public pleasure may be asserted in industries which are mistrusted. (*Engineering News-Record*, vol. 87, no. 26, December 29, 1921, pp. 1046-1047)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

The report (Great Britain) made by Lord Newton's Committee on Smoke and Noxious Vapor Abatement emphasizes the fact that smoke pollution is mainly due to the indiscriminate and wasteful use of raw coal for all purposes, and that this pollution can only be overcome by the government and municipalities taking joint legislative action. Among the recommendations of the Committee is one to the effect that the Ministry of Health should be given power to deal with local authorities who fail to administer the law with regard to smoke emission.

The situation with respect to the domestic fuel problem is recognized and control recommended over the heating arrangements in such new buildings as hotels, clubs, and offices. (*Cp. The Electrician*, vol. 87, no. 2276, Dec. 30, 1921, pp. 806-807.)

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Gases in Metals

A WIDE field for research of great practical value is the acquiring of exact knowledge of the gas content of metals. Aside from the more or less familiar relation of gases to the deoxidation of steel and the production of sound ingots and castings, many operations in the refining, working, and treating of metals are vitally effected by the presence of various gases.

Many of the inherent differences in quality of steels made by different processes are generally attributed to the amounts and compositions of the gases with which the metal is in contact when in the molten state in a converter, open-hearth or electric furnace, or in a crucible. It is reported that steel converters operating in a vacuum have recently been successfully used on a commercial scale in England to produce cutlery steel of unusually fine quality. The presence and nature of occluded gas in cast iron has been said to be closely connected with two of its important characteristics, namely, the graphitization of cast iron and the growth of gray cast iron.

Of no less importance are dissolved or occluded gases in non-ferrous metals. For example, the fire refining of copper is wholly a matter of intentionally dissolving a gas (oxygen) in crude copper and then removing nearly but not quite all of this same gas. If the final step of this refining is carried only a minute or two longer than necessary resulting in the complete removal of oxygen, the whole furnace charge must be entirely reworked as if it were a fresh charge of crude copper.

In the working and fabrication of copper, gases also play a part. Operations involving the cleansing of steel or iron by pickling in acids must be followed by treatments designed to remove the hydrogen taken up from the metals by the gases. If not removed this occluded gas will render the metal too brittle to work or will give trouble in subsequent operations when the metal is exposed to heat, as, for instance, causing blisters in enamel. Occluded gases have also been shown to have a marked effect on the electrical conductivity of metals, their magnetic properties, their consistency in dimensions, as well as their mechanical properties.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Automotive Vehicles and Equipment A1-22. METHOD OF MEASURING TEMPERATURE AT DIFFERENT POINTS IN THE BODY OF AN AUTOMOBILE TIRE. Mr. A. O. Ashman in a 14-page pamphlet describes a simple method of using thermocouples to explore the temperature conditions in rubber tires. A copper-constantan thermocouple is employed in conjunction with a potentiometer. Address the New Jersey Zinc Company, 160 Front St., New York.

Fire Prevention A1-22. "SHEETROCK." A series of exhaustive tests on this material which may be used for interior wall, ceiling and partition finish have been conducted by the Underwriters' Laboratories and are published by them in a 97-page pamphlet. "Sheetrock" is of the single-cored wall-board type and paper-covered fibered gypsum-plaster pattern. It consists of a layer of fibered hydrated gypsum reinforced by a sheet of heavy tough sized paper securely bonded to the surface on each side. The surfaces on both sides are smooth and true and light gray in color. Great strength combined with toughness as well as heat insulation and fire-resisting qualities are the principal claims for this building material. Address Underwriters' Laboratories, Chicago, Ill.

Fuels, Gas, Tar and Coke A4-22. COAL CARBONIZATION. Present Status of Coal Carbonization at Low Temperatures is the title of Report 2292 to the Bureau of Mines by Joseph D. Davis. The paper was read at the meeting of the American Gas Association on Nov. 9, 1921. The conclusions of the report which gives the meaning of low-temperature carbonization, amount and character of products, uses of products, suitable coals, principles, apparatus and processes are as follows:

"Although increased interest has been manifested in low-temperature carbonization during the past year, progress toward commercial development has been slow. This is probably due in part to market conditions and in part to difficulties experienced by builders in perfecting their apparatus mechanically.

"In order that a low-temperature industry may be firmly established, it is necessary that the popular prejudice against soft coke be overcome, and it will take time to accomplish this.

"It does not appear that low-temperature methods are destined soon to occupy an important place in the gas industry in so far as gas for city supply is concerned. They may, however, be used to advantage in the production of industrial gas.

Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Machine Design A1-22. BEARINGS IN BRONZE BUSHINGS. As a result of a research carried on by the Engineering Department of the American Bronze Corporation, data sheets have been developed which contain considerable information of value under the headings, Running Clearances, Permissible Angular Deflection for Journals in Plain Bearings, Relation of Rubbing Speed to R.P.M. Allowances for Press Fits, and A Meritorious Design of Water Pump for Automotive Engines. These data sheets are numbered 107, 108, 109, 110, 111 and 112. Address American Bronze Corporation, Berwyn, Pa.

Mechanics A1-22. FATIGUE OF METALS. The results of the past three years' investigations of Profs. H. F. Moore and J. B. Kommers on the Fatigue of Metals have just been published as Bulletin No. 124 of the Engineering Experiment Station of the University of Illinois. This bulletin consists of 185 pages and reports in full the method of procedure of experimenters, results obtained and the conclusions which they have drawn. A summary of their conclusions is as follows:

1 For the metals tested under reversed stress there was observed a well-defined critical stress at which the relation between unit stress and the number of reversals necessary to cause failure changed markedly. Below this critical stress the metals withstood 100,000,000 reversals of stress, and, so far as can be predicted from test results, would have withstood an indefinite number of reversals. The name endurance limit has been given to this critical stress.

2 In the reconnaissance tests made in the field of ferrrous metals no simple relation was found between the endurance limit and the "elastic limit," however determined. The ultimate tensile strength seemed to be a better index of the endurance limit under reversed stress than was the elastic limit. The Brinell hardness test seemed to furnish a still better index of the endurance limit. The reason why the Brinell test, and, to a less degree, the ultimate tensile strength, seem to be better indices of the endurance limit than the elastic limit is not clear, and this result should be regarded as tentative. Elastic limits determined from compression tests and torsion tests gave no better index than did those from tension tests.

3 The single-blow impact tests (Charpy tests) and the repeated-impact tests did not furnish a reliable index for the endurance limit under reversed stress of the ferrous metals tested.

4 Accelerated or short-time tests of metals under repeated stress, using high stresses and consequent small numbers of repetitions to cause failure, are not reliable as indices of the ability of metal to withstand millions of repetitions of low stress.

5 The endurance limit for the ferrous metals tested could be predicted with a good degree of accuracy by the measurement of rise of temperature under reversed stress applied for a few minutes. This relation is explicable in view of the intercrystalline and intracrystalline slippage under repeated stress shown by the microscope. It is believed that this test, which is a development of a test proposed by Mr. C. E. Stromeyer, can be developed into a reliable commercial test of ferrous metals under repeated stress. Its applicability to non-ferrous metals has not been investigated.

6 Abrupt changes of outline of specimens subjected to repeated stress greatly lowered their resistance. Cracks, nicks, and grooves caused in machine parts by wear, by accidental blows, by accidental heavy overload, or by improper heat treatment may cause such abrupt change of outline. Shoulders with short-radius fillets are a marked source of weakness.

7 Poor surface finish on specimens subjected to reversed stress was found to be a source of weakness. This weakness may be explained by the formation of cracks due to localized stress at the bottom of scratches or tool marks.

8 Stress above the endurance limits, due to either a heavy overload applied a few times or a light overload applied some thousands of times, was found to reduce somewhat the endurance limit of two ferrous metals tested.

9 In none of the ferrous metals tested did the endurance limit under completely reversed stress fall below 36 per cent of the ultimate tensile

strength, for only one metal did it fall 40 per cent, while for several metals it was more than 50 per cent. However, these metals were to a high degree free from inclusions or other internal defects; the specimens had no abrupt changes of outline, and had a good surface finish.

10 It is well known that subjecting steel to a stress beyond the yield point raises the static elastic tensile strength to a marked degree. The effect is less marked on the endurance limit, although some increase was observed for 0.18 carbon steel with the surface polished after being stretched well beyond the yield point. Annealing of commercial cold-drawn screw stock was found to lower its endurance limit somewhat less than it did its static strength.

11 The test results herein reported indicate the effectiveness of proper heat treatment in raising the endurance limit of the ferrous metals tested. Here again it should be noted that an increase in static elastic strength due to heat treatment is not a reliable index of increase of endurance limit under reversed stress.

12 The phenomenon known as "fatigue" of metals under repeated stress might better be called the "progressive failure" of metals. The most probable explanation seems to be that such failure is a progressive spread of microscopic fractures. A nucleus for damage may be a very small area of high, localized stress, due to a groove, a scratch, or a crack; in other cases failure may be due to internal inclusions or irregularities of structure; it may be due to internal stress remaining after heat treatment; it may be due to a grain or group of grains unfavorably placed to resist stress; or failure may begin in the weaker grains of a metal whose structure consists of two or more kinds of grains; or it may, or course, begin in any portion of the metal which, by accidental overload or otherwise, is stressed to the yield point. Address Engineering Experiment Station, The University of Illinois, Urbana, Ill.

Metallurgy and Metallography A1-22. ZIRCONIUM. Bulletin 186 of the Bureau of Mines gives reports of investigations on zirconium with reference to the metal and oxide by J. W. Marden and M. N. Rich with historical review and bibliography. The Bulletin covers 152 pages and contains numerous drawings and tables. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Paints, Varnishes and Resins A1-22. WATER-RESISTING SPAR VARNISH. Circular 103 of the Bureau of Standards is devoted to specifications for water-resisting spar varnish. These specifications were prepared under the auspices of the Bureau of Standards by the U. S. Interdepartmental Committee on Paint Specification Standardization, which consists of representatives of all the Governmental Departments, the U. S. Shipping Board, and the Educational Bureau of the Paint Manufacturers' Association of the United States. The specification gives the general requirements and detailed methods of sampling and testing as well as the basis for purchase. Address Superintendent of Documents, Washington, D. C.

Paints, Varnishes and Resins A2-22. INTERIOR VARNISH. The Bureau of Standards has recently prepared Circular No. 117 which consists of specifications for interior varnish. This specification was prepared by the same Committee mentioned above and gives the general requirements and detailed methods for sampling and testing of interior varnish as a basis for purchase. Address Superintendent of Documents, Washington, D. C.

Photography A1-22. BATHS FOR COLOR SENSITIVE PHOTOGRAPHIC PLATES. An interesting paper on color sensitive plates and methods of sensitizing by bathing has been prepared by the Bureau of Standards and issued as Scientific Paper No. 422. Directions are given for sensitizing plates and film, and the relative advantages of various sensitizers are considered. The various brands of orthochromatic plates which are found to be especially satisfactory, are mentioned, and it is noted that washing commercial panchromatic plates had a favorable action on the color sensitiveness. Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Properties of Engineering Materials A7-21. WASTE SLATE AS FILLER. Report 2283 of the Bureau of Mines discusses the use of waste slate as a filler for various materials. Report 2230 discussed the use of slate dust in asphalt road mixtures. The present report discusses the use as a filler for mechanical rubber goods such as disks, sheet packings, molded heels and soles, hard-rubber battery jars, carriage tires, garden hose, clutch facings and similar products. Slate flour was used successfully as a substitute for whiting, clay, barytes and aluminum flakes. With this filler the rubber would not stand repeated stretchings so readily. It has been found that it may be used as a filler for oilcloth, floor coverings and window-shade materials. It has been used as filler for plaster roofing and flooring. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Protective Devices and Methods A1-22. GAS MASKS FOR GASES MET IN FIGHTING FIRES. As a result of the war the gas mask, which uses a chemical filter for removing poisonous gases and fumes from air, has been developed to a high state of perfection. The mask used by the United States Army is capable of giving complete protection against all the deadly gases that have been met on the battle field, but it does not protect against all the gases or atmosphere encountered in mines and in the industries and in fire fighting. A very thorough study of the construction of the various types of gas masks for use in fighting fires has been made by Arno C. Fieldner, Sidney H. Katz and Selwyne P. Kinney. The results of their investigation are recorded in Technical Paper 248 of the Bureau of Mines. Address Bureau of Mines, Washington, H. Foster Bain, Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Foundry Equipment, Materials and Methods B1-22. MOLDING SAND. Hundreds of thousands of tons of molding and core sands are used annually in the iron, steel and non-ferrous foundries of America. A little of it is re-used; much more might be. Sands are not always correctly selected for specific purposes. Mixing and other treatment can secure improvement. In what ways can foundry practise as to sands be bettered? What economies can be realized, not only in reduced expenditure for sand, but also in less number of lost castings and higher quality of accepted product?

Last spring, the American Foundrymen's Association decided that thorough study of this subject would be profitable and asked the coöperation of the American Institute of Mining and Metallurgical Engineers. The Institute referred this request to the Division of Engineering of the National Research Council, of which it is a member. Through joint action with the division a valuable digest of the literature has been made by Professor Robert E. Kennedy, of the University of Illinois, and a large committee of foundrymen, engineers and scientific men has been selected, under the general direction of President W. R. Bean, of the Foundrymen's Association and the chairman of the division.

This committee on molding sand research has just been organized with the following officers and executive committee:

Chairman: R. A. Bull, consulting engineer, Sewickley, Pa.
Secretary: Robert E. Kennedy, assistant secretary of the American Foundrymen's Association, Urbana, Illinois.
W. R. Bean, president of the American Foundrymen's Association, Naugatuck, Conn.
Henry B. Hanley, metallurgist and chemist, New London, Conn.
Jesse L. Jones, metallurgist of the Westinghouse Electric and Manufacturing Co., E. Pittsburgh, Pa.
Prof. Henry Ries, Department of Geology, Cornell University, Ithaca, New York.
Dr. Bradley Stoughton, consulting engineer, New York City.
Dr. George K. Burgess, chief of the Division of Metallurgy, Bureau of Standards, Washington, D. C.

The committee has thirty-five members, representing the many interests in the use of molding sand.

At a meeting of the executive committee on November 26, in the office of Division of Engineering, Engineering Societies Building, New York City, three subcommittees were appointed to deal (1) with the formulation of standard tests for determining the working properties of molding sand, (2) reclamation of molding sands and greater use of old sands and (3) methods of manufacturing synthetic sands. A meeting of the main committee in the Engineering Societies Building, New York, was planned for December 9, to lay out a comprehensive program of research which will include the assigning of the various problems to appropriate laboratories and industrial plants. Some field work will be necessary in connection with these investigations.

The coöperation of men having like interests in Canada and England is assured and invitations have been extended to France and Belgium. Address Alfred D. Flinn, Chairman of Division of Engineering, National Research Council, 29 West 39th Street, New York.

Foundry Equipment, Materials and Methods B2-22. ELIMINATION OF OXIDIZIBLE ELEMENTS IN CAST IRON. John H. Moffett, formerly metallurgical engineer at the University of Cincinnati, is now in charge of the foundry practice in the Department of Mechanical Engineering at the University of Minnesota. He is at present carrying on a research on the Relative Rates of Elimination of Oxidizible Elements in Cast Iron. Address Professor Moffett at the University of Minnesota.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire cooperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring cooperation or aid will state problems for publication in this section.

Highways C1-22. COORDINATION OF HIGHWAY RESEARCH. *See Road Materials and Equipment C1-22.*

Road Materials and Equipment C1-22. COORDINATION OF HIGHWAY RESEARCH. Mr. W. K. Hatt, a member of the Advisory Board on Highway Research of the National Research Council, discusses this subject completely in a paper read at the meeting of the American Association of State Highway Officials, Omaha, Neb., December, 1921. He discusses first the present situation in highway research and then points out how the various state highway commissions may assist in developing as rapidly as possible the data which can be a safe foundation for the scientific construction and operation of highways. Address A. D. Flinn, Chairman of Division of Engineering, National Research Council, 29 West 39th St., New York.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure of commercial work or notes regarding the conduct of various laboratories.

Research Agencies E1-22. Personnel Research Agencies. The Bureau of Labor Statistics of the U. S. Department of Labor has just issued a 107-page Bulletin No. 299 in which it has attempted to provide information about all existing agencies in the United States in the field of Personnel Research. Personnel research has been construed to include within its scope studies and investigations of all kinds concerned with any of the problems of (*a*) employment management and industrial relations (such as selection and placement of employees, job analyses and specifications, rating and grading, lines of promotion, labor turnover, absenteeism, wage and other incentives, joint control, etc.); (*b*) vocational psychology, including the development and standardization of intelligence and trade tests; (*c*) training of managers, foremen and workmen, either in schools and colleges, in the factory, or under schemes of coöperation between educational institutions and industrial establishments; (*d*) working conditions in relation to output, including hours of labor, fatigue, lighting, ventilation, food; (*e*) health hazards and occupational diseases; (*f*) safety codes and appliances; also the special problems connected with the employment of women and young persons, foreign-born workers and colored workers, the handicapped or disabled, and the mentally deficient or unstable. The agencies whose activities are described are arranged in the following main divisions:

1 Official agencies: (*a*) Federal, (*b*) State, (*c*) Municipal.
2 Non-official agencies: (*a*) Associations, foundations, research bureaus, and institutions; (*b*) Universities and colleges.

Address Bureau of Labor Statistics, Washington, D. C.

Research Agencies E2-22. New Division of Coöperative Research. Under the Directorship of Dr. W. V. Bingham, the Carnegie Institute of Technology has recently organized a Division for Coöperative Research. This is new evidence of efforts of the Institute to foster research of the highest order in all the scientific and technical departments of the Institute. The plan and purpose of the organization of this new activity of the Carnegie Institute is outlined in the November, 1921 issue of "*The Carnegie Technical Journal* under the heads, The Need for a Research Center, Industrial Problems, Commercial Problems, Educational Research, and Organization and Program of the New Division. Address Carnegie Institute of Technology, Pittsburgh, Pa.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Cement and Other Building Materials F1-22. Acid-Proofing of Concrete. A bibliography of $2^{1}/_{2}$ pages. Search 3472.

Cement and Other Building Materials F2-22. Waterproofing of Concrete. $5^{1}/_{2}$ pages. Search 3473.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 375 and 376, as formulated at the meeting of December 6, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 375

Inquiry: Is it permissible, under the requirements of the Boiler Code, to weld a seam in a vertical firebox not over 38 in. in diameter, and in length ranging from 20 in. up, by the autogenous or fusion process where the firebox has no support other than the tube sheet, mud ring and fire door?

Reply: It is the opinion of the Committee that, under the requirements of the Code, autogenous or fusion welding is not permissible for the seam in the firebox of a vertical-tubular boiler, unless the sheet containing the seam is supported by staybolting.

Case No. 376

Inquiry: An interpretation is requested of the limitation of 50 hp. in Par. 318 of the Boiler Code to different classes of boilers. Is it the intention that the horsepower capacity be based on water heating surface as specified in the requirement in Par. 274?

Reply: It is the opinion of the Committee that the intent of Par. 318, relative to the determination of the feeding devices required for boilers, will be met if boilers having over 500 sq. ft. of water-heating surface are provided with two or more feeding devices.

Boiler Code Sub-Committee on Code for Care of Steam Boilers in Service

When the A.S.M.E. Boiler Code Committee was appointed in 1911, it was given the following title: Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for Their Care in Service. Since its inception however, the great volume of the Committee's work has been devoted to the formulation of rules for the construction of steam boilers of different classes and little opportunity has been given to consider the important problem of their operation.

Realizing this lack in the Committee's function, attention has recently been given to the need for operating rules and there was appointed by the Council at the meeting of January 7, at the request of the Boiler Code Committee, the following Sub-Committee for this purpose:

F. M. Gibson, *Chairman*, Boston, Mass.
H. F. Scott, Framingham, Mass.
J. R. Gill, Meadville, Pa.
W. H. Larkin, Jr., Passaic, N. J.
J. Wolff, Cleveland, O.
W. G. Diman, Manchester, N. H.
J. S. Schumaker, Lincoln, N. H.
E. G. Bailey, Cleveland, O.
J. W. Hays, Michigan City, Ind.
S. F. Jeter, Hartford, Conn.
Nicholas Stahl, Providence, R. I.

This Sub-Committee consists of active operating engineers who have had long and varied experiences and are eminently fitted for the preparation of rules for the care of boilers in service. The code which they may formulate should be welcomed by all boiler owners, insurance companies and in fact anyone directly or indirectly interested in the field of steam boilers or other pressure vessels.

The Boiler Code Committee desires coöperation in this new department of its activities and requests everyone interested to assist in this important work for the general good. Mr. F. M. Gibson, to whom the Committee is indebted for the active effort in inaugurating this work and who has been appointed Chairman, will greatly appreciate the assistance of all those who may contribute.

He should be addressed care of the American Sugar Refining Co., 49 Granite St., South Boston, Mass.

Bombing of the U. S. S. "Ex-Iowa" and the Former German Ships

By COMMANDER F. J. CLEARY,[1] U. S. N.

IN agreeing generally to Mr. Elmer A. Sperry's editorial on "What the Virginia Capes Aircraft Bombing Test Show" in the September, 1921 issue of Mechanical Engineering I desire to point out that some of his statements taken by themselves are susceptible of erroneous conclusions. The bombing experiments are of sufficient value to warrant presentation of the facts observed and the conclusions reached by the Board of Observers and by the Army and Navy Joint Board.

The bombing of the U. S. S. ex-*Iowa* and of the ex-German ships, including the *Ostfriesland*, was conducted by the Naval Air Force of the Atlantic Fleet under Admiral Henry B. Wilson, Commander-in-Chief. The Army was invited to participate and did so by a Provisional Air Brigade operating under the orders of the Commander-in-Chief, Atlantic Fleet. The plans for the experiments were set forth in Fleet Operations Order 261–24–5 of May 25, 1921, from which the following extracts are taken:

"Vice Admiral H. P. Jones, Commander Battleship Force, is in charge of operations scheduled."

"The Commander of the Air Force Atlantic Fleet is charged with the operations of all Air Forces engaged."

"Brigadier General William Mitchell, U. S. Army, has been designated by the War Department as the Commander of the Army Provisional Air Brigade and is in immediate command of all Army Air Forces engaged in these exercises."

The *Ostfriesland* was 50 miles from the coast, and the attacking planes were guided to the target by a double line of destroyers stationed for that purpose and to aid any planes taking the water.

The ex-*Iowa* was approximately 100 miles off shore, and the search for and the bombing of her were conducted by Navy planes. Three army blimps took part in the search operations. The Army was invited to take part in the bombing of the ex-*Iowa*, but did not.

The Army was also represented on the Board of Observers, composed of 13 Naval Officers (ranking from Captain down to Lieutenant Commander) and 6 Army Officers (Lieutenant-Colonels and Majors), 3 of the Army Air Force and 3 of the Ordnance Department.

The *Ostfriesland* was turned over to the U. S. with the understanding that she would be sunk, and the bombing experiments were planned to cause as much destruction as possible so that any weak features of construction would be revealed. She was an old ship, laid down in 1909 and launched in 1911, and displaced 24,000 tons, and her protection above and below water was much less effective than in a modern ship. She had no anti-aircraft gun fire and could not maneuver to avoid attack, and the planes bombed from the extremely low altitude of 1200 to 2000 ft. The ship had been badly damaged by the Germans before she was delivered. She leaked to such an extent that on the trip down from New York to her anchorage she took in 1020 tons of water increasing her draft one foot.

The bombing on the first day lasted from 1:40 to 4:25 p.m., during which time 52 planes, both singly and in formation, made 31 flights over her, dropped 52 bombs and made 13 direct hits as follows:

Navy	33–230-lb. bombs 8 hits
Navy	8–550-lb. bombs 4 hits
Army	11–600-lb. bombs 1 hit

At the end of the first day's bombing, the ship had received little damage from the direct hits, except a hole in the starboard side of the forecastle made by a 600-lb. bomb which caused some general damage to light fittings under this deck. A few holes were made by fragments in the second deck, but this second deck practically stopped the whole force of the explosion. No damage whatever was done to the protective deck.

A number of these bombs had fallen close aboard. Examination below showed 7 of the 9 fire rooms clear of water, one fire room could not be entered, the other was taking in water. Two out of the three engine rooms were taking in water. This water was from the old leaks and from new leaks, but the water was coming in so slowly that the ship could have been pumped out by the powerful outfit of pumps which are a part of the machinery equipment of all naval ships The ship took in water during the night so that the next morning her draft had been increased by an additional 3 ft , showing that she now had 4080 tons of water in her (which could have been kept clear had she been in good condition at the beginning and had the pumps been operating), bringing her water line within 1 or 2 ft of the 3d-deck air ports.

Bombing with 1000-lb. bombs commenced at 8:30, and during the morning 11 Army planes made 11 single flights over her, dropping 11 1000-lb. bombs and making three direct hits. A careful inspection was made. The three direct hits caused no vital damage to the ship and none to her main battery; two of these 1000-lb. bombs detonated between the two starboard waist turrets but no damage to the turrets resulted. The other bomb blew a hole in the starboard side of the forecastle extending down near the water line. This injury would have undoubtedly affected the speed of the ship; there was no bursting effect below the 2d deck and all fragments were stopped by the protective deck. The damage in every case where bombs struck the ship was purely local; the vertical blast effect was considerable but the horizontal blast effect was so comparatively slight that a 1 inch steel bulkhead about 25 ft. from the point of impact would have afforded protection to personnel. No damage was suffered to the battle lighting and battle control systems and absolutely no damage was caused behind armor or below the protective deck. By noon, from the water taken aboard through the leaks, the ship was down 5 feet by the stern.

Bombing with the 2000-lb. bombs was commenced at 12:30 in 12½ min. 6 bombs were dropped—there were no direct hits. Three bombs dropped far enough away to do no damage; the other three dropped very close alongside, one detonated very close to the port bow but appeared to do no appreciable damage; the third detonated under water close to the port quarter severely damaging the already weakened port side and at the same time blew in the glass air ports of the gun deck and 3d decks aft, these ports being awash and not fitted with steel battle covers as is usual. This allowed a heavy rush of water into the already waterlogged hull. The vessel began to settle rapidly by the stern, listed heavily to port, and at 12:40 she turned completely over and went down by the stern throwing her bow high in the air.

In all the following bombs were dropped on the *Ostfriesland:*

	Direct hits
33 Navy– 230 lb.	8
8 Navy– 550 lb.	4
11 Army– 600 lb.	1
11 Army–1000 lb.	3
6 Army–2000 lb.	0
69	16

The damage done by the bombs was identical to the damage that would have been caused by mines.

The mining effect on the underwater structure by the bombs which detonated under water close to the ship, together with the flow of water through the equalizer pipes and the fire-room doors (which were opened by the Board of Observers to keep the ship on an even keel) and the rush of water through the blown-in glass air ports caused her to sink finally. All this was cumulative, and it is probable that if she had been manned, her pumps could have controlled the leakage resulting from all attacks but the final one, and consequently the mining effect of the final attack would have been greatly reduced, and it is very possible that sinking might not have resulted from the damage inflicted by all of these attacks. Our latest capital ships are so constructed that the damage from these attacks would have been very much less than that inflicted on the Ostfriesland.

At an immovable target 548 ft. long by 94 ft. beam and at the low altitude of 1200 to 2000 ft. 16 direct hits were made out of 69 shots, the misses varying from close aboard to 300 ft. distant.

(Continued on page 135)

---

[1] Bureau of Steam Engineering, Washington, D. C.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers
29 West 39th Street, New York

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

The Development of the Colorado River

The convention of the League of the Southwest at Riverside, California, on December 8 to 10 and the hearing on the Boulder Canyon Project before Secretary Fall at San Diego on December 12 has aroused general interest in the various proposals which have been made for the development of the Colorado River. The basin of this river includes parts of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming, and has an area of about 250,000 square miles. It contains some five million acres of irrigable lands, and has power possibilities aggregating six million horsepower. Its most pressing problem, however, is flood protection.

Clinedinst

O. C. Merrill

The Gulf of California originally extended northwestward into California. The silt-laden water of the Colorado gradually formed a delta extending across the Gulf, cutting off the northern end, and deflecting the flow of the river wholly to the south. The waters inclosed in the northern and evaporated leaving a depression, now known as the Imperial Valley, and the Salton Sea with its surface 250 ft. below sea level. The silt-formed delta is unstable; the river is constantly depositing more sediment and shifting its channel back and forth over the flat ridge—some 30 ft. above sea level—which forms the crest of the delta; and there is danger at each flood season that it may break northward into the Imperial Valley instead of continuing southward into the Gulf. The river did break through in 1905 and for a year and a half discharged into Salton Sea before it was turned back with great difficulty and much expense into its old channel. The levees which were later built to protect the valley have several times been awash in periods of floods; it is necessary to raise them about a foot a year to keep pace with the rise of the river channel; and it is only a matter of time when the river will break through again unless steps are taken to control the floods. It is this situation which has placed primary emphasis on flood control in all plans for the development of the Colorado River.

Less than one acre in thirty in the Colorado Basin is irrigable. The general development of the basin will, therefore, be likely to require all the agricultural products that its lands can produce long before there will be a demand for all its potential water powers. For this reason irrigation is secondary only to flood control in a general plan of development, and irrigation use of the waters of the stream will take precedence over power use wherever these uses conflict.

Although the Colorado Basin has important mineral resources, only partially developed on account of lack of power and of transportation, and has several lines of trunk railroads and many flourishing towns and cities, all of which would serve to create a demand for power, the individual markets would be so small and so widely scattered that it is hardly probable that the requirements of the basin itself would justify any large-scale development on the main river at the present time. Such a development must first seek primary markets outside the basin. The only section which seems capable of furnishing the requisite demand in the near future is Southern California; and all proposals for extensive development on the river have that territory in view. If, however, primary lines are once established and the main load secured, extension of service will be made into the local territory, provided the projects are operated by agencies which have the authority and the disposition to extend their lines for such purpose.

Applications for power projects on the Colorado and its tributaries aggregating 4,500,000 primary horsepower are now on file with the Federal Power Commission. The most important of the proposed projects are the Lees Ferry Project of the Southern California Edison Company, the Diamond Creek Project of James B. Girand, and the Boulder Canyon Project of the United States Reclamation Service. The first proposes a dam near Lees Ferry of approximately 500 feet in height forming a reservoir 125 miles in length with a capacity of 30 million acre feet and capable of producing 600,000 horsepower from the regulated flow of the stream. The Diamond Creek Project involves a dam some 250 feet high, has no provision for seasonal storage, and would be capable of producing some 125,000 horsepower from the unregulated flow of the stream. The Boulder Canyon Project proposes a dam 550 feet in height forming a reservoir of 30 million acre feet capacity. This project, while intended primarily for flood control and irrigation would be capable of producing 600,000 horsepower. The Boulder Canyon Project is approximately 250 miles from Los Angeles, and the Lees Ferry Project 450 miles. The Diamond Creek Project midway between the other two is intended primarily for supplying power in Arizona.

The general problem of the Colorado River Development and the relation to each other of flood control, irrigation and water power can best be understood by reference to the accompanying map and profile and by a consideration of the different characteristics of the upper, middle and lower sections of the river. The upper section from the headwaters to the mouth of the San Juan comprises about 40 per cent of the area of the basin and affords about 87 per cent of the total runoff, or an average of 15,000,000 acre ft. per annum. In this section are some 2,500,000 acres of irrigable land, one-half of the total in the basin. It also has power possibilities aggregating 2,000,000 horsepower. In this section, both upon the main stream and upon its tributaries are many favorable reservoir sites by means of which it would be practicable to regulate the flow of the streams for irrigation within the section, for power development both within the section and outside, and, if desirable, for flood control on the lower river.

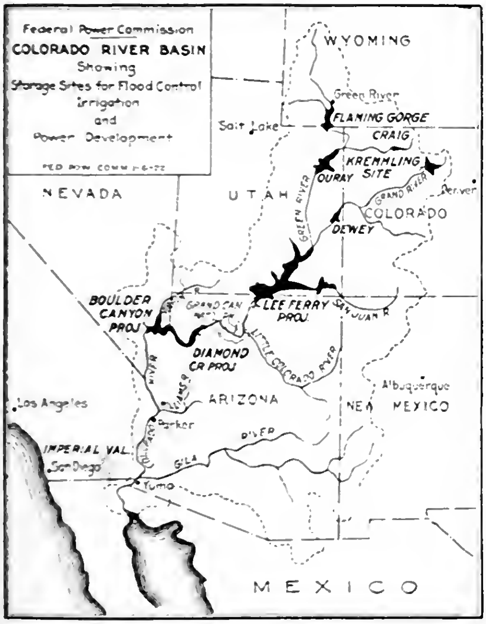
The middle section from the mouth of the San Juan to the mouth of the Williams comprises about 35 per cent of the area of the basin and supplies about 7 per cent of the annual runoff. There are no irrigable lands along the river in this section and only 250,000 acres on the tributaries, none of which can be reached from the main river. In this section, however, there is a total drop of some 3,000 ft., capable, if fully utilizing the average annual runoff entering the section, of producing 4,000,000 horsepower. Except for the Boulder Canyon Site near the lower end of the section there are no feasible storage sites. Dams erected for power development would be primarily for the purpose of concentrating the head and of providing daily load regulation. Seasonal regulation would be dependent upon storage in the upper section.

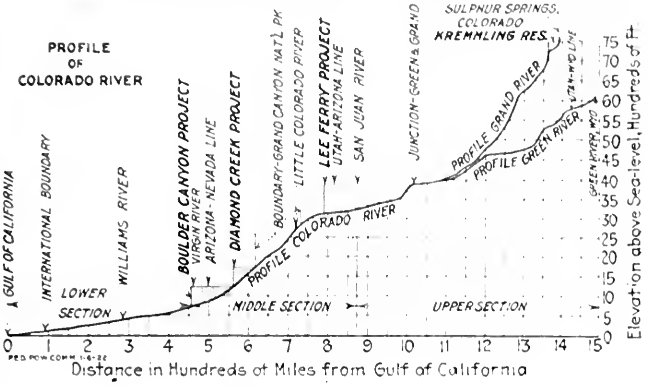
The lower section from the mouth of the Williams River to the Gulf, and including the drainage of the Gila and the Imperial and

Coachella valleys in California, comprises some 25 per cent of the total area of the basin and furnishes about 6 per cent of the average annual runoff. Its power possibilities are relatively unimportant, but it contains some 2,250,000 acres of irrigable land, the most fertile and most valuable in the basin.

Viewed solely from the physical standpoint, the upper section of the basin might have its primary development directed either toward irrigation or toward water power. On the other hand, the middle section, with the exception of storage below the mouth of the Virgin and of relatively small irrigable areas on the tributaries, is suitable only for power development. Equally clearly the lower section should be devoted primarily if not exclusively to irrigation. The primary elements of a general plan for river development for the several purposes are, therefore, storage at the headwaters for irrigation and power in the upper section, storage below the San Juan for the regulation of the waters available at that point for power use in the middle section, and storage below the Virgin for re-regulation to meet irrigation requirements and flood protection in the lower section. If these can be provided, and an equitable distribution of irrigation waters between the upper and lower sections effected, the fullest utilization of the stream can be effected with the least conflict of use.

There seems to be a reasonably close agreement on the general features of a plan of development. Such disagreement as has appeared has had reference to the order in which the various steps of the general plan should be undertaken and to the agencies which should carry it out. It is agreed that flood control is the most pressing problem. This could be effected by storage in the upper section,—which was the original proposal—but such a plan would require the use of several of the best reservoir sites in this section, and would render them practically useless for irrigation or power development. Flood control could also be effected by storage either below the mouth of the San Juan at the upper end of the middle section or at Boulder Canyon at the lower end of the section. Storage primarily for flood control and irrigation at the former location would at the same time provide all the regulation likely to be needed for many years for power development below although eventually when power demands called for the entire use of the upper reservoir for such purposes, storage below the Virgin would be required for re-regulation to meet the needs of irrigation and flood control. On the other hand, if the sole dependence for flood control and irrigation storage is to be placed on the Boulder Canyon site, the investment must be duplicated above in order to provide regulation for power purposes in the middle section, and when this has been done the greater part of the storage capacity at Boulder Canyon will be valueless, unless the excess cost can be justified wholly from the standpoint of the power which may be produced, or unless the imminence of flood danger to the Imperial Valley and the time element in favor of Boulder Canyon justify the additional cost as a measure of insurance.





It was the consensus of opinion at the San Diego hearing that the Boulder Canyon dam, at least, should be built and owned by the United States and that the power produced should be disposed of by the United States. The Boulder Canyon site is estimated to be capable of producing 500,000 horsepower, and the only market for such a block of power at the present time is in Southern California. Under such circumstances there is not likely to be any further move made toward large-scale development upon the river until Congress either approves or disapproves the proposal for Government construction and, if it approves, until the question of the distribution of the power is settled. The municipalities of Southern California, particularly Los Angeles, are making a strong bid for this power. If they secure it, it will be taken out of the basin, will not be a factor in the development of the basin itself, and the other six States which have not the means to enter upon a program of public development will either have to wait until local demands have increased to an amount which will justify private capital in undertaking the service, or depend upon the Federal Government to supply their needs from Boulder Canyon or elsewhere.

O. C. Merrill.[1]

A.S.M.E. Announces Spring Meeting Plans

At the meeting of the A.S.M.E. Council held in Norfolk, Va., on January 7, the Committee on Meetings and Program received full support in its stand that papers for the 1922 Spring Meeting must be in hand before March 15. This action was taken to permit the Committee to give proper consideration to contributions for the meeting. The time limit is also set to insure printing and issue previous to the meeting. In this way proper discussion is provided and it is the consensus of opinion that discussion is necessary to the life of a meeting. At the last Annual Meeting, papers were ready only a few days before the professional sessions started and as a result, some of the notable papers did not receive the study their contents really required. Many members expressed dissatisfaction which it is believed this Council action will remove in the future. It should be borne in mind, however, that March 15 is the last date that papers will be accepted. All of the papers can not be properly handled if they arrive at the last moment, and the Committee on Meetings and Program will exercise its judgment as to the papers that should be printed.

The adoption of this procedure at this time is especially fortunate as it will give considerable strength to the program of the Spring Meeting at Atlanta.

An exceedingly interesting Spring Meeting week has been tenta-

---

[1] Executive Secretary, Federal Power Commission, Washington, D. C.

tively decided upon by the A.S.M.E. Committee on Meetings and Program. The festivities will start at the University of Virginia on Friday and Saturday, May 5 and 6, preceding the meeting. This will give an opportunity to members attending from the North to stop over and enjoy the hospitality of the Virginia Section. The program at Atlanta will start on Monday, May 8, and will extend through May 11. The Atlanta Section is offering a remarkable program of entertainment in which a real southern barbecue and exhibition golf match will be offered. The climate in Atlanta at that time of the year is very pleasant and those coming from other sections of the country not so well favored will enjoy the week out of doors well in advance of the open season in the North.

The technical program in Atlanta will include papers furnished by the Power, Fuels, Materials Handling, Management, Machine Shop and Textile Professional Divisions.

The Power Division will present a program relating to hydroelectric power development, particularly in the Southeast. A paper giving the results of recent tests on the 60,000 kw. turbine of the Interborough Rapid Transit Company of New York City will be presented by title.

The Fuels Division promises three papers as follows:

Relation of combustible elements of coal to the oxygen content and the establishment of a fuel unit of practically constant heat value for over 90 per cent of all bituminous coals, E. A. Uehling. Boiler Room Performance and Practice at the Colfax Station of the Duquesne Light Company and the Seward Station of the Pennsylvania Public Service Corporation, C. W. E. Clarke. Reduction of Fuel Wastes in the Steel Industry, F. G. Cutler.

Materials Handling Equipment in the Steel Industry is the subject of a paper to be given before the Materials Handling Division by F. L. Leach of Perin and Marshall. Mr. Leach has treated the entire industry in a comprehensive manner and shows how its operation hinges on adequate design of equipment.

The programs of the Management, Textile, and Machine Shop Divisions treats of the problems of the textile industry. The Management Division plans three papers as follows: Comparison of Southern white labor with foreign labor of the North, Frank H. Neely. General subject of management in textile plants, George S. Harris. Reducing costs in textile mills by increasing production, E. A. Lucey.

The Machine Shop and Textile Divisions will coöperate in joint sessions on textile machinery. The papers will discuss textile machinery maintenance, weaving, ginning, and carding machines.

After the sessions at Atlanta those interested in seeing textile plants in operation will visit Greenville, S. C., where thorough inspection trips will be held. Other members of the Society will be given an opportunity to take a trip to Birmingham, Ala., where the remarkable series of plants engaged in the manufacture of iron and steel will be inspected.

Patent Relief Bill Passes House

As we go to press, word is received from Chairman Edwin J. Prindle, of the American Engineering Council Committee on Patents, advising that the Lampert Patent Office Bill has passed the House of Representatives. This is the first step in securing the much needed relief in the Patent Office for which the American Engineering Council has been struggling for considerable time.

Engineering Societies Library Now Loans Books

In the book column on page 139 Director Craver of the Engineering Societies Library explains the plan by which members of any of the Societies participating in the library may have books loaned to them.

In the early days of the Society when the membership was not so widely scattered or its interests so diversified, the library privileges were more generally appreciated than at the present time. Technical book publications, which are usually expensive, are still needed for reference and this new attempt on the part of the Library to satisfy the demand from outside the environs of New York City is particularly noteworthy. This step is along the line of the photostat and search services in placing the resources of the library at the disposal of the individual members of the profession.

Industrial Standardization

E. C. Peck

We are apt to think of mass production as primarily an American development, but the experiences of the War brought its possibilities home to the leaders of industry in the principal European countries, even if all of them had not realized its significance before. Today there are being planned and carried out in each of these countries, far-reaching programs of industrial standardization. In a large measure, the work is national in its scope. That is to say, any particular piece of work is carried out through the systematic coöperative effort of the industries concerned, functioning through their national industrial associations, technical societies, and government bureaus.

The two countries in which such work has reached its greatest development, both in scope and in activity, are Great Britain and Germany. A description of the German work is presented on page 136 of this issue. The Germans, taking full advantage of the lessons of the War, are making industrial standardization an essential part of their scheme of reconstruction and are relying on it to play an important role in rebuilding their foreign trade on a vastly increased scale. Managers of American industries may well give serious study to the German work. It behooves them to intensify their efforts toward standardization, or they will be left behind in the competition for world commerce. It is not enough that there be standardization work done by sections of industries and by individual firms, although such work, prior to the War, made possible a considerable amount of mass production, which attracted the attention of European industrialists. To reap the full benefits the work must be broadened and intensified, and made national in its scope. This requires the joint effort of manager and engineer, of producer, distributor, consumer and independent specialist, all speaking through the organized bodies which represent their interests. Fortunately such industry-wide coöperation has already been brought about in a large number of projects now going forward under the auspices of the American Engineering Standards Committee, and very substantial results have already been achieved. It must be evident that considerable prestige is acquired by manufacturers whose products are in accord with the standards that have been established by national organizations and especially those approved by the American Engineering Standards Committee.

The many benefits of standardization are by no means limited to the production side. In the long run standardization is bound to be of even greater importance in the reduction of distribution and selling costs,—perhaps the most important problem of our economic system. A comprehensive program of standardization planned and carried out by our great national industries will mean the saving of hundreds of millions—even billions of dollars.

E. C. Peck[1]

Ordnance Department Needs Manufacturers' Aid

With the passing of emergency, the Ordnance Department of the Army, which during the war was able to enlist close and hearty coöperation from manufacturers of ordnance material and mechanical engineers generally, is now finding it difficult to secure from private industry the assistance which is so necessary if the most practical types of ordnance material are produced. It is essential to the national interest that this apathy on the part of outside manufacturers be broken down, in the opinion of Brigadier General W. S. Peirce, assistant chief of Ordnance, in immediate charge of the work which involves this problem. He is at this time making a renewed effort to solve this problem.

General Peirce believes that a widely held view that ordnance specifications are too theoretical, can be offset entirely if machinery and material manufacturers can be interested sufficiently to go into the subject deep enough to understand the military problems involved.

---

[1] General Supt., Cleveland Twist Drill Co., Chairman A.S.M.E. Standardization Committee.

BOMBING OF THE U. S. S. "EX-IOWA"

(Continued from page 131)

That accuracy of bomb dropping rapidly decreases with increase of altitude and a moving target is proved by the bombing tests on the ex-*Iowa* a few days earlier when 22 planes bombed her from 11:24:00 a.m. to 3:10 p.m. from an altitude of 4000 ft. dropping 85 (dummy) bombs and making 2 direct hits, the 83 misses varying from close aboard to 600 or 700 ft. distant. The speed of the ex-*Iowa* was only 6 knots which should have had little or no effect upon the accuracy of bomb dropping.

The problem of avoiding a bombing plane by maneuvering or of hitting a bombing plane is much simpler than avoiding or hitting a plane not bombing for the reason that the bombing plane must steady on a course heading almost directly toward the target for an appreciable period and the position at which the bomb must be released can be forecast with fair accuracy.

If the *Ostfriesland* had been underway at 20 knots or more and if her anti-aircraft battery had been in action, keeping the heavy bombing planes at a safe altitude of 6000 ft., it is reasonable to believe that the chance of serious damage would not have been very great from the 69 bombs which were dropped at her during the two-days attack. If, in addition, she had carried three or four fast pursuit planes (with machine guns firing explosive and incendiary bullets), as all capital ships now carry or will carry, these fast planes would have outmaneuvered and shot down a number of the bombing planes before they arrived within bombing distance.

The Navy has known for many years that any ship could be seriously damaged or sunk by detonating heavy charges of high explosive under water against or very close to the body of the ship below armor. Such damage from mines or torpedoes has been guarded against by numerous watertight bulkheads or by the British "blister" until the latest capital ships can survive direct hits from two or three torpedoes or the explosion of two or three heavy mines fairly close aboard.

If the explosion takes place beyond a certain distance from the ship (depending upon the weight of the explosive charge and its distance below the surface) little or no damage will result. The distance within which a charge of high explosive must be placed to seriously damage the thin plating below armor is comparatively very short; for instance—a 250- or 300-lb. bomb detonated under water probably within 15 or 20 ft. of the hull of the light cruiser *Frankfort* without appreciable effect.

The Navy fully believed that very heavy charges of high explosives could be detonated on the upper decks of a modern capital ship with no damage to turrets or other heavy fittings, and while such heavy charges would probably penetrate the upper decks, the heavy protective decks would render the propelling machinery boilers, magazines, and the greater part of the personnel immune, from overhead attack.

This knowledge and this belief have been confirmed by the experiments on the ex-*Iowa* and the *Ostfriesland*, and the Navy faces the same problem—to keep high explosive charges from detonating under water within the comparatively short danger space of the underwater body below armor.

Under the same conditions, i.e., a stationary target and immunity from hostile fire, an attack by destroyers, by submarines, or by another battleship would have resulted in sinking the Ostfriesland in a very short space of time.

The experiments demonstrated that the airplane is a powerful weapon of offense, capable under favorable conditions of placing heavy charges of high explosive sufficiently close to a capital ship to sink her eventually. The airplane menace to the capital ship is commensurate with the destroyer menace and the submarine menace. The destroyer menace was met by numerous watertight bulkheads, rapid fire guns and protecting destroyers; the added submarine menace was met by the added protection of listening devices, depth charges, speed and quick maneuvering, the added airplane menace is being met by the added protection of (first and most important) fast pursuit planes, and anti-aircraft batteries.

The Joint Army and Navy Board consists of the following very able and experienced officers: General Pershing, Chief of Staff; General Harboard, Director of the Operations Division, General Staff; General Haan, Director of War Plans Division, General Staff; Admiral Coontz, Chief of Naval Operations; Admiral Williams, Director of Plans Division, Naval Operations; Captain Cole, Assistant Chief of Naval Operations. This Joint Board, from a careful study of the reports of the Boards of Observers, from actual observations by some of the members of the Joint Board of the bombing experiments, and from their general knowledge of the principles of war and methods of conducting war, arrived at certain general conclusions. These general conclusions are concurred in by a large majority of officers of both the Navy and the Army who have had access to the report of the Joint Board. These general conclusions have been approved by the Secretary of War and the Secretary of the Navy and are quoted below:

> "Aircraft either singly or in combination have pronounced ability to search sea areas within their radius of action and to locate naval vessels operating in such areas. When armed with heavy bombs the radius of action of heavier-than-air types is inadequate for extensive search operations. Darkness, fog, falling or squally weather will greatly reduce the effectiveness of aircraft in search operations.
>
> "Inasmuch as these experiments were not conducted under battle conditions it is difficult to draw conclusions as to the probability of hitting a target with bombs from aircraft while in action. Under the favorable conditions existing during the experiments, namely stationary or practically stationary targets, immunity from enemy interference, excellent visibility and flying conditions, the percentage of hits was greatly in excess of that to be expected under battle conditions. The probability of hitting will be reduced in the case of a target moving at high speed on varying courses; further reduced if the target vessel is protected by effective anti-aircraft armament; and will be practically negligible if the target is protected by effective pursuit planes. The effectiveness of the bomb carried by aircraft emphasizes the necessity for the rapid development of anti-aircraft armament and the provision of pursuit planes as a part of the fleet. Aircraft carrying high-capacity high-explosive bombs of sufficient size have adequate offensive power to sink or seriously damage any naval vessel at present constructed provided such projectiles can be placed in the water alongside the vessel. Such bombs hitting the upper works of the vessel are disastrous to exposed personnel, serious to light upper works, comparatively slight to heavy fittings such as guns, and negligible to turrets. The effect of direct hits was completely local. In the case of capital ships, the mining effect of bombs will be materially reduced due to the ability of the personnel to free the ship of large quantities of water by means of pumps and to shore up watertight doors and bulkheads which are in danger of carrying away due to water pressure. Aircrafts possess sufficient offensive power to seriously threaten the exposed personnel of naval vessels unless such vessels are protected by pursuit planes. This emphasizes the necessity for the further protection of personnel and for the provision of aircraft carriers to accompany the fleet.
>
> "The radius of action of bombing planes limits their effectiveness against Naval vessels to coast defense or base defense.
>
> "The mission of the Navy is to control vital lines of transportation upon the sea. If no opposition is met from enemy naval vessels this mission can be accomplished without entering an enemy's coast zone within which bombing aircraft based on shore are effective.
>
> "Without an effective Navy in time of war a nation must submit to an economic blockade fatal to its trade and the importation of necessary materials for the production of war supplies.
>
> "If heaver-than-aircraft are to be effective in naval warfare they must have great mobility, and since their radius of action is not great, additional mobility must be obtained by providing aircraft carriers. So far as known, no planes large enough to carry a bomb effective against a capital ship have been flown from or landed on an airplane carrier at sea. Future development may make such operations practicable. Aircraft carriers are essential to the highest efficiency of the fleet. Aircraft carriers are subject to attack by vessels carrying guns, torpedoes or bombs, and will require, as all other types of vessels require, the eventual support of the battleship.
>
> "The battleship is still the backbone of the fleet and the bulwark of the Nation's sea defense, and will so remain as long as safe navigation of the sea for purposes of trade or transportation is vital to success in war. The airplane, like the submarine, destroyer and mine, has added to the dangers to which battleships are exposed, but has not made the battleship obsolete. The battleship still remains the greatest factor of naval strength. The development of aircraft, instead of furnishing an economical instrument of war leading to the abolition of the battleship, has but added to the complexity of naval warfare.
>
> John J. Pershing,
> Senior Member.
>
> Approved
> Theodore Roosevelt,
> Acting Secretary of the Navy.
>
> Approved
> John W. Weeks,
> Secretary of War."

Every new development in naval warfare has its advocates who have predicted that the battleship was doomed. First, the small torpedo boat was to render the battleship obsolete; next the fast destroyer, then the submarine, and now the airplane—each new challenge to the supremacy of the capital ship has been met by the development of the defense and by adopting and adapting the challenger as an efficient auxiliary to the capital ship, and the Navy is dealing with the airplane in the same manner as it has successfully dealt with the torpedo boat, the destroyer and the submarine.

Engineering and Industrial Standardization

Industrial Standardization in Germany

INSUFFICIENT attention has been given to the role which standardization is playing in German industrial reconstruction. The German industries are planning and are carrying out a far-reaching program of standardization as a necessary step in building up an unprecedented industrial structure which must rest in large measure on an extensive foreign trade. In no other country except Great Britain is standardization work being carried on upon a scale, or with an intensity, comparable to that in Germany.

The German work is of special interest to those responsible for the management of American industries, not only because of its importance, but also because of the similarity in the historical conditions surrounding the national standardization movements in Germany and in America.

Prior to 1917 a vast amount of standardization work had been carried out in Germany by individual companies, and by engineering societies and industrial associations, but, as was the case in America before the organization of the American Engineering Standards Committee, the work had not been unified along national lines.

As has been the case with all the other national standardizing bodies except the British, which was organized in 1901, the success of the standardization work carried out by the various countries during the World War as a part of their national conservation programs, was a chief cause of the formation of the Central German Body. It is called the Normenausschuss der Deutschen Industrie, and was organized by the Verein deutscher Ingenieure, at the suggestion of the German Government in 1917. The present membership consists of engineering societies, industrial associations and government ministries, and in addition there are 700 firms who are contributing members. The work of the Normenausschuss deals only with those subjects which concern two or more industries or branches of industry.

It is remarkable that the national standardization movement in Germany should have been so thoroughly organized and that so much work should have been accomplished in four years. 144 approved standards sheets have been issued and over 500 others have been so far developed that they have been published in tentative form. The standards are issued under the general designation of German Industrial Standards (Deutsche Industrie Normen, usually contracted to the slogan "DINORM"). The Germans were the first of the national bodies to publish standards in loose-leaf form. The work is so divided as to make each sheet as nearly independent as possible. Firms purchase these sheets in quantity, issuing them directly to designers, draughtsmen and foremen for use as working drawings and data sheets. (This plan is now followed by the Austrian, Dutch, Swedish and Swiss bodies.) The sale of sheets amounts to about 100,000 monthly.

From almost the first the Normenausschuss has been a periodical publication dealing with standardization. Formerly it was a separate publication, but now it forms a section of "Der Betrieb," a journal dealing with the general question of production and efficiency engineering. The communications from the Normenausschuss (Mitteilungen) average about 16 quarto pages per issue and form a separate section in this journal which appears semi-monthly, and has a circulation of 8000 copies.

The organization provides an extensive information service on standardization work in Germany and other countries, which is available to the industries as well as to their working committees. This is along much the same lines as the information service which has been started by the American Engineering Standards Committee. In this connection it is interesting to note that in general the German and Japanese industries appear to study foreign developments much more closely than do those of other countries.

Organization and Methods of Work

The organization and methods of work are similar to those in other countries. Next to the American Engineering Standards Committee, the German organization is the most decentralized of the national standardizing bodies. There is a Main Committee composed of representatives of the various national organizations supporting the movement, and a smaller Executive Committee. The detailed technical work of each project is in the hands of a working committee which in Anglo-Saxon countries would be called a "sectional committee" i.e., a committee made up of representatives of all bodies interested in the particular subject in hand.

Proposals for new subjects for standardization must come from some responsible body. The industry concerned is consulted, generally by a conference of the various organizations interested, to determine whether it is the consensus of opinion that the work should go forward. In case it is decided to undertake the work, the conference designates the chairman of the working committee.

The central office digests the information available on the subject for the use of the working committee. When agreement is reached in the committee on the draft of a standard it goes to the central office for editorial work. There it is scrutinized to see whether it is consistent with other standards; whether points have been included which concern other working committees; whether the drawings and nomenclature are in approved form, etc. After this editorial checking the central office has the draft of the standard put into proof form. It is then reviewed by an official clearing house committee, which contains a representative from each major line of work being carried on by working committees. If any change in substance has been made, it goes back to the working committee. If no such change has been made, it is published in the Mitteilungen, the official publication of the Normenausschuss, as a tentative proposal. Upon recommendation of the working committee, the standard is mailed to the members of the Executive Committee with a supporting statement. With their approval it is then republished as an official proposal. Six weeks are allowed for criticism, when a standard is finally published unless additional important criticisms are received.

Work in Special Industries

The foregoing refers to the work of the Central Body only, which is limited to subjects common to two or more industries. In addition there are some fifteen organizations known as special industry committees, each of which deals with the standardization work peculiar to a single industry, such as shipbuilding, electrical, agricultural, automotive, elevator, locomotive, paper, textile, and woodworking.

These committees are closely affiliated with, but not strictly an organic part of, the central body. They are organized not by the Normenausschuss, but by one or more technical or trade associations concerned with the particular subject in hand. Standards formulated by the special industry committees are published by the organization responsible. In most cases the final standards are published in loose-leaf form modeled closely after that of the standards issued by the Normenausschuss itself. These standards are submitted to the Normenausschuss before publication, in order to keep them consistent with the regular series of German industrial standards.

The volume of work being carried out through these special industry committees appears to be at least as great as that under the direct control of the Central Body.

Characteristics of Continental Work

Looked at broadly, and with exceptions such as must always be made in general statements of the kind, the Continental countries are going much further into dimensional standardization than has been done in Anglo-Saxon countries. This includes interchangeability of supplies and of machine elements, the interworking of parts and of related apparatus made by different makers, and the interchangeability, so far as the use is concerned, of complete machines and apparatus. By far the greater part of the work of the Normenausschuss is dimensional, greater attention being paid to such matters as machine elements, screw-threads, bolts and nuts, standard diameters, and systems of limit gaging. The Anglo-Saxon mind takes more to matters having to do with purchase and contract, such as specifications for materials, and for performance of apparatus, methods of test, etc. The Normenausschuss itself has done very little of this type of work as yet, but it has been highly developed by some of the German special industry committees, for

example, in the electrical industry. Some of these special industry committees are very active in the elimination of types, sizes and grades of manufactured products, and a special word has been introduced for this type of work, "Typung."

There is a greater dependence, on the Continent, upon theoretical and fundamental considerations, the Anglo-Saxon temperament giving rise to a much larger degree of expediency in adjusting commerical considerations in the process of arriving at agreements.

German manufacturers will go farther in yielding apparent temporary commerical advantages for the sake of advancing their national industry as a whole than is the case in America or Great Britain. Three principal reasons for this are: the great economic pressure under which German industry is laboring; the mental trait of more readily acquiescing in decisions affecting national welfare; and the belief that an essential to the rehabilitation of German industry is the rebuilding and great enlargement of their export trade, for which the importance of standardization on national lines is more readily apparent than it is in domestic trade.

The Germans have not yet had their standards translated into foreign languages for use in export, as the British are doing, but they are now giving consideration to this question.

German System of "Preferred Numbers"

As typical examples of the German work, their system of "preferred numbers" and their standard series of handles may be mentioned. The first is a fundamental piece of work, founded on theoretical considerations and of the first importance. It is a simple system of numbers for use in all new standardization work, in which gradated numerical values are required, such as standard gradated diameters of pulleys, thicknesses of plates, or capacities of machines. The Germans believe that its use is going to lead to great economies in material, in reducing the number of sizes, ranges, etc., simplify the carrying of stocks, facilitate interchangeability. It may be shown theoretically that, under average conditions, a given number of standard sizes laid out according to these numbers, will be better fitted to any series of jobs taken at random, than would be the same number of sizes laid out in any other way, and this with a minimum of material.

The standard handles furnish a typical example of German love of thoroughness of detail. There are two shapes, each adapted to a particular method of use, and there is a series of sizes for each shape. The profiles have been worked out with the most extreme care, an efficiency engineer having been employed to make time-motion studies to determine the exact profile that would insure the greatest accuracy in operaton with the minimum fatigue of the workman's hand. It is felt that by doing a thorough job once for all, different industries and firms will be saved from doing the same thing over and over, but always less well, and that at the same time interchangeability is introduced.

Industrial Significance

The standardization movement in Germany is particularly significant, since Germany is one of the three leading industrial countries. The industries of Austria, Holland, Sweden, and Switzerland, are so intimately related to those of Germany on account of geographical and other relationships that they are necessarily affected very largely by developments in Germany.

It appears that the work is being woven very intimately into the industrial fabric. The very large number of standards purchased by the industry, and the fact that the central organization has 5000 firms which are coöperating members, are a sufficient indication of this.

There seems to be a striking analogy between the present standardization movement in Germany, and the research movement developed there a generation ago. Whatever estimate one may place upon the role it played in German industries generally, everyone agrees that research was fundamental in the development of their great chemical industries. The role which the Germans are expecting standardization to play in all their industries would be not unlike the role which research has played in their chemical work.

A copy of a report on this subject, which was rendered to the American Engineering Standards Committee by its Secretary, will be sent upon request.

First Annual Report of the Federal Power Commission

Power developments of the past year, as shown in the first annual report of the Federal Power Commission, include a large number of projects on which, notwithstanding the industrial depression and the uncertain financial situation, construction work has already started, under license issued by the Commission, and indicate that the production and use of hydroelectric power in the United States is destined to be an outstanding industrial fact of the next twenty-five years.

Between 1910 and 1920 there was comparatively little waterpower development on the public domain or on navigable streams due to the fact that the legislation then on the statute books was, because of its limitations, considered unworkable. In the sixteen months following the passage of the Federal Water Power Act of 1920 there were filed with the Commission 185 applications for preliminary permit and 85 applications for license to develop waterpower, aggregating totals of 11,060,000 primary and 5,766,000 secondary horsepower or 16,826,000 horsepower of estimated installation. This is twice the water horsepower which has been developed in the United States to date and from five to six times greater than the aggregate of all applications filed with the Federal Government during the preceding 15 years.

Up to November 1, final action has been taken on 89 applications, in which 27 preliminary permits and 31 licenses were authorized, involving 1,415,600 primary and 2,627,000 installed horsepower. Construction is now under way on the following licensed projects.

	Primary horsepower	Installed horsepower
Henry Ford & Son, Inc., Hudson River, N. Y. . .	3,640	8,100
Niagara Falls Power Co., Niagara River, N. Y. . . .	341,500	572,230
Southern California Edison Co., Big Creek, Cal. . .	165,000	546,000
Alabama Power Co., Coosa River, Ala.	21,760	110,000
Snow Mountain Power & Water Co., Eel River, Cal.	9,500	16,670
Western States Gas & Electric Co., American River, Cal.	6,400	6,400
Wisconsin-Minnesota Light & Power Co., Chippewa River, Wis. . . . . (Preliminary construction only)	10,000	20,000
Total.	557,800	1,279,400

Much time and care has been devoted during the year to compilation of the rules and regulations governing administration of the Federal Water Power Act. The Commission's serious need at present is for Congressional authorization permitting the use of its appropriations in employment of personnel sufficient to make up a small organization of trained and experienced men capable of meeting intelligently the important and perplexing engineering and economic problems which are constantly arising and upon the correct solution of which will depend the value of Federal legislation and, in no small degree, the future of the electric-power industry.

A.S.M.E. Transactions Index to be Published

For the past forty-three years valuable information has been accumulating in the Transactions of The American Society of Mechanical Engineers. The Publication Committe now plan to render this material available by the publication of an index which will include the first forty-two volumes. The index, however, will be published solely on a subscription basis and those who desire to have this valuable means of reaching the important information included in the A.S.M.E. Transactions should write at once to the Secretary indicating their desire to have a copy printed for them. The book will be bound in morocco to conform to the edition of Transactions. The exact price will depend upon the number ordered and announcement of it will be made upon the closing of the subscription list. This offer will be announced only through the columns of Mechanical Engineering and the *A.S. M.E. News*. An order card will be included in volume forty-two of Transactions which will be mailed to the membership early in March. The subscription list will be closed on April 15 and if the number of orders is sufficient, work will be started at once on the preparation of the book.

NEWS OF OTHER SOCIETIES

American Institute of Chemical Engineers

The fourteenth annual meeting of the American Institute of Chemical Engineers, held at Baltimore, Md., Dec. 6–9, 1921, was devoted primarily to the subject of gas warfare and chemical preparedness. A symposium on chemical engineering and national defense, continued from the first to the third day of the convention, was opened by an address by President David Wesson and included papers pointing out the humane aspects of gas warfare and reviewing the capacity for the production of chlorine in the United States, its uses, storage, and transportation.

At other sessions of the convention a survey of the lime industry was presented; Professor Cavalier, of France, exchange professor at Johns Hopkins University, read a paper on the Development of the Chemical Laboratories in France; glass as a material for chemical use was discussed; and the difficulties encountered in attempting to utilize low pressure steam after compression in evaporators were pointed out.

At a joint meeting with the Maryland Section of the American Chemical Society at Johns Hopkins University, a paper dealing with the development of a catalyzer by means of which carbon monoxide can be oxidized at room temperature to carbon dioxide was presented, and applications of ultra violet light described.

A number of excursions were held during the meeting, the most popular of which was an all-day visit to Edgewood Arsenal, where the entire morning was spent in inspection of the large installations of Nelson chlorine and caustic cells, the multiple effect evaporators, the gas-mask factory and the extensive research laboratories.

In the afternoon there was a field demonstration of various forms of gas warfare. In connection with the inspection of the Arsenal an address on chemical warfare was delivered by Brig-Gen. Amos A. Fries.

At the business meeting on the first day of the convention the council of the Institute reported an amendment to the constitution providing for student chapters similar to those affiliated with other engineering societies and another resolution providing for the organization of local sections of the Institute.

Arthur D. Little, as chairman of the Committee on Chemical Engineering Education, presented a study of the courses in chemical engineering offered at all the technical schools and universities of the United States and it was voted to call a meeting of representatives of institutions offering courses in chemical engineering for the purpose of securing greater uniformity in such courses.

L. W. Wallace, executive secretary of the F.A.E.S., addressed the business session on the most important activities of the Federation, of which the Institute is a member society.

American Society of Refrigerating Engineers

The three-day annual meeting of The American Society of Refrigerating Engineers, held in New York, Dec. 5–7, 1921, included six technical sessions. At the first of these the subjects considered were the artificial production of natural ice, the use of automatic temperature-controlled expansion valves, and small insulated containers, the speakers on these respective subjects being R. H. Hemphill, Charleston, S. C., G. A. Wegner, Rochester, N. Y., and M. E. Pennington, New York, N. Y.

In three papers presented at an evening session on December 5, C. S. Cragoe, of the U. S. Bureau of Standards, outlined the present status of the measurements of superheated ammonia at the Bureau, and discussed specific volumes of superheated ammonia vapor and of ethyl chloride, liquid and vapor. G. F. O'Conner, also of the Bureau, was co-author with Mr. Cragoe of the last paper. It was announced that the Bureau of Standards would soon be in a position to issue tables on superheated ammonia. A paper entitled Coördinating Technical Knowledge and Practical Conditions in Refrigerating Plants, by Peter Neff, Canton, Ohio, was also presented at this session.

Ammonia compression was the main topic at the two sessions held on December 6. The construction and operation of three types of compressors were described by F. L. Fairbanks, of Boston. These types were a slow-speed steam-driven compressor with a booster set, a motor-driven compound compressor and a uniflow steam-engine-driven compound compressor with feather valves. George A. Horne, New York City, spoke on the subject of compound ammonia compression, describing one of the most complete tests for a compound compressor which had even been conducted. Synchronous and starterless induction motors for ammonia compressors were discussed, and a paper on cooling systems of buildings presented.

Among the papers presented at the session on the closing day of the meeting was one by H. J. Macintire, of Urbana, Ill., dealing with research work in refrigeration conducted at the University of Illinois; the presentation of a total-heat diagram for carbon dioxide, showing the effect of pressure, also by Mr. Macintire; a description of a new thermal testing plate for conduction and surface transmission, by A. J. Wood, State College, Pa.; and a discussion of the theory and practice of spray nozzle cooling, by B. H. Coffey and G. S. Dauphinee, both of New York City.

An excursion to the North Moore Street Power Plant of the Merchants Refrigerating Co. of New York was held on the second day of the convention.

Items of business at the opening session included a discussion of the Mechanical Refrigeration Safety Code.

American Petroleum Institute

The American Petroleum Institute held its second annual meeting in Chicago, Ill., December 6–8, 1921. In his opening address, Thomas A. O'Donnell, president of the Institute, referring to the adequacy of the world's supply of petroleum, gave as his opinion that if unrestricted opportunity for development is afforded to those engaged in the industry, the supply of petroleum products will be adequate for all requirements for many generations to come.

Walter C. Teagle, president of the Standard Oil Company of New Jersey, believed that in adequate storage facilities lies the chief requisite for securing a better balance between production and consumption of petroleum products and the resulting avoidance of the serious price fluctuations which the industry has seen during the current year.

The technical sessions of the Institute were devoted almost exclusively to a discussion of the automotive fuel problem. Dr. Van H. Manning, director of research of the Institute, presented a quantitative survey of the petroleum industry from the standpoint of motor fuel, and Edward S. Jordan, president of the Jordan Motor Car Company, a similar survey of the automotive industry. These speakers pointed out the effect of automotive fuel requirements on the petroleum industry and upon the future development of motor cars.

N. A. C. Smith, petroleum chemist, of the Bureau of Mines, discussed the volatility of motor fuel as marketed in the United States, and stated that he believed that eventually we would have as nearly uniform gasoline as is commercially possible.

The motor fuel problem from the standpoint of the automotive engineer was discussed by O. C. Berry, chief of the Wheeler-Schebler Carburetor Company, who stated that the present grade of fuel can be used with fair success in the laboratory and urged that refiners make no further reduction in volatility until the automotive industry is prepared to meet it.

F. C. Mock, research engineer, Stromberg Motor Devices Company, discussing the effect on motor economy of volatility changes in the fuel, urged as great a uniformity as possible in motor fuel, and the adoption of a recognized standard to which motor fuels should conform.

Greater uniformity in motor fuel was the chief point brought out in all the discussions. The adoption of uniform specifications was urged and some speakers suggested the appointment or establishing of a referee laboratory to which all fuel questions arising between automotive engineers and refiners could be referred.

National Society for Vocational Education

The National Society for Vocational Education, which as the National Society for the Promotion of Industrial Education, was the "first national organization to promote interest in publicly supported vocational education," held its fifteenth annual convention in Kansas City, Mo., Jan. 5, 6, and 7, 1922.

The larger part of the program was given over to sectional meetings on various phases of vocational education. These covered agricultural, commercial, home-making, and industrial education,

part-time and continuation schools, teacher training, training in industry, and industrial rehabilitation.

The work being done by other national associations engaged in vocational education was told by representatives of such organizations at one of the general meetings.

A joint meeting of the Industrial Education Section and the Training in Industry Section considered the subject of cooperation between public and private training agencies, the present situation was outlined, its causes discussed, and ways and means of dealing with it suggested.

Other sessions of the Industrial Education Section gave special attention to the day industrial and trade schools, and their relation to industry.

Problems of the part-time and continuation schools were studied at several sessions and their value as economic, industrial and social factors brought out. What is being done in industrial rehabilitation formed the topic of several sessions.

Among educational exhibits at the convention, of interest to all and of special value to teachers and supervisors in vocational work, were those showing building plans for vocational schools, vocational education material not published in book form, and the use of motion pictures in teaching shop precesses.

LIBRARY NOTES AND BOOK REVIEWS

Library Book Loans

The Library Board has adopted rules authorizing the Director of the Library to lend to members of any Founder Society any duplicate books in the Library, subject to the following four rules:

1 Duplicate books may be lent to members of Founder Societies or of any other societies that contribute to maintain the Library

2 Books will be lent for twenty-eight days, including time in transit

3 Five cents a day will be charged for each book kept longer than twenty-eight days

4 Borrowers shall be responsible for books borrowed, and shall pay shipping and insurance charges from and to the Library.

The Library has several thousand volumes that can be lent under this authorization. These include a considerable number of textbooks, reports, etc., of various dates. Periodicals are not included, as the cost of storing duplicate sets seems prohibitive and individual articles can be photoprinted at little expense. The collection is being increased regularly by the addition of any suitable duplicates received by the Library. Members are invited to present any books of permanent value for this purpose, which they can spare from their libraries. It is hoped that the collection may in time become adequate to meet the usual needs of members by providing any standard book needed for a short time.

No catalog has been published, although it is hoped that one may be, when the collection becomes extensive enough to warrant doing so. Until that time, the Director will be glad to receive requests and report as to whether the books are available or not.

The A.S.M.E. Issues Westinghouse Biography

The subscription edition of the Life of George Westinghouse was mailed early in January and the popular edition, published by Charles Scribner's Sons, was placed on sale on January 27. The subscription edition, which was sold to members of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers, appeared in two bindings, the half morocco and the buckram. This edition, in contents and form, is a worthy addition to the publications of the A.S.M.E.

Through the courtesy of some friends of Mr. Westinghouse, the plates for the book have been placed at the disposal of the Society, and, with the coöperation of Charles Scribner's Sons, a plan is being developed whereby the popular edition can be widely distributed.

The book is already attracting wide interest as a story of the life of a man preëminent among engineers.

The author of the book, Colonel Henry G. Prout, was an intimate friend of Mr. Westinghouse and in its fascinating record of a remarkable life, he has developed a great amount of material which is of value, not only in connection with the life of George Westinghouse, but as an inspiring revelation of the part the engineer must play in our present day civilization. A more complete review will appear in this section of the March issue of Mechanical Engineering.

Automobile and Aircraft Engines. By Arthur W. Judge. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. Cloth, 6 × 8 in., 642 pp., illus., tables, $9.50.

Presents, in as concise and elementary form as possible, an account of the theory of the lighter-fuel type of high-speed internal-combustion engine, and of the experimental results obtained from it. Intended especially for engineers and designers of automotive machinery. Nearly twice the size of its predecessor, the additions being chiefly experimental data obtained in recent years.

Automobile Engineering. Chicago, American Technical Society, 1920. 6 vols. Fabrikoid, 6×8 in., illus., $29.80.

A course of self-instruction and a book of reference covering the maintenance and operation of automobiles of all kinds. Information given is presented clearly and without mathematics, and is illustrated by many cuts and drawings. Earlier editions were entitled Cyclopedia of Automobile Engineering.

Cane Sugar. By Noel Deerr. Second edition. Norman Rodger, London, 1921. Cloth, 7×10 in., 644 pp., plates, illus., 42s.

The author of this work, writing from long experience in the cane-sugar industry, acquired in the more important sugar-producing districts of the world, gives an account of the salient points of the industry, with a detailed treatment of its more important aspects. The botany, agriculture and pathology of the sugar cane, sugar-house practice and the control of the processes are given careful treatment. Many colored plates are included, and there are numerous lists of references and an extensive bibliography. This edition has been reset and enlarged.

Compteurs de Vapeurs. By E. Hoehn. Ch. Béranger, Paris, 1921. Paper, 6×9 in., 34 pp., illus., 2 fr.

This pamphlet by the chief engineer of the Swiss association of boiler owners describes the theory and operation of ordinary and recording steam meters, with notes on the advantages and disadvantages of the different types.

Cours de Mecanique Rationelle. By Louis Roy. Gauthier-Villars et Cie, Paris, 1921. Paper, 5×10 in., 259 pp.

This volume, with the author's previous book on graphic statics and strength of materials, forms a course of instruction in mechanics for students of engineering. The present work is intended for beginners and therefore is confined to the elements of mechanics, which it presents so that students will have the grounding necessary for the study of applied mechanics, general physics and electrical engineering.

Economics of Petroleum. By Joseph E. Pogue. John Wiley & Sons, Inc., N. Y., 1921. Cloth, 6×9 in., 375 pp., plates, illus., $6.00.

The purpose of this book is to present the more important economic facts relating to petroleum, to interpret the changes that are taking place in the industry and to forecast the future trend of these changes. The book is intended for those engaged in the petroleum industry as engineers or producers, and for those engaged in industries dependent on petroleum products, and contains useful information on our resources, the trend of development, production and refining, transportation, prices, trend of consumption, and similar topics.

Die Steuerungen der Dampfmaschinen. By Heinrich Dubbel. Second edition. Julius Springer, Berlin, 1921. Cloth, 6 × 9 in., 384 pp., illus., 69 marks.

This is a treatise on the theory and design of valve and reversing gears for reciprocating steam engines, for the use of designers. The discussion is confined chiefly to the modern forms that have been introduced to meet the demands of high steam pressures and increased speeds, and the competition of steam turbines and gas engines. Matter which is only of historical interest has been omitted, but full attention is given to gearing of the types which have proved best fitted to modern requirements. The discussion of reversing gears includes material on locomotives, rolling-mill and hoisting engines.

Invention the Master-Key to Progress. By Bradley A. Fiske. Dutton & Co., New York, 1921. Cloth, 6 × 8 in., 356 pp., illus., $4.

The thesis of this author is that invention, acting through literature, science, art, war and the other activities of men, has initiated all creative human progress; and his book is an interesting account of what inventors have accomplished through the ages, and a forecast of what may be done in the future, if the art of invention is properly fostered.

Machine Drawing. By Carl L. Svensen. D. Van Nostrand Co., New York, 1921. Cloth, 6 × 9 in., 214 pp., illus., $2.25.

This textbook is written for students who have had previous instruction in mechanical drawing and is intended to develop an understanding of the relation of machine drawing to engineering. It includes a complete treatment of working drawings, drafting-room practice, a chapter on the principles and practice of dimensioning, a study of the common machine details, jigs and fixtures, and a large collection of problems.

Material Handling Cyclopedia. Compiled and edited by Roy V. Wright, John G. Little and Robert C. Augur. Simmons-Boardman Publishing Co., N. Y., 1921. Cloth, 9×12 in., 846 pp., illus., $10.

Designed to present comprehensively definitions, descriptions, illustrations, applications and methods of operation of industrial devices for handling materials. Covers hoisting machinery, package conveyors, loose-material conveyors, elevators, trackless transportation, industrial rail transportation and handling systems. Each section has been prepared by a specialist.

Mechanical Handling of Goods. By C. H. Woodfield. Sir Isaac Pitman & Sons, Ltd., London, 1921. (Technical primers.) Cloth, 4 × 6 in., 116 pp., illus., $0.85.

The object of this book is to set forth sufficient information upon the handling of goods and material to enable the uninitiated to understand the methods and equipment employed and appreciate the economic possibilities of dealing with goods by mechanical methods.

Mechanical Principles of the Aeroplane. By S. Brodetsky. The Macmillan Co., New York, 1921. Cloth, 6 × 10 in., 272 pp., illus., $7.

Section one, Motion in Air, contains a brief statement of the general theory of resisted motion, a discussion of the dynamics of a body moving in air and the theory of steady flight, which indicates what it is that aerodynamical research must investigate. In section two, Dynamics of Air, the hydrodynamical method of attacking the problem is set forth, and in section three, Aeroplane Motion, theoretical and experimental results are applied to the steady flight and stability of aeroplanes, followed by an account of the motion of a disturbed aeroplane. The treatment is confined to the mathematical parts of these problems.

Memoires Sur L'Electromagnetisme et L'Electrodynamique. By André-Marie Ampere. Paper, 4 × 7 in., 110 pp., illus., 3 fr.

The two classic memoirs in this little book are that in which Ampère described his experiments upon the action exerted on an electric current by another current or a magnet, and the one giving the results of his study of the formula expressing the attraction and repulsion between two infinitely small elements of two conductors. They are here reprinted from the best text, in attractive form.

La Physique Theorique Nouvelle. By Julien Pacotte. Gauthier-Villars et Cie, Paris, 1921. Paper, 182 pp., 6 × 10 in., 12 fr.

The new physics in question had its origin in Lorentz's electrodynamics, which is the definitive form of Maxwell's theory; its most advanced theories are due to Einstein; it has to do with relativity, with the energy equivalent of two masses of matter, with atoms of energy. The author presents a historical, critical, non-mathematical account of the theories that underlie modern ideas, suitable as an introduction to the subject.

Practical Least Squares. By Ora Miner Leland. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 237 pp., $3.00.

This textbook is based on the course given to students of civil engineering at Cornell University and is designed particularly for use in short courses of instruction and by engineers and scientists in connection with their private practice. It will not replace more elaborate treatises, but the author hopes it will introduce the student directly to the simpler methods of solving the ordinary problems in adjustment.

Power's Practical Refrigeration. Compiled by the editorial staff of *Power*. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Fabrikoid, 6 × 8 in., 283 pp., illus., tables, $2.

A volume dealing with the practice of refrigeration, but also including the laws governing its production. Chiefly made up of articles that have appeared in *Power* and have proven of particular value to those operating refrigerating plants.

Profit Sharing by American Employers. A report of the Profit Sharing Department of the National Civic Federation. Dutton & Co., New York, 1921 Cloth, 5 × 8 in., 416 pp., $8.

The first edition of this book, published in 1916 by The National Civic Federation, was based on analyses of more than two hundred plans for profit-sharing in use in this country. It was intended to present testimony, from managers of manufacturing establishments, concerning the success and failure of such plans. This edition is practically a new book, as much of the former material has been omitted and numerous additions have been made, enlarging the book and bringing it up to 1919.

The Psychology of Industry. By James Drever. Dutton & Co., New York, 1921. Cloth, 5 × 8 in., 148 pp., $2.50.

Dr. Drever discusses such topics as the intelligence and vocational fitness of the worker, scientific mental engineering, the factors determining efficiency of work, fatigue, economy of movement, advertising and salesmanship. Upon these and similar matters he sets forth what has been done by the psychologist, in language understandable by the ordinary man. A special effort is made to adhere to the psychological point of view and to emphasize principles rather than details of results.

Radio Questions and Answers. By Arthur R. Nilson. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Boards, 5 × 7 in., 86 pp., illus., $1.

A quiz compend for those preparing for examination. Treats of theory, apparatus, laws and regulations, etc.

Railroad Shop Practice. By Frank A. Stanley. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 331 pp., illus., $4.

The purpose of this book is to show typical methods and appliances as adapted to the work of various railroad repair shops, large, medium and small, situated in different parts of the United States. Much of the material presented has been taken from the articles by the author and others in technical journals, but a considerable amount is new.

Railway-Signaling. By Everett Edgar King. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 371 pp., illus., diagrams, $4.

The purpose of this book is to collect what is already in common practice in railway signaling and to present it in text-book form, suitable for use by those beginning the study of this subject. The volume discusses signal indications, interlocking, block signaling, signal mechanisms and highway-crossing signals.

Steam Boilers. By Terrell Croft. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 8 in., 412 pp., illus. $4.

This book has been compiled for men of little schooling who wish to inform themselves about the construction and operation of steam boilers, especially those preparing for examinations for engineers' licenses. It treats of the functions, history and modern types of boilers, boiler construction, accessories, steam generation, superheating, fuels, settings, furnaces, feedwaters, boiler-room equipment, inspection and management, in clear, simple and easily read language.

Steam-Engine Valves and Valve Gears By E. L. Ahrons. Sir Issac Pitman & Sons, Ltd., London, 1921 (Technical primers.) Cloth 4 × 6 in., 112 pp., illus., $0.85.

This primer gives, in an elementary form, a concise description of the usual forms of steam-engine valves and valve gears, and an explanation of their action.

Temperature Indicating and Controlling Systems. By Franklin D. Jones. First edition. Industrial Press, New York, 1921. Paper, 6 × 9 in., 59 pp., illus., $0.50.

A general review of the application of thermoelectric pyrometers to the heat-treatment of steel parts. The methods and apparatus used in various plants to indicate, control and record temperature are described and illustrated.

Theorie und Wirklichkeit bei Triebwerken und Bremsen. By St. Löffler. R. Oldenbourg, München und Berlin, 1919. Paper, 6 × 9 in., 94 pp., 5.50 M.

This small volume contains the author's answers to various criticisms of the theory advanced by him in his earlier volume entitled Mechanische Triebwerke und Bremsen. The various objections to the author's former assertions are met and answered in detail.

Thermodynamics. By J. E. Emsweiler. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 266 pp., diagrams, $3.

An attempt to present the subject progressively so that the reader may easily recognize the relation of each new demonstration to the whole. For this purpose the order of presentation is changed from that usually employed. Steam is placed first, followed by vapor refrigeration, after which the permanent gases, mixtures and air-heat engines are studied. Formal discussion of the laws of thermodynamics and the kinetic theory of gases is postponed until the close of the book

Der 1000 PS Flugmotor. By Edmund Rumpler. R. Oldenbourg, München, 1921. Cloth, 10 × 21 in., 63 pp., plates, 50 M.

Present-day aviation engines are, according to this monograph, only lighter automobile engines, constructed in almost every case by automobile engineers without special knowledge of the problems of flight. The engine here described is designed to meet the peculiar conditions of flight and overcome the deficiencies of the engines hitherto used. The text and drawings illustrate a 1000-hp. engine, a combination of the radial and horizontal arrangement of cylinders, having four sets of seven radial cylinders.

Tidal Power. By A. M. A. Struben. Sir Isaac Pitman & Sons, Ltd., London, 1921. Boards, 4 × 6 in., 115 pp., diagrams, $0.85.

This little book is intended to stimulate interest in a field that is likely to attract attention in the near future. It indicates some of the possibilities, the difficulties that are found and the systems that have been proposed.

Time Study and Job Analysis. By William O. Lichtner. Ronald Press Co., New York, 1921. Cloth, 6 × 9 in., 397 pp., illus., $6.

The author attempts to explain the practical application of these methods in simple, non-technical terms, as might be done in a series of conferences with an executive charged with the responsibility of decision. The book first presents a general review of the principles of job standardization and their application to time study and job analysis. The organization of a staff to carry out the work is then described in detail. This is followed by a detailed description of the technique of the subject, and the book closes with a consideration of the relation of job standardization to industrial problems.

Traité de Balistique Extérieure. By P. Charbonnier. Volume I. Gauthier-Villars et Cie, Paris, 1921. Paper, 6 × 10 in., 637 pp., diagrams, 7 francs.

This is the first of the six volumes in which it is proposed to publish Charbonnier's treatise on external ballistics to which the Poncelet prize was awarded by the French Institute in 1919. The author has planned a treatise, embracing everything relating to the science, methodically classified and treated in detail, suited to the needs of students of its theory and of practical artillerymen. His book therefore is a summary of our knowledge at the close of the great war.

The present volume, intended as an introduction to the subject, is divided into two parts. The first is a discussion of the three limiting cases of the ballistic problem, motion in a vacuum and rectilinear motion and vertical motion in a resisting medium. The second considers the general theorems of ballistics, and includes the general properties of atmospheric trajectories and the application of analysis to the ballistic problem.

Turbines. By A. E. Tompkins. Third edition, revised. The Macmillan Co., New York, 1921. Cloth, 5 × 8 in., 180 pp., illus., $2.50.

Describes, in simple, non-mathematical fashion, good modern practice in the construction and working arrangement of water turbines, turbine pumps and steam turbines. The book will be useful to students and to men engaged in fitting and repairing turbines.

Union Engineering Handbook; Pumping Machinery, Air Compressors, Condensers. Compiled by E. P. Ordway. First edition. Union Steam Pump Co., Battle Creek, Mich., 1921. Cloth, 5 × 9 in., 442 pp., illus., $2.

Intended for engineers, architects and others interested in air compressors, condensers and steam, centrifugal, power and vacuum pumps. Contains the engineering information and data usually desired in calculating the problems encountered in handling these machines, with special information on the products of the company which publishes the book.

Vorrichtungen im Maschinenbau nebst Anwendungsbeispielen. By Otto Lich. Julius Springer, Berlin, 1921. Cloth, 6 × 9 in., 507 pp., illus., diagrams, 120 m.

A detailed study of clamps, fixtures and jigs for machine tools and of their application to increase output. All the customary operations, boring, slotting, planing, milling, forging, hardening, etc., are considered. There is also a section on the savings obtainable by such attachments and one on maintenance and repair. The book is intended for machine builders, and for operators who wish to increase the efficiency of existing equipment. The author presents his book as a contribution toward the reconstruction of the German metal industries, which he believes will be possible only through the greatest possible economy of time and of labor.

The Working of Steel. By Fred H. Colvin and K. A. Juthe. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 245 pp., illus., $4.

The authors have collected, from their own experience and that of others, information upon the most approved methods of working the various kinds of steel in use today. These include low-carbon, high-carbon and alloy steels of various kinds and from a variety of industries. The book discusses the chemical and physical properties of steels, forging, annealing, case-hardening, heat treatment and hardening.

Index to Volume 43 of Mechanical Engineering

An index to Volume 43 of Mechanical Engineering is now in the course of preparation, and, it is expected, will be issued the latter part of February. A copy of this index will be sent to each member of the Society or subscriber who sends in a written request therefore. In order that no more copies than are necessary to supply the demand may be printed, requests for copies should be received at headquarters not later than February 15.

THE ENGINEERING INDEX

(Registered U. S. Patent Office and Canadian Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCOUNTING

Power Plants. Power-Plant Accounts, Wilfred A. Miller. Power, vol. 54, nos. 16, 17, 18, 19, 20, 21, 22, 23, 24 and 25, Oct. 18, 25, Nov. 1, 8, 15, 22, 29, Dec. 6, 13 and 20, 1921, pp. 596–599, 636–638, 680–684, 719–723, 769–772, 805–809, 848–852, 891–894, 934–936 and 979–980, 59 figs. Oct. 18: How to record indirect expenses. Oct. 25: Interest on borrowed money, profit and related subjects. Nov. 1: Considerations in buying equipment; meaning of depreciation. Nov. 8: Power plant as manufacturing department. Nov. 15: "Income" and "profit and loss" accounts. Nov. 22: The "surplus" account. Nov. 29: Debit and credit; the cash account. Dec. 6: Closing ledger accounts. Dec. 13: Investment account and reserve for depreciation and obsolescence. Dec. 25: Scrapping equipment. (Continuation of serial.)

AERODYNAMICS

Standardization. Standardization and Aerodynamics, L. Prandtl. Aerial Age Weekly, vol. 14, no. 4, Oct. 3, 1921, pp. 79–80. Discusses wind tunnels, size of models and air velocity, placing of models, drift coefficients and the results.

AIR

Joule-Thomson Effect. The Joule-Thomson Effect for Air, Frederick G. Keyes. Jl. Am. Chem. Soc., vol. 43, no. 7, July 1921, pp. 1452–1470, 2 figs. Discusses Hoxton's investigation; expansion coefficients of a gas; absolute ice-point temperature; Joly constant-volume specific-heat values for air.

AIR COMPRESSORS

Combination Hoist and. New Combination Hoist and Air Compressor. Eng. & Contracting, vol. 46, no. 21, Nov. 23, 1921, p. 483, 1 fig. Designed especially for bridge and elevated-tank erection, and brought out by Novo Engine Co., Lansing, Mich. Can also be used for trench work.

German. Air Compressors and German Aviation (Les compresseurs d'air dans l'aviation Allemande), G. Lehr. La Technique Moderne, vol. 13, no. 9, Sept. 1921, pp. 369–376, 11 figs. Discusses compressors by Schwade, Brown-Boveri, A. E. G., Siemens-Schueckert; also control systems of air supply for combustion.

Regulation. The Regulation of Air Compressors. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 918–921, 11 figs. Discusses various arrangements used to control amount of air delivered by compressor.

AIR CONDITIONING

Chemical Processes. Notes on the Relation of Atmospheric Conditions to Chemical Processes, A. E. Stacey. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 8, Nov. 1921, pp. 777–781, 3 figs. Gives a few typical examples of need of air conditioning in chemical industry.

AIRPLANE ENGINES

Bristol Jupiter. Tests of the 450 Hp. Bristol Jupiter Engine. Aviation, vol. 11, no. 24, Dec. 12, 1921, pp. 685–686, 2 figs. An air-cooled radial aero engine, which has passed the tests of the British Air Ministry.

Carburetors. See CARBURETORS.

Cylinders. Preliminary Calculation of Cylinder Dimensions for Aircraft Engines, Otto Schwager. Aerial Age Weekly, vol. 14, no. 8, Oct. 31, 1921, pp. 179–180 and 187. Method described depends on air requirement of fuel. Gives examples for water-cooled, air-cooled and rotary engines. Translated from Zeit. fur F. & M., Dec. 31, 1920.

Fuel. The Problem of Fuel for Aviation Engines, Aerial Age Weekly, vol. 14, no. 1, Sept. 12, 1921, pp. 8–11 and 22–23, 6 figs. Technical note of Nat. Advisory Committee for Aeronautics. Discusses composition, quantity available, price per heat unit, stocks of fuel at aerial ports, preparation of fuel mixtures, carburetor function, etc. Lecture given by Prof. Kutzbach.

Fuel Pump. The Sylphon Fuel Pump for Liberty "12" and Wright Model "H" Engines. Air Service Information Circular, vol. 3, no. 281, Oct. 15, 1921, 8 pp., 4 figs. Designed to fill need for an engine-driven fuel pump in order to obviate use of air pressure where sufficient gravity head is not available. Description and rules for dissembly.

Gear Pump. Performance of a Vane-Driven Gear Pump, R. H. Heald. Aerial Age, vol. 14, no. 4, Oct. 3, 1921, pp. 81–83 and 90, 8 figs. Gives results of tests with pumping unit driven by a wind wheel in air stream during flight, for pumping gasoline to tank in upper wing from which it flows by gravity.

Radiators. Cooling System Test of the Curtiss JN-6 with Packard 1A-744 Engine Equipped with Side Radiators. Air Service Information Circular, vol. 3, no. 294, Oct. 20, 1921, 12 pp. 8 figs. Result of test to determine effectiveness of side radiators.

Getting Airplane Details on a Manufacturing Basis. Am. Mach., vol. 55, no. 22, Dec. 1, 1921, pp. 886–887, 7 figs. Economical methods in radiator construction. Soldering tube ends in multiple. Punches and dies for fittings made adjustable by insertion of loose pieces.

AIRPLANE PROPELLERS

Tandem. The Question of Tandem Propellers, A. Lapresle. Aviation, vol. 11, no. 24, Dec. 12, 1921, pp. 679–680, 3 figs. Gives results of experiments carried out by Eiffel; tandem propellers must turn in opposite directions if the rear propeller is to have a satisfactory efficiency. Translated from L'Aerophile.

AIRPLANES

Aerofoils. The Influence of Aerofoil Dimensions on Speed (Ueber den Einfluss der Flügelabmessungen auf die Fluggeschwindigkeit), E. Lupberger. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 21, Nov. 15, 1921, pp. 316–318, 2 figs. Concludes that all efforts to increase difference between flying and landing speed by changing surface dimensions or by use of divided planes have little prospect of practical success.

Blériot Passenger. The New Blériot-Aeronautique Airplanes (Les nouveaux avions de "Blériot-Aeronautique"). L'Aeronautique, vol. 3, no. 30, Nov. 1921, pp. 436–437, 5 figs. Describes Spad 34, 38 and 45, the latter transporting 17 passengers and crew of 3 and having four 275-hp. Hispano-Swiss engines, marine type.

Brakes. Electro-Magnetic Brakes for Aeroplanes. Aerial Age Weekly, vol. 14, no. 3, Sept. 26, 1921, pp. 57 and 54. Describes the Gernsback device, an electromagnetic attracter on the landing stage which brings airplane to a stop at a definite point and within short range. From "Sea, Land and Air."

Commercial. The Barnhart Twin No. 15 "Wampus-Kat." Aerial Age Weekly, vol. 13, no. 26, Sept. 5, 1921, pp. 615–617, 4 figs. Commercial airplane built by C. R. Little Aircraft Works, Pasadena, Cal. Report of test pilot; describes principal features and gives specifications.

Curtiss Navy Racer. The Navy Racer Which Won the Pulitzer Trophy, Herbert Chase. Automotive Industries, vol. 45, no. 21, Nov. 24, 1921, pp. 1015–1016, 2 figs. Designed and built complete in Curtiss plant. Gives specifications and equipment; average speed attained 176.7 m.p.h.; 12-cylinder V-type engine; 405 b.hp. at 2,000 r.p.m.

DH-4 Corps Observation. Performance Test of DH-4 with 400 Hp. Liberty "12" Engine, Equipped as Two-Seater Corps Observation Airplane. Air Service Information Circular, vol. 3, no. 287, Oct. 1, 1921, 7 pp., 5 figs. Summary of test results; distribution of weights; description of airplane and power plant.

Fokker Monoplane. A Dutch Passenger-Carrying Monoplane, P. M. Heldt. Automotive Industries, vol. 45, no. 23, Dec. 8, 1921, pp. 1113–1114, 2 figs. Describes a Fokker carrying six passengers and fuel for 500 miles; 200-hp. B.M.W. engine.

Official Performance Test of Fokker Monoplane D-VIII Equipped with 110 Hp. Oberursel Engine. Air Service Information Circular, vol. 3, no. 288, Oct. 1, 1921, 8 pp., 5 figs. Gives summary of results of test, pilot's observations, and description of airplane and power plant.

Improving Performance. Means for Improving Airplane Performance, Harlan D. Fowler. Aviation, vol. 11, no. 23, Dec. 5, 1921, pp. 652–655, 14 figs. Discusses aerofoils, combining high speed with large load, variable area, etc.

Load Factors. Effect of Variation in Load Factor on Structural Weight of Wings, R. A. Miller. Aerial Age Weekly, vol. 14, no. 8, Oct. 31, 1921, pp. 177–178, 1 fig. Concludes that area of spars varies directly with load factor, area of struts varies with load factor and increases at slightly smaller rate than load factor, etc.

Martin Bomber. Official Performance Test of Martin Bomber N.B.S.-1 Equipped with Two 400 Hp. Liberty "12" Engines. Air Service Information Circular, vol. 3, no. 290, Oct. 1, 1921, 10 pp., 6 figs. Summary of test results; discussion of flight with one engine; pilot's observations; description of airplane and power plant.

Messenger. Performance Test of Messenger Airplane Equipped with 3-Cylinder 60 Hp. Lawrence Engine. Air Service Information Circular, vol. 3, no. 280, Oct. 15, 1921, 7 pp., 5 figs. Summary of test results; description of airplane and power plant; and pilot's observation.

Multi-Engined. Multi-Engined Commercial Airplanes, Donald W. McIlhiney. Aviation, vol. 11, no. 18, Oct. 31, 1921, pp. 506–507. Gives table of principal data of 44 such airplanes, and discusses main points.

Orenco. The Orenco Type F-4 Five-Place Tourister. Aerial Age Weekly, vol. 14, no. 11, Nov. 21, 1921, pp. 246–248, 4 figs. Built by Ordnance Eng. Corp. Wright E-2 engine; 200 hp. at 1800 r.p.m. Specifications and description

---

Note.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U.S.)
Ventilating (Vent.)
Western (West)

Racing. Airplane Racing and Racing Machines (Flugzeug-Rennen und Rennflugzeuge), Fr Wm Seekatz. Motorwagen, vol 24, no 3, Jan 31, 1921, pp. 48-53, 10 figs Presents table and chart showing results of Gordon Bennett races from 1909 to 1920 Notes on French and American racers, the Verville-Packard biplane the Dayton-Wright monoplane, and the Curtiss-Cox monoplane

Soaring. The Soaring Airplane (Das Segelflugzeug der akademischen Fliegergruppe der technischen Hochschule Hannover), W Blume Zeit fur Flugtechnik u Motorluftschiffahrt, vol 12, no 21, Nov. 15, 1921, pp. 313-316, 9 figs Details of monoplane designed by G. Madelung and constructed under his supervision by student group of Hannover Technical Acad

Speed Meters. N A C A Recording Air Speed Meter, F. H. Norton Aerial Age Weekly, vol. 14, no 7, Oct. 24, 1921, pp 151 and 154, 7 figs Describes new type designed by technical staff of Nat Advisory Committee for Aeronautics, consisting of a tight metal diaphragm of high natural period which is acted upon by the pressure difference of a pilot-static head.

Staggering of Biplane. The Effects of Staggering a Biplane, F H Norton Aerial Age Weekly, vol. 14, no. 5, Oct 10, 1921, pp 103-104, 5 figs. The lift, drag and center of pressure travel are determined for a biplane with a stagger varying from −100 per cent to +100 per cent.

Static Test. Report of Static Test on Engineering Division Messenger Airplane. Air Service Information Circular, vol. 3, no 270, Oct. 1, 1921, 15 pp. 10 figs Particulars of tests carried out at McCook Field, Dayton, Ohio, to determine strength of wings, ailerons, empennage, fuselage, and chassis.

Storage of Parts. Instructions for the Storage of Airplanes, Engines, Their Parts and Accessories. Air Service Information Circular, vol. 3, no. 256, July 15, 1921, 9 pp Deals with storage of wooden airplane parts, airplane materials, engines, armament, equipment and propellers Specifications covering requirements of Air Service for rust-preventing compound for protection against corrosion of aircraft engine

Struts. Tests on Combined Loading of Wooden Struts Air Service Information Circular, vol. 3, no. 276, Oct. 1, 1921, 11 pp., 5 figs. Results of investigation to determine whether test data obtained when a wooden strut is subjected to a column load and also to a side or lateral bending load verify formulas now in use.

Tests. Aerodynamical Report and Tests on the Eggleston Air-Cell Giant Biplane. Aerial Age Weekly, vol. 14, no. 14, Dec. 12, 1921, pp. 323-324 and 326, 4 figs. Report of tests carried out at wind speed of 30 m p h. by Cox-Klemin Aircraft Corp., College Point, L. I.

Truss Ribs. Experimental Reinforced Plywood Truss Ribs, B. C. Boulton. Aerial Age Weekly, vol. 13, no. 25, Aug. 29, 1921, pp. 591-594, 17 figs. Gives tables of data for rib design and direct stresses in rib trusses. Test data on 15 ft. truss ribs. (Concluded.)

Zeppelin. The 1000 Hp. Passenger-Carrying Aeroplane of the Zeppelin works in Staaken, K. Rohrbach. Eng. Progress, vol. 2, no. 11, Nov. 1921, pp. 259-262, 6 figs. Entirely constructed of duralumin. Attained a velocity of 211 km. per hour at trial flights. Equipped with four 260-hp. Maybach engines.

[See also FLYING BOATS; SEAPLANES.]

AIRSHIPS

Commercial Transportation. Commercial Transportation By Dirigibles (Le trafic commercial par ballons dirigeables), L. Hirschauer. La Technique Moderne, vol. 13, no. 6, June 1921, pp. 241-249, 4 figs. Discusses developments, speed and regularity of trips already made, and freight capacity; calculates cost for various lines from Paris.

Mooring. The Mooring of Airships, G. H. Scott. Flight, vol. 13, no. 48, Dec. 1, 1921, pp. 803-804. Discusses mooring on surface of land or water; mooring in the air on one or more wires, and towing; and mooring at a mast. Extract of paper read before Cambridge Univ. Aeronautical Soc.

Non-Rigid, Stresses in. Bending Moments, Envelope, and Cable Stresses in Non-Rigid Airships, C. P. Burgess. Nat. Advisory Committee for Aeronautics, report no. 115, 1921, 14 pp., 4 figs. Describes theory of calculations and methods in use in U. S. Navy Bur. of Aeronautics. Principal stresses are said to be due to gas pressure and unequal distribution of weight and buoyancy, and concentrated loads from car suspension cables. Deals also with variations of tensions in car suspension cables of any type of airship, with special reference to rigid type, due to propeller thrust or inclination of airship longitudinally.

Passenger. Airships for Passenger Transportation, Ralph Upson. Aviation, vol. 11, no. 21, Nov. 21. 1921, pp. 598-600, 5 figs. Discusses advantages of aerial transportation and size and type of ships and terminals. Paper presented to Int. Aero Congress.

The Employment of Airships for the Transport of Passengers, Umberto Nobile. Aerial Age Weekly, vols. 13 and 14, nos. 26, 1 and 2, Sept. 5, 12 and 19, 1921, pp. 618-620, 12-14 and 33-37, 9 figs Indications on the maximum limits of their useful load, distance covered, altitude and speed. From Giornale del Genio Civile, Anno LIX, 1921.

Spain-Argentine Service. Spain to Argentine Airship Service. Aviation, vol. 11, no. 23, Dec. 5, 1921, pp. 656-658, 3 figs. Three Zeppelins are to be used costing about $7,000,000 with terminal facilities costing $8,000,000.

ALCOHOL

Industrial. Manufacture of Industrial Alcohol from the Carob Bean (La fabbricazione industriale dell' alcohol dalle carrube), Giuseppe Mezzadroli Giornale di Chimica Industriale ed Applicata, vol. 3, no 9, Sept. 1921, pp. 399 403 Describes such a plant at Catania, extraction of the sugar, fermentation, distillation and rectification, makes recommendations

ALLOY STEELS

Cracking During Dip Brazing. Report on Cause of Cracking of Alloy Steels During Dip Brazing. Air Service Information Circular, vol. 3, no. 295, Oct 20, 1921, 3 pp., 2 figs. Results of investigation show that two influences contribute to cracking, namely, a sudden rise in temperature after immersion in brass, and sharp changes in cross-sectional area in specimen. Slow preheating to brazing temperature is said to obviate this difficulty.

Impact Tests. Effect of Repeated Impact on Steels (Influence des chocs repétés à la compression sur les aciers), Fernand Éloy. Révue de l'Industrie Minerale, no 19, Oct. 1, 1921, pp. 603 606. Discusses tests with special and carbon steels, showing superiority of former.

Tool Steel. Tool-Steel Specifications—A Hard Nut to Crack, Charles M. Brown. Raw Material, vol. 4, no 10, Oct. 1921, pp. 349-352. Advocates formulation of definite standards as an advantage from user's point of view.

ALLOYS

Carbon-Chromium-Silicon. A New Carbon-Chromium-Silicon Resistance Material. Raw Material, vol. 4, no. 10, Oct. 1921, pp. 359-361, 4 figs. Discusses physical properties of "Silchrome" and gives results of tests made at Columbia University for electric resistance, etc.

Chemical Properties. The Chemical Properties of Alloys (Die chemischen Eigenschaften der Legierungen), G. Tammann. Zeit. fur Metallkunde, vol. 13, no. 12, Sept. 1921, pp. 406-419 and (discussion) pp. 419-424, 27 figs. Deals with limits of influence of chemical media on mixed crystals and the electro-thermal behavior of alloys.

Distribution of Metals in. A Method for Determination of the Percentage Distribution of Metals in Alloys Whose Qualitative Composition is Known (Ueber eine Methode zur Bestimmung der prozentualen Verteilung von Metallen in Legierungen, deren qualitative Zusammensetzung bekannt ist), Karl Schmidt. Chemiker-Zeitung, vol. 45, no. 103, Aug. 27, 1921, pp. 825-826. Method is developed with which it is possible to determine quantitatively the composition of an alloy without destroying it and with the same accuracy as is obtainable by weight analysis.

[See also ALUMINUM ALLOYS; BEARING METALS; MAGNESIUM ALLOYS.]

ALUMINUM

Chill Casting. Chill Casting of Aluminum (Le Moulage en Coquille de l'Aluminium). La Fonderie Moderne, no. 9, Sept. 1921, pp. 254-256, 2 figs. Describes the various operations and alloys to be used.

Industrial Applications. New Industrial Application of Aluminum, Magnesium, Calcium and Sodium (Conférences et exposition publiques des nouvelles applications industrielles de l'aluminium, du magnésium, du calcium et du sodium). Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 7, July-August-September 1921, pp. 683-956, 186 figs. partly on supp. plates. Papers read at recent Aluminum Exposition, discussing manufacture, properties, alloys, castings, use in electric and food industries, welding, enameling, etc. See also Revue de Métallurgie, vol. 18, no. 9, Sept. 1921, pp. 541-607, 43 figs.

ALUMINUM ALLOYS

Bronzes. On the Heat-Treatment of Aluminum Bronze, A. A. Blue. Chem. & Met. Eng., vol. 25, no. 23, Dec. 7, 1921, pp. 1043-1048, 25 figs. Concludes from experiments that heat treatment produces marked and consistent changes in Brinell and scleroscope hardness and has little or no effect on tensile strength and yield point.

Heat Treatment. Heat Treatment of Certain Complex Aluminum Alloys (Sur le traitement thermique de certains alliages complexes d'aluminium), Léon Guillet. Comptes Rendus des Séances de l'Académie des Sciences, vol. 173, no. 21, Nov. 21, 1921, pp. 979-982. Examines part taken by constituents of duralumin (Cu, Mg, Mn, Si, Fe) in the high resistance of the alloy; describes experiments with Al-Cu, Al-Si, Al-Si-Mg, Al-Cu-Si-Mg alloys.

Researches. Researches on Aluminium Alloys, Walter Rosenhain, Sydney L. Archbutt and D. Hanson. Engineering, vol. 112, nos. 2913 and 2914, Oct. 28 and Nov. 4, 1921, pp. 613-615 and 644-645, also Engineer, vol. 132, nos. 3435 and 3436, Oct. 28 and Nov. 4, 1921, pp. 461-463 and 489-490. Brief account of principal contents of report to Alloys Research Committee. Deals with cast and wrought alloys; permanence and constitution of alloys.

APPRENTICES, TRAINING OF

Shipyards. American Shipyard Apprenticeships, Evening Schools and Scholarships, Charles F. Bailey. Advance Copy, Soc. of Naval Architects & Mar. Engrs., meeting Nov. 17-18, 1921, no. 8, 10 pp., 1 fig. Reviews present situation, including requirements for apprenticeship, pay, bonus, evening schools, scholarships, etc., and makes suggestions for improvement.

AUTOMOBILE ENGINES

Anti-Freezing Solutions. Anti-Freezing Solutions, O. B. Zimmerman. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp 307-310 and (discussion) 310-312 Progress report of Committee of S.A.E., discussing cooling media and their ideal requirements.

Camshafts. Manufacture of Accurate Camshafts. Machinery (Lond.), vol. 19, no 477, Nov. 17, 1921, pp. 189-191, 9 figs. Description of important operations, and complete tabulated data on manufacturing procedure in making camshafts for a high-grade motor-car.

Carburetors. See CARBURETORS.

Cylinders. Machining the "Bean" Motor Cylinder I. William Chubb. Am. Mach., vol. 55, no. 21 Nov. 24, 1921, pp. 827-830, 10 figs. Methods used in well-equipped English motor plant. Cylinders produced on American machine tools. Power-washing machine

The Molding of Automobile Cylinder Blocks (Formerei von Auto-Zylinderblocken), Carl Irresberger. Stahl u. Eisen, vol. 41, nos. 35, and 43, Sept. 1 and Oct. 27, 1921, pp. 1217-1222 and 1529-1533, 48 figs. Notes on upright molding of a one-piece six-cylinder block.

Peugeot Co., France. Internal Combustion Engines of the Peugot Automobile Company (Le moteur à injection de la Société des Automobiles Peugeot) Henri Petit. La Technique Automobile et Aerienne vol. 12, no. 113, 1921, pp. 42-49, 4 figs. Discusses construction and operation of the various parts including combustible mixture, atomizer, injector pumps, regulators, etc.

The Heavy Oil Engine of the Peugeot Automobile Co. (Le Moteur a huile lourde de la Société des Automobiles Peugeot), Henri Petit. La Vie Automobile, vol. 17, no. 741, Nov. 10, 1921, pp. 415-421 7 figs. Describes the Peugeot motor (Tartrais patent) principles of which are (1) combustion in a hot chamber, (2) high compression, (3) constant volume combustion, (4) fuel injection in cylinder head. Atomizer, feed pump, efficiency, etc.

AUTOMOBILE FUELS

Air-Fuel Mixtures. Condensation Temperatures of Gasoline and Kerosene-Air Mixtures, Robert E. Wilson and Daniel P. Barnard. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 313-319, 11 figs. Describes simple and reliable method for determining temperatures of initial condensation of fuels from air-fuel mixtures, and an approximate method of determining temperatures of partial condensation in such mixtures. From paper read before Am. Chem. Soc.

Benzol. See BENZOL.

Mixed. Diagram for Mixed Automobile Fuels (Rechentafel fur Mischkraftstoffe), Wa. Ostwald. Chemiker-Zeitung, vol. 45, no. 112, Sept. 17, 1921, p. 897, 1 fig. Presents triangle chart for determination of specific weight and heating value for mixtures of benzol, tetraline and alcohol when percentage weight of composition is known.

Oil-Shale. Motor Car Fuel Prospects in the Oil Shales. Automotive Manufacturer, vol. 63, no. 7, Oct. 1921, pp. 7-10. Discusses quality and composition, distillation analysis, and production with steam.

Standard German. Germany's New Standardized Motor Fuel, Benno R. Dierfeld. Automotive Industries, vol. 45, no. 20, Nov. 17, 1921, pp. 974-975, 2 figs. Mixture of benzol and alcohol with tetralene has produced excellent results in road tests and races.

AUTOMOBILES

Beardmore 11-Hp. The 11 hp. Beardmore. Autocar, vol. 47, no. 1357, Oct. 22, 1921, pp. 717-718, 3 figs. Describes 1922 model embodying minor modifications.

Belsize-Bradshaw 9-Hp. The 9 hp. Belsize-Bradshaw. Autocar, vol. 47, no. 1358, Oct. 29, 1921, pp. 803-804, 4 figs. Specifications and description, including oil cooling for engine, automatic oil lubrication, etc.

Brakes, Four-Wheel. The History of Four-Wheel Brakes. Autocar, vol. 47, no. 1361, Nov. 19, 1921, pp. 1057-1064, 21 figs. A series of articles on brakes, including, operating front wheel brakes, Servo brakes, and four-wheel brake tests.

Design. Car Design and Production. Autocar, vol. 47, no. 1362, Nov. 26, 1921, pp. 1123-1126, 7 figs. Shows how design, workshop processes and material costs influence selling price of a motor vehicle.

Frame Stresses. Automobile Frame Stresses, Ethelbert Favary. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 301-303 and (discussion) 303-306, 3 figs. Gives frame-stress calculations intended to enable the designer to proportion frames and parts with the view of eliminating some of the factors that are productive of excessive weight which causes fuel wastage. Laboratory tests of tensile strength, elastic limit, yield point, etc., of materials.

Francon Light. The Françon Light Car (La Voiturette Francon), A. Contet. La Vie Automobile, vol. 17, no. 739, Oct. 10, 1921, pp. 369-372, 7 figs. 10 hp ; two separate cylinders; consumes 296 gr. gasoline per hp.-hr. Detailed description of construction and equipment.

German 1921 Show. The German Automobile Exhibition 1921, A. Heller. Eng. Progress, vol. 2, no. 11, Nov. 1921, pp. 241-246, 9 figs. Discusses motors, carburetors, radiators, electric equipment, head lights, speed change gear, back-axle drive, road wheels and springs.

The German 1921 Automobile Show (Die Deutsche Automobil-Ausstellung 1921), A. Heller. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 45, Nov. 5, 1921, pp. 1155-1159, 7 figs. Most important

innovations are said to be use of suspended inlet valves and steel cylinders for engines; the dimensioning of cylinders in excess of requirement of their driving gear, which makes it possible to construct car without the usual control-gear mechanism; progress in field of electric starting and lighting installations new Rumpler rear-axle drive; and new aluminum-silicium alloy known as silumin, from which complete rear-axle housings are cast.

Italian S.P.A. The 30–40 hp. Six-Cylinder S.P.A. Autocar, vol. 47, no. 1358, Oct. 29, 1921, p. 794, 2 figs. Specifications and description, including anti-rolling device.

Machining Differential Gear Case. Methods and Tools Used in Machining the Peerless Differential Carrier and Gear Case, Fred H. Colvin. Am. Mach., vol. 55, no. 23, Dec. 8, 1921, pp. 912–914, 11 figs. Turret lathe tooling for special jobs; drilling fixture for rapid handling of work; gages for surfaces which are not easy of access.

Mechanical Features. Progress in Design. Autocar, vol. 47, no. 1360, Nov. 12, 1921, pp. 945–953, 21 figs. Notes on engine design, gas passages, valves, lubrication, carburation, transmission, brakes, steering, suspension, and wheels.

Repair Service. Automotive Service Methods and Equipment, Howard Campbell. Am. Mach., vol. 55, no. 22, Dec. 1, 1921, pp. 870–873, 7 figs. Details of service plant of Hellman Motor Corp., Long Island City, N. Y.

Rumpler Streamline. The New Rumpler Streamline Automobile ("Tropfenwagen"), Curt Eppinger. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 19, Oct. 15, 1921, pp. 287–289, 11 figs. Based on experiences in airplane construction. Entire drive is located in rear and the streamline form is adopted for body. Advantages and possibilities of new type are set forth.

Standard Motor Co. An 8 hp. Four-Cylinder Standard. Autocar, vol. 47, no. 1358, Oct. 29, 1921, pp. 791–793, 8 figs. Specifications and description of Standard Motor Co.'s 8-hp. and 11-hp. cars.

AVIATION

Commercial. Commercial Aviation in France (L' Aviation Commerciale Française), L. Hirschauer. La Technique Moderne, vol. 13, no. 4, April 1921, pp. 145–153, 12 figs. Gives tabulation of lines in existence; shows development of aerial transport companies, their flying machines and government action; reviews activity in other countries.

Technique and Economics in Commercial Aviation (Technik und Oekonomik im Luftverkehr mit Flugzeugen), E. Offermann. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, nos. 19 and 20, Oct. 15 and 31, 1921, pp. 289–298 and 301–302. Oct. 15. Technical requirements of traffic airplanes with special regard to the Junkers airplanes. Oct. 31: Organization problems of air traffic. Prospects of air traffic in Argentine.

Developments and Progress. Aviation, Present and Future (L'Aviation d'hier and de demain), Louis Breguet. L'Aerophile, vol. 29, no. 17–18, Sept. 1–15, 1921, pp. 265–272, 1 fig. Discusses from a technical standpoint what has been accomplished so far and what the possibilities are for aerial transportation.

B

BALANCING

Reciprocating Masses. The Exponential Method in the Analysis of the Balance of Reciprocating Masses, P. Cormack. Engineering, vol. 112, no. 2919, Dec. 9, 1921, pp. 778–780, 1 fig. Calculation of inertia forces for radial and rotating cylinder engines.

Rotating Parts. Balancing Rotating Parts (Sur l'equilibrage des pieces en rotation), P. Lemaire. Le Technique Moderne, vol. 13, no. 6, June 1921, pp. 249–257, 27 figs. Discusses static and dynamic balancing of machinery.

BALLOONS

Pilot. Resistance of Air to Spheres and the Rising Speed of Pilot Balloons (La résistance de l'air au mouvement des sphères et la vitesse ascensionnelle des ballons pilotes), C.-E. Brazier. Compt. Rendus des Séances de l'Académie des Sciences, vol. 173, no. 16, Oct. 17, 1921, pp. 644–646. Discusses determination of K, the coefficient of resistance, and gives table of calculated and experimental values for it.

BEAMS

Irregularly Distributed Loads. Beams with Loads Irregularly Distributed, T. Thompson. Engineering, vol. 112, nos. 2915 and 2916, Nov. 11 and 18, 1921, pp. 656–658 and 686–689, 7 figs. Describes method for speedy and accurate calculation of bending moments and deflections of beam with irregularly distributed loading.

BEARING METALS

Babbitt. Characteristics of Bearing Metals, Edward T. Keenan. Power, vol. 54, no. 25, Dec. 20, 1921, pp. 977–978. Composition of various babbitt metals for various kinds of bearings. List of babbitts and their compounds.

Industrial Value. Bearing Metals and Their Industrial Value, J. Czochralski. Brass World, vol. 17, nos. 9 and 10, Sept. and Oct. 1921, pp. 245–248 and 281–286, 33 figs. Sept.: Discusses alloys in which tin is replaced by lead, and experiments carried out for the purpose. Oct.: Methods of testing and comparative efficiency of bearing metals. (Abstract.) Zeit. f. Metallkunde.

BEARINGS

Hand vs. Machine-Finished. Hand Versus Machine Finished Bearings, E. A. Dixie. Am. Mach., vol. 55, no. 22, Dec. 1, 1921, pp. 888–890. Comparison of machine and hand-finished surfaces. Some examples of better and quicker work.

BEARINGS, BALL

Friction and Safe Load. Friction and Carrying Capacity of Ball and Roller Bearings, H. L. Whittemore and S. N. Petrenko. U. S. Bur. Standards Technologic Papers, no. 201, Oct. 6, 1921, 34 pp 30 figs. Account of experiments undertaken to determine maximum safe load and static friction under load of ball and flexible roller bearings. Results agree roughly with Hertz's theory, differences being ascribable to inhomogeneity of material.

Grinders. Use of Ball Bearings as Adapted to Grinders, Donald A. Hampson. Can. Machy., vol. 26, no. 17, Oct. 27, 1921, pp. 30–32 and 36, 9 figs. Discusses advantages as to lower cost of production, increased output, higher efficiency, saving of power, etc.

BEARINGS, ROLLER

Calculation. Practical Calculations of Roller Bearings (Calcul pratique des roulements a rouleaux), P. Massot. La Technique Moderne, vol. 13, no. 5, May 1921, pp. 193–197, 3 figs. Discusses cylindrical and conical roller bearings and works out formulas. Comparison with ball bearings.

Types. Usual Forms of Roller Bearings (Les formes usuelles de roulements a rouleaux), La Technique Moderne, vol. 13, no. 6, June 1921, pp. 258–263, 22 figs. Describes products of various American, British, French and Swedish firms.

BENZOL

Production in Gas Works. The Production of Benzol in Medium-Size and Small Gas Works (Die Benzolgewinnung in mittleren und kleinen Gaswerken), H. Menzel. Gas- u. Wasserfach, vol. 64, no. 19, May 7, 1921, pp. 294–296, 2 figs. Describes improved type of benzol plant constructed by Berlin-Anhalt Machine Constr. Corp. by means of which, it is claimed, a quality of benzol well adapted for engine drive can be recovered from gas produced in gas works.

BLAST-FURNACE GAS

Burning under Boilers. Burning Blast-Furnace Gas Under Boilers, Gordon Fox and F. H. Willcox. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 930–931. Discusses gas burner, ignition, combustion chamber, baffling, and draft losses through boiler passes.

BLIND

Employment of. The Employment of the Blind in Workshops. Engineering, vol. 112, no. 2917, Nov. 25, 1921, pp. 715–717, 7 figs. Deals with experience gained in Germany in employment of blind on machine work, and machining operations performed by blind at the Siemens-Schuckert Works.

BLUEPRINTING

High-Speed Machine. A High-Speed Blue Printing Machine. Engineer, vol. 132, no. 3438, Nov. 18, 1921, p. 345, 5 figs. Describes new photo-printing machine brought out by B. J. Hall & Co., Ltd., London.

BOAT LIFTS

120-ft. Lift. Elevators for Raising Boats to Considerable Heights (Elevators di navi per grandi altezze de sollevamento). L'Industria, vol. 35, no. 17, Sept. 15, 1921, pp. 391–394, 5 figs. Describes installation designed by four German companies for raising boats 36 meters, which works successfully.

BOILER FEEDWATER

Treatment. Boiler Feed Water Treatment and Treatment Control, E. C. Bashore. Powec Plant Eng., vol. 25, no. 21, Nov. 1, 1921, pp. 1050–1052. Causes of scale, corrosion, foaming, embrittlement, and methods of treatment. (Abstract). Paper read at Nat. Exposition of Chem. Industries.

The Interior Treatment of Boiler Waters, C. R. Knowles. Ry. Age, vol. 71, no. 20, Nov. 12, 1921, pp. 935–936. Discusses introduction of substances into boiler to prevent scale, corrosion, foaming or other ill effects of bad water.

The Treatment of Boiler Feed Water, Robert June. Power House, vol. 14, no. 21, Nov. 5, 1921, pp. 21–23, 3 figs. Discusses artificial zeolite systems and evaporating methods.

BOILER OPERATION

Coal Consumption, Control of. The Influence of Weather on Coal Consumption, Malcolm C. W. Tomlinson. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 321–326, 13 figs. Describes method of using outside temperatures to check boiler operation.

BOILER PLANTS

Economical Design. Boiler and Furnace Economy, D. S. Jacobus. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 779–782. Deals with such questions as when it will pay to use economizers in a new plant; most economical rating at which to operate a boiler; limitations imposed on efficiency by inability of furnace brickwork to withstand temperatures available with many classes of fuel; furnace volume and length of flame travel; use of air heaters, etc.

Boiler-House Management, David Brownlie. Iron & Coal Trades Rev., vol. 103, nos. 2803 and 2804, Nov. 18 and 25, 1921, pp. 721–722 and 700–702. Nov. 18: Discusses efficient design and equipment of boiler plant and scientific control of the working of the plant. Types of boilers and relative advantages and disadvantages. Nov. 25: Discusses mechanical stoking, economizers and feedwater heaters, superheaters, forced or induced draft, and auxiliary machinery. (Abstract). Paper read before South Wales Inst. Engrs.

Steam Accumulators. Steam Accumulators, System Ruths (L'Accumulateur de vapeur Ruths), E.-G. Constam-Gull. Le Génie Civil, vol. 79, no. 22, Nov. 26, 1921, pp. 453–457, 13 figs. A Swedish patent apparatus designed to equalize boiler pressure. Describes a number of installations in metallurgical and electric power plants.

BOILERS

Corrosion. Corrosion Caused by Carbonic Acid (Rostbildung durch Kohlensäure), G. Bruhns. Chemiker-Zeitung, vol. 45, no. 111, Sept. 15, 1921, pp. 885–887. Gives results of investigation of corrosive effect of free carbonic acid in steam and condensation water, and means for its prevention.

Preheating with Flue Gas. Utilizing Flue Gases to Preheat Air to Furnace—Consideration o Some of the Problems Involved, E R. Welles and C. T. Mitchell. Power, vol. 54, no. 22, Nov. 29, 1921, pp. 844–846, 1 fig. Points out that rough calculations (the best that can be made with available data indicate reasonable possibility of economic application of preheating.

Water Works. Selecting Steam Boilers for Water Works, F. W. Dean. Fire & Water Eng., vol. 70, nos. 22 and 23, Nov. 30 and Dec. 7, 1921, pp. 1007–1008, 1014 and 1027–1029 and 1053–1054 and 1058. Importance of choosing most economical type. Various kinds of boilers with their characteristics considered. Proper setting and fuel to be used. Boiler safety. (Abstract). Paper read before N. E. Water Works Assn.

BOILERS, WATER-TUBE

Vertical. Feedwater-Heater Vertical Water-Tube Boilers with Combined Trough-Grate and Step-Grate Furnace for Burning Low-Grade Lignite (Vorwärmer-Steilrohrkessel mit kombinierter Muldenrost-Treppenrostfeuerung zur Verbrennung minderwertiger Braunkohle). Wärme- u Kälte-Technik, vol. 23, no. 14, July 15, 1921, pp. 159–160, 1 fig. Points out advantages of new boiler system which consists of three upper drums connected with the two bottom drums through tubes. Built by Karlsruhe Machine Constr. Corp.

BRAKES

Combination Air and Vacuum. Brakes on the Paulista Railroad (Frenos para el Ferrocarril Paulista), F. H. Parke. Ingenieria Internacional, vol. 6, no. 6, Dec. 1921, pp. 348–351, 3 figs. A combination of air and vacuum brake for electric locomotives drawing trains provided with air brakes, constructed by Westinghouse Air Brake Co.

Pneumatic. Continuous Brake for Freight Trains (Le freinage continu des trains de marchandises), G. Tongas. La Technique Moderne, vol. 13, no. 10, Oct. 1921, pp. 417–425, 6 figs. Describes the Lipkowski brake, a single chamber pneumatic brake, used on some French locomotives for seven years with success.

Westinghouse Double-Capacity. Exceptional Train Loading in the United States and the Westinghouse Double Capacity Brake. Ry. Gaz., vol. 35, no. 21, Nov. 18, 1921, pp. 769–771, 5 figs. Tests with 75,100 and 110-car coal trains, respectively 12,000, 16,000 and 17,250 American tons, on Virginian railway, fitted with Westinghouse empty and load brake.

BRASS

Compressibility. Compressibility of Brasses at Temperatures up to 800 Deg. C. Engineering, vol. 112, no 2918, Dec. 2, 1921, p. 770, 3 figs. Results of series of experiments on compressibility of copper and various brasses at temperatures ranging from 20 to 800 deg. cent. carried out at Hirsch Brass Works, Inc., Eberwalde, Germany. Translated from Zeit. für Metallkunde, vol. 12, pp. 340–358 and vol. 13, pp. 305–315.

Heat Treatment. Heat-Treatment of Brass and Brasses Containing Tin, Léon Guillet. Chem. & Met. Eng., vol. 25, no. 22, Nov. 30, 1921, pp. 1009–1014, 16 figs. Brasses containing a little beta respond to heat treatment; tin-brasses, developing special constituent analogous to delta in bronzes, may have their physical properties changed very notably by proper annealing and quenching. From Revue de Métallurgie, July 1921.

Hot-Working. Hot Working of Brass (Le travail du laiton a chaud), A. Devilliers. La Technique Moderne, vol. 13, no. 5, May 1921, pp. 206–209, 8 figs. Discusses hot rolling, critical content of lead, effect of aluminum and pros and cons of hot and cold working.

BRASS FOUNDING

Electric-Furnace Melting. Brass Melting in Electric Furnaces (Messingschmelzen im elektrischen Ofen), Herbert Hein. Siemens-Zeit., vol. 1, no. 10, Oct. 1921, pp. 380–385, 5 figs. Describes induction furnace developed during war. Furnaces of this type for three-phase and two-phase current and charges of 500 to 1000 kg. have been in operation for several years, consuming 100 and 150 kw. at power factor of 0.4 to 0.6 at 50 cycles. Higher hygienic qualities are claimed for induction furnace than for one of arc type due to smaller amount of injurious zinc fumes.

BUSHINGS

Drill. Drill Bushings (Bohrbuchsen), Fritz Herkner. Betrieb, vol. 4, no. 1, Oct. 8, 1921, pp. 8–12, 32 figs.

For giving to drills, reamers, countersinks, etc. the necessary accuracy in guidance, direction and position. Notes on their manufacture, dimensions, adjustment, and security against being pulled out.

C

CALORIMETERS

Gas. A New Gas Calorimeter (Ein neues Gaskalorimeter), E. Langthaler. Gas- u. Wasserfach, vol 64, no. 6, Feb. 5, 1921, pp. 83-86, 2 figs. Describes Union calorimeter designed by O. Dommer, which, as shown by test results, has a high degree of accuracy. It is easily transportable and adaptable for many uses.

Recording. Report on Recording Calorimeters. Gas World, vol 75, no. 1943, Oct. 15, 1921, pp. 314-319 and (discussion) 319-321, 5 figs. Fifth report of Research Sub-Committee of Gas Investigation Committee giving results of tests made.

CAR LIGHTING

Generators. The Economy of Electric Car Lighting (Die Wirtschaftlichkeit elektrischer Zugbeleuchtung), H. Hoepner. Verkehrstechnik, vol. 38, no. 25, Sept. 5, 1921, pp. 383-395. Demonstrates advantages of generator lighting with auxiliary batteries over pure storage-battery lighting.

CARBURETORS

Aircraft. Instructions to Designers of Aircraft Carburetors. Air Service Information Circular, vol. 3, no. 291, Oct. 20, 1921, 4 pp., 2 figs. Deals with general requirements of carburetor design, gasoline inlet connection, gasoline strainer, float chamber, metering jets, air intake pipe, venturis, throttles, mixture control, performance, tests inspection, etc.

Griffon. The Griffon Carburetor (La carburateur Griffon), Henri Petit. La Vie Automobile, vol. 17, no. 739, Oct. 10, 1921, pp. 378-381, 4 figs. Discusses the various parts and their operation.

Kerosene Carburetion. Actual State of Kerosene Carburetion (Etat actuel de la carburation au petrole lampant), Sigma. La Métallurgie, vol. 53, no. 45, Nov. 10, 1921, pp. 2101-2102. Discusses mixing, ignition, combustion, flame control, etc. (Concluded)

Metering Characteristics. Report on the Control of Carburetor Metering Characteristics by the Supplementary Admission of Air. Air Service Information Circular, vol. 3, no. 292, Oct. 20, 1921 14 pp., 9 figs. Results of test to determine characteristics of mixture-control device operating on principle of supplementary admission of air, particularly as applied to high-compression, over-dimensioned aviation engine, under laboratory and flight conditions.

Testing Zenith. Testing a Zenith Carburetor (Essai d'un carburateur Zénith a triple diffuseur sur voiture 16 hp. Panhard S.S.), Henri Petit. La Vie Automobile, vol. 17, no. 739, Oct. 10, 1921, pp. 374-375, 2 figs. Details of three tests on a 16-hp. Panhard.

CARS

Electric. Illinois Central Steel Suburban Coaches. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921 pp. 755-759, 11 figs. Designed for future electrification; doors electrically controlled; total weight 92,100 lb.

CARS, COAL

Steel Hopper. All-Steel Coal Hopper Wagons for Bengal-Nagpur Railway. Ry. Engr., vol. 42, no. 502, Nov. 1921, pp. 405-409, 5 figs. High-capacity hopper wagons constructed by Midland Railway Carriage & Wagon Co., Ltd., Birmingham, for Bengal-Nagpur Railway, to the design of J. W. Barry.

CARS, FREIGHT

Box. The Use of Ordinary Box Cars for Shipping Fruit, Vane G. Gibson and Herbert Graff. Ry. Rev., vol. 69, no. 20, Nov. 12, 1921, pp. 643-646, 7 figs. Tests undertaken by Department of Agriculture show most practical means for ventilating box cars. (Abstract).

Container. Avoidable Waste in Car Operation—The Container Car, Walter C. Sanders. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 799-802, 9 figs. Describes "container" cars recently placed in service on N. Y. Central lines and others having improvements on original type which are now under construction. Advantages of described car are enumerated.

Wood in Construction of. The Use of Wood in Freight Car Construction, H. S. Sackett. Ry. Age, vol. 71, no. 22, Nov. 26, 1921, pp. 1037-1042, 6 figs. Relative advantages of double- and single-sheathed box car; composite gondola car, advantages of composite design; etc. Gives table of lumber grades and dimensions.

CARS, PASSENGER

All-Steel. Illinois Central Suburban Operation and Equipment. Ry. Rev., vol. 69, no. 21, Nov. 19, 1921, pp. 669-677, 14 figs. Describes new all-steel cars just put in service as first step toward electrification.

New All-Steel Suburban Coaches for the South African Railways. Ry. Gaz., vol. 35, no. 20, Nov. 11, 1921, pp. 722-725, 6 figs. Describes all-steel composite bogie coaches built by Leeds Forge Co., Ltd., constructed on central gangway principle.

Design. On the Question of Passenger Carriages, W. J. Tollerton. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1399-1440, 52 figs. Gives list of questions and answers regarding general types and arrangements of passenger carriages used in U. S., Canada and Mexico, details of construction of principal parts of carriages, lighting, heating, ventilating, etc.

CARS, TANK

Milk. Handling Milk in Specially Constructed Tank Cars. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921, pp. 763-764, 3 figs. Large glass-lined steel tanks save expense in handling and haulage, refrigeration in transit eliminated.

CAST IRON

Self-Corrosion. Self-Corrosion of Cast Iron and Other Metals in Alkaline Soils, W. Nelson Smith and J. W. Shipley. Elec. Ry. Jl., vol 58, no 21, Nov. 19, 1921, pp. 911-912. Results of investigation to show that city water main external corrosion could not be due to electrolysis from stray currents. (Abstract.) Paper read before Eng. Inst. of Can.

CENTRAL STATIONS

Auxiliary Drives. Relation of Auxiliary Drives to Heat Balance, J. R. McDermet. Power, vol. 54, no. 23, Dec. 6, 1921, pp. 888-890, 1 fig. Deals with direct steam drive, motor drive, house turbines, combination drives, and feedwater heating by bleeder condensers.

Hartford, Conn. South Meadow Station. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1177-1184 and 1210-1217, 23 figs. Describes new plant of Hartford Elec. Light Co. with ultimate capacity of 130,000 kw. at 11,000 volts. Centrifugal auxiliary pumps, inbuilt economizers, washed air for cooling generators, centralized station control. See also Elec. World, vol. 78, no. 24, Dec. 10, 1921, pp. 1163-1166, 6 figs.

Manchester, N. H. Central Station Service for Manchester, N. H. Power Plant Eng., vol. 25, no. 22, Nov. 15, 1921, pp. 1079-1087, 13 figs. Hydro-electric and steam standby stations of Manchester Traction, Light & Power Co.

Oakland, Cal. Oakland Station of the Pacific Gas & Electric Co., Charles W. Geiger. Power Plant Eng., vol. 25, no. 21, Nov. 1, 1921, pp. 1033-1039, 10 figs. Describes 12,500-kw. addition to Station C, turbo-generator, circulating pump, fuel oil, water supply, etc.

Superpower. A Superpower System for the Region Between Boston and Washington, W. S. Murray. U. S. Geol. Surv. professional paper 123, 1921, 261 pp., 61 figs. and 11 supp. plates. Market for superpower energy will be furnished by electric utilities, industries, and railroads. Estimated requirement for energy supplied through electric utilities for municipal, private, industrial, and railroad purposes in 1930 is 31,000,000,000 kw-hr., which could be supplied by coördinated power system such as is described. Study of 96,000 manufacturing establishments operating within superpower zone shows that by 1930, they can save $190,000,000 annually above fixed annual charges against capital investment of $185,000,000. See also Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1185-1187, 1 fig.

CHARTS

Nomograms. Graphic Charts (Graphische Tafeln), Wilhelm Vieser. Bauingenieur, vol. 2, no. 21, Nov. 15, 1921, pp. 569-575, 6 figs. Review of nomographic methods, and construction of charts. Bibliography.

Scale Selection. Scale Selection for Z Charts, Arthur R. Burnet. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 365-370, 4 figs. Describes new method of chart making and curve plotting and compares it with older method.

CHIMNEYS

Tall, Design of. Notes on the Design of Tall Chimneys and Their Foundations, J. M. Wade. Roy. Engrs. Jl., vol. 34, no. 5, Nov. 1921, pp. 209-219, 6 figs. Discusses design, height, draft, and calculations, including calculations of gases formed by combustion of one ton of coal, and for height and outlet of a chimney for furnaces consuming two tons of fuel per hour.

CHROME STEEL

Automobile Industry. Chromium Steels and Irons, Leslie Aitchison. Iron & Coal Trades Rev., vol. 103, no. 2802, Nov. 11, 1921, pp. 686-687. Discusses alloy and carbon steels, effect of alloying on critical temperature, mechanical properties, stainless steels, and vanadium additions, especially in connection with the automobile industry.

Mechanical Properties. Chromium Steels and Iron, Leslie Aitchison. Engineering, vol. 112, nos. 2918 and 2919, Dec. 2 and 9, 1921, pp. 771-772 and 805-807, 5 figs. Brief account of general effect which chromium exerts upon steels, followed by description of mechanical properties of chrome steels. Paper read before Instn. Automobile Engrs.

CHROMIUM

Alloys of. Chromium Alloys (Les alliages industriels de chrome), J. Herbert. La Technique Moderne, vol. 13, no. 5, May 1921, pp. 197-205. Discusses metallic chrome, ferro-chrome, silico-chrome, chrome and chrome-nickel steels, chrome salts, etc.

COAL HANDLING

Plants. Coal and Ash-Handling Plant of the Royal Naval Cordite Factory, Near Poole, George F. Zimmer. Engineering, vol. 112, no. 2916, Nov. 18, 1921, pp. 706-707, 7 figs. Railway sidings on which coal arrives and from which ashes leave, run alongside and parallel with boiler-house; full trucks arrive on inner track and pass over a large track hopper into which coal is dumped by truck tippler, by completely overturning trucks.

Reinforced-Concrete Coal-Handling Plant with Storage Bunker (Kohlenförderanlage in Eisenbeton fur den Betrieb der Firma F. A. Schmidt in Guben), A. Burghardt. Beton u. Eisen, vol 20, no. 16, Oct. 5, 1921, pp. 177-178, 7 figs. Installation built in 1919 consists of a 7.2-m. long, 3.6-m.-wide bunker for storage of 80 cu. m. of lignite; and a smaller bunker, 2.64 m. long and 2.5 m. wide for 20 cu. m.

COLUMNS

Buckling under Axial Load. Buckling of Elastic Structures, H. M. Westergaard. Proc. Am. Soc. Civ. Engrs., vol. 47, no. 9, Nov. 1921, pp. 455-533, 14 figs. Investigation deals with structural actions in which stresses are not proportional to loads, although proportional limit of material has not been exceeded and deflections remain small. Describes astatic and in particular, heterostatic action. Deals also with columns carrying axial and transverse loads at same time. Formulas are given for buckling of slabs and systems of crossing-beams. Classified bibliography.

COMBUSTION

Controlling Rate. Controlling the Rate of Combustion. Sanitary and Heating Eng., vol. 96, no. 11, Nov. 18, 1921, pp. 313-314, 2 figs. Discusses hydraulically operated damper regulators in low pressure heating plants.

COMPRESSED AIR

Intercooling. Value of Intercooling Compressed Air, C. K. Bennett. Power Plant Eng., vol. 25, no. 23, Dec. 1, 1921, pp. 1142-1144, 5 figs. Methods and means of cooling air during and after compression.

Pneumatic Mail Tubes. Pneumatic Street Tubes in London, A. B. Eason. Compressed Air Mag., vol. 26, no. 11, Nov. 1921, pp. 10279-10282, 8 figs. Used for conveying parcels, letters, newspapers and other matter which must be delivered expeditiously. Describes machinery for supplying compressed air, and terminal apparatus.

CONDENSERS, STEAM

Cooling-Water Treatment. Chemical Treatment of Water for Cooling Condensers (Du traitement chimique des eaux servant à la réfrigération des condenseurs), G. Paris. Chaleur et Industrie, vol. 2, no. 18, Oct. 1921, pp. 634-642, 12 figs. Describes Balke process which changes bicarbonate of lime and magnesium into chlorides by addition of hydrochloric acid, and the Hulsmeyer process depending on thermic action and addition of sodium carbonate.

CONVEYORS

Mold. Conveyor System Cuts Moulding Costs, Herbert H. Leonard. Can. Manufacturer, vol. 41, no. 11, Nov. 1921, pp. 31-35, 11 figs. Molding car wheels on jolt machines is made possible by adoption of conveyor systems for transferring molds, flasks and sand, supplemented by I-beam trolleys and gravity conveyors.

New System. Tramrail Reduces Labor Force to Half. Iron Age, vol. 108, no. 24, Dec. 15, 1921, pp. 1523-1525, 3 figs. States that marked reduction in production costs has been effected by Globe Machine & Stamping Co., Cleveland, by installation of new conveying system and japanning equipment.

COST ACCOUNTING

Job Cards. Job Cards, Hubert Bentley. Eng. & Indus. Management, vol. 6, no. 19, Nov. 10, 1921, pp. 533-534, 2 figs. Outlines useful method of keeping distinct record of time taken on jobs for costing purposes. Describes specimen job cards.

COST SYSTEMS

Foundry. Advantages of a Foundry Cost System, Robert E. Belt. Iron Age, vol. 108, no. 21, Nov. 24, 1921, pp. 1351-1353. Points out that it forms basis for establishing selling price and indicates degree of efficiency of various departments. Paper read before Nat. Founders' Assn.

CRANES

Dock. New Special Types of Mammoth Dock Cranes (Neue Sonderbauarten von Riesenwerftkranen im Ausland), H. Wintermeyer. Fördertechnik u. Frachtverkehr, vol. 14, no. 23, Nov. 11, 1921, pp. 289-291, 6 figs. Describes examples of English and American stationary and floating-dock mammoth cranes.

Floating. Floating Crane for Coaling Vessels. Engineering, vol. 112, no. 2919, Dec. 9, 1921, p. 784, 5 figs. partly on p. 592. New crane recently installed in Montreal Harbor by George Hall Coal Co. of Can., Ltd. Its features include a gooseneck boom which enables it to deliver coal into deck shoots on either side of steamer without moving its station. Slewing angle of boom is 180 deg., enabling it to coal not only from its own stock, but from coal barges alongside.

Metallurgical Industry. Modern Cranes and Conveyors in the Metallurgical Industry (Les appareils modernes de levage et de manutention dans l'industrie métallurgique), Lucien Dujardin. L'Outillage, vol. 230, no. 42 Oct. 20, 1921, pp. 1087-1103, 50 figs. A number of articles discussing construction and operation of apparatus for charging furnaces of various systems, electromagnets, crane trucks, etc.

Mounted on Trucks. The Truck with the Giant Arm. Commercial Vehicle, vol. 25, no. 8, Nov. 1921, pp. 30-31, 4 figs. Universal crane, mounted on different trucks, speeds up all types of loading and gives greater flexibility in maneuvering into position.

CRANKSHAFTS

Grinding. Crankshaft Grinding. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, pp. 447-450, 11 figs. Notes on special machines and attachments.

CUTTING METALS

Acetylene Jet-Cutting Machines. Economy in Metal Cutting. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 565–566, 2 figs. Describes Godfrey acetylene jet-cutting machine and its economic advantages.

Oxy-Hydrogen Cutting. Effect of Oxy-Hydrogen. Cutting on Locomotive Rods, Arthur F. Pitkin. Am. Mach., vol. 55, no. 24, Dec. 15, 1921, pp. 964–965, 11 figs. Unusual examples of rapid cutting together with data as to its effect on steel used in locomotive rods.

D

DIE CASTINGS

Design and Use. Die Castings and Their Use in Industry, C. T. Roder. Iron Age, vol. 108, no. 22, Dec. 1, 1921, pp. 1409–1411. Their relation to consumers of sand or malleable castings. Dies and their construction. Designing of castings.

DIESEL ENGINES

Ansaldo-San Giorgio. 300-Hp. Two-Cycle Diesel Engine. Engineering, vol. 112, no. 2917, Nov. 25, 1921, pp. 721–722, 10 figs. on supp. plate. Describes new series of engines built by Ansaldo-San Giorgio of Turin and Spezzia, Italy, intended primarily for industrial purposes. Results of tests with two-stroke, single-acting engine with three vertical cylinders.

Beardmore-Tosi. Trials of the Beardmore-Tosi Diesel Engine. Engineer, vol. 132, no. 3437, Nov. 11, 1921, pp. 508–510, 12 figs. one on p. 512. Results of trial are presented. Beardmore-Tosi engine, salient features of which are described, is said to mark distinct advance in four-cycle engine construction. See also Shipbldg. & Shipg. Rec., vol. 18, no. 19, Nov. 10, 1921, pp. 605–606, 3 figs. on pp. 600–601.

Compressorless. A Compressorless Diesel Engine. Power Plant Eng., vol. 25, no. 23, Dec. 1, 1921, pp. 1146–1147, 2 figs. Fuel injected without air, under pump pressure; gradual combustion at constant pressure; air compressed by lower end of piston; crosshead to take connecting-rod thrust.

Electricity Supply and. The Function of the Heavy Oil Engine in Connexion with the General Supply of Electricity, Geoffrey Porter. Gas & Oil Power, vol. 17, no. 194, Nov. 3, 1921, pp. 22–24, 2 figs. Discusses oil fuels, Diesel engine design, especially the Still engine, and advantages of heavy-oil engines based on comparative figures. From paper read before Diesel Engine Users' Assn.

Fishing Boats. Engines for Fishing Boats (Le moteurs de bateaux de pêche), Edmond Marcotte, La Technique Moderne, vol. 13, no. 7, July 1921, pp. 298–305, 9 figs. Describes various types of semi-Diesel and Diesel engines.

German Submarine. The Augsburg Ten-Cylinder Four-Stroke-Cycle U-Boat Diesel Engine, John L. Bogert. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 932–933, 2 figs. Characteristics of the Augsburg 3000-hp. high-speed engine designed by I. Lauster, used on German submarines.

Sulzer. The New Sulzer Diesel Engine, A. P. Chalkley. Mar. Eng., vol. 26, no. 11, Nov. 1921, pp. 815–816, 2 figs. Describes new Sulzer marine Diesel engine with turbo-scavenging; 1,350 b.hp. at 95 r.p.m.; built by Winterthur works and being installed in a 9,000-ton deadweight motorship.

DISABLED MEN

Training of. On Behalf of the Industrial Disabled, Gerald A. Boate. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 345–352, 2 figs. Includes alphabetical list of occupations in which disabled men have been retrained. Scientific selection of suitable occupations for disabled men.

DRAWINGS

Production and. Drawings and Production. Eng. Production, vol. 3, no. 62, Dec. 8, 1921, pp. 533–536. Discussion of Albert F. Guyler's paper with above title read before Instn. Production Engrs.

Suggestions for Making. Drawings and Production. Albert F. Guyler. Eng. Production, vol. 3, no. 61, Dec. 1, 1921, pp. 509–513, 13 figs. Suggestions for the making of drawings. Paper presented before Instn. Production Engrs.

DRILLING MACHINES

Radial. Centralized Control Radial Drilling Machine Machinery (Lond.), vol. 19, no. 477, Nov. 17, 1921, pp. 197–202, 8 figs. A new tool in which all the means of control are grouped together near working position of operator.

Recent Developments. Recent Machine-Tool Developments—XXIII, Joseph Horner. Engineering, vol. 112, no. 2919, Dec. 9, 1921, pp. 780–783, 11 figs. Deals with different types of drilling machines.

Sensitive. A New Sensitive Drilling Machine. Eng. Production, vol. 3, no. 61, Dec. 1, 1921, p. 523, 1 fig. Describes machine designed by Adept Eng. Co., Birmingham, England. Work is held in vice of special construction which trips up to diameter of 3 in.

DROP FORGING

Modern Practice. Modern Drop forging Practice, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 308–312, 7 figs. Notes on trimming forgings; forging heats. Typical examples of drop-forging work.

E

ECONOMIZERS

Feedwater Heaters and. The Selection of Economizers and Feed-Water for Municipal Power-Plants, W. F. Schaphorst. Am. City, vol. 25, no. 6, Dec. 1921, pp. 489–493, 4 figs. Discusses operation of economizers and two types of feedwater heaters.

EDUCATION, ENGINEERING

Early Training. The Education of Engineers, E. A. Allcut. Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 633–637. Refers to lack of coordination in connection with early training of engineers and points out discrepancies (starting at elementary schools) with view to their ultimate disappearance or modification.

ELECTRIC FURNACES

Gray-Iron Castings. Electric-Furnace Casting in Germany (Elektroofenguss in Deutschland), H. Kölla. Giesserei-Zeitung, vol. 18, no. 28, Oct. 18, 1921, pp. 379–381. Enumerates its advantages for production of gray-iron casting.

Melting and Refining. The Electric Furnace in Melting and Refining, John B. C. Kershaw. Electrician, vol. 87, no. 2270, Nov. 18, 1921, pp. 636–639, 5 figs. Annual review of developments, including modern tendencies in electric-furnace design, the Soderberg electrode, and the Russ electric arc furnace.

Resistance. New Electric Resistance Furnaces for Heat Treating Steel (Nouveaux fours électriques a résistance pour le traitement thermique de l'acier). L'Industrie Électrique, vol. 30, no. 705, Nov. 10, 1921, pp. 405–407, 4 figs. Describes vertical furnace and horizontal continuous furnace developed during war.

Smelting. Smelting Iron Ore Electrically, Frank Hodson. Iron Trade Rev., vol. 69, no. 23, Dec. 8, 1921, pp. 1492–1493. Points out that inexperience and inadequate financing have been responsible for failure of many efforts to place direct processes of steelmaking on practical basis.

ELECTRIC LOCOMOTIVES

Design. Selecting Designs for Electric Locomotives, A. W. Gibbs. Ry. Age, vol. 71, nos. 21 and 22, Nov. 19 and 26, 1921, pp. 987–989, 4 figs. and pp. 1057–1060, 15 figs. Nov. 19: Describes methods used for testing locomotive and discusses electric locomotive drives. Nov. 26: Tests indicate that non-symmetrical wheel arrangement is essential for best performance. (Abstract). Paper read before Franklin Inst.

Freight. Electric Freight-Train Locomotives (Elektrische Güterzuglokomotiven), Karl Trautvetter. Fördertechnik u. Frachtverkehr, vol. 14, nos. 21 and 22, Oct. 14 and 28, 1921, pp. 259–261 and 281–283. 6 figs. Discusses different German types.

Storage-Battery. Storage-Battery Locomotives in Metal Mines, E. V. Daveler and R. E. Renz. Min. & Sci. Press, vol. 123, no. 22, Nov. 26, 1921, pp. 751–752. Describes experience in Butte & Superior mine; provisions for safety; care and service of locomotives. Paper read before Nat. Safety Congress.

ELECTRIC PLANTS

Blackburn, England. The New Blackburn Power Station. Tramway & Ry. World, vol. 50, no. 25, Nov. 17, 1921, pp. 261–264, 8 figs. Describes equipment; two 10,000-kw. turbo-alternators, coal and ash-handling plant, boiler plant, switch gear, etc.

Buenos Aires. The "Dock Sud" Power Station in Buenos Aires, E. Hayn. Eng. Progress, vol., 2, no. 11, Nov. 1921, pp. 247–251, 7 figs. Position and general plan; coal supply; boiler house and engine plant; supply of cooling water; switch gear house.

Hartford Electric Light Co. The Hartford Electric Light Company's South Meadow Station. Power, vol. 54, no. 23, Dec. 6, 1921, pp. 872–882, 14 figs. Equipment arrangement particularly adapted to operating convenience. Plant laid out for 130,000 kw. in five units. Turbine's guaranteed water rate 10.1 lb. per kw-hr. Closed system of generator cooling. Boiler operation centered in boiler-control room.

Industrial Works. A Modern Works Power Plant. Eng. Production, vol. 3, no. 59, Nov. 17, 1921, pp. 469–474, 12 figs. Describes plant installed by Marshall Sons & Co., Ltd. to serve their various works at Gainsborough.

Outdoor Stations. Outdoor Stations (Les sous-stations exterieures), Leon Drin. Révue Générale de l'Électricité, vol. 10, no. 20, Nov. 19, 1921, pp. 717–728, 27 figs. Describes American stations at Tacoma, Newark, N. J., Hastings, and Minneapolis, also some French stations, and their arrangement.

Runcorn, England. New Electric Power Station at Runcorn. Engineer, vol. 132, no. 3440, Dec. 2, 1921, pp. 584–588, 13 figs. partly on p. 596. Site is laid out with view to ultimate output of 100,000 kw. and first installation comprises two 12,500-kw. Parsons turbo-generators supplied with steam from Babcock & Wilcox marine-type water-tube boilers. Supply is on three-phase a.c. system at 440 volts for power and on single-phase a.c. system at 250 volts for lighting, long-distance transmission being carried out at 33,000 volts and short-distance at 6000 and 3000 volts.

Sheffield, England. Electricity Supply in Sheffield. Electrician, vol. 87, no. 2268, Nov. 4, 1921, pp. 566–570, 7 figs. Describes new Blackburn Meadows station; coal and ash handling, boiler house, economizers, feed pumps, generators (four three-phase 50-cycle 6,600 volt two at 1,500 and two at 3,000 r.p.m.), and auxiliaries. See also Elec. Rev. (Lond.), vol. 89, nos. 2293 and 2294, Nov. 4 and 11, 1921, pp. 605–608 and 628–630, 13 figs.; also Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 641–643, 4 figs.

Unit Costs. Unit Costs of New Bedford Generating Station. Elec. World, vol. 78, no. 22, Nov. 26, 1921, pp. 1072–1073, 1 fig. Discusses economical construction and efficient operation of Cannon Street station of Edison Gas & Elec. Light Co. and gives analysis of operating and construction costs.

ELECTRIC WELDING

Science of. The Science of Electric Welding, W. E. Ruder. Jl. Franklin Inst., vol. 192, no. 5, Nov. 1921, pp. 561–583, 24 figs. Notes on carbon electrode arc welding; metallic arc process; metallography of welds; metal transfer; electrodes; reliability of welded joints; electrical characteristics and equipment; automatic arc welding.

ELECTRON METAL

See MAGNESIUM ALLOYS.

ELEVATED RAILWAYS

Hamburg, Germany. Ten Years of the Hamburg Elevated Railway, Wilhelm Mattersdorff. Elec. Ry. Jl., vol. 58, no. 23, Dec. 3, 1921, pp. 879–985, 16 figs. Describes improvements made in recent years and gives operating data.

ELEVATORS

Interlocks, Survey of. Results of a Survey of Elevator Interlocks and an Analysis of Elevator Accident Statistics, C. E. Oakes and J. A. Dickinson. U. S. Bur. Standards Technologic Papers, no. 202, Oct. 17, 1921, 30 pp. Gives results of field survey of several thousand elevator landings equipped with various types of mechanical and electromechanical interlocks and contact devices. Survey was conducted in connection with preparation of elevator safety code in coöperation with engineers of Am. Soc. Mech. Engrs. Statistics show that 73.8 per cent of all fatal accidents might be prevented by well-designed interlocks.

Power for. Continuous Motors and Pneumatic Gear for High-Power Machinery (Durchlaufender Motor und Druckluftsteuerung für Arbeitsmaschinen grosser Leistung), Franz Jordan. Fördertechnik u. Frachtverkehr, vol. 14, no. 22, Oct. 28, 1921, pp. 271–274, 6 figs. Advantages of continuously over intermittently operating motors for elevators, cranes, etc., are enumerated.

EMPLOYMENT

Continuous, Problem of. The Engineering Approach to the Problem of Continuous Employment, Richard A. Feiss. Bul. Taylor Soc., vol. 6, no. 5, Oct. 1921, pp. 187–194. Deals with problems and importance of stabilization of employment.

EMPLOYMENT MANAGEMENT

Trade Tests. The Value of the Trade Test in Industry, Russell J. Waldo. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 351–357, 7 figs. Shows parts of typical trade tests used by writer with unusual success.

ENGINEERS

Business Methods. Business Methods of European Engineers Compared with Those of American Engineers, Axel Malm. Jl. Engrs.' Club Phila., vol. 38–11, no. 203, Nov. 1921, pp. 389–391. Discusses salesmanship, advertising methods and education of foreign and American engineers.

Training. Training the Engineer for Industrial and Social Service. Eng. News-Rec., vol. 87, no. 24, Dec. 15, 1921, pp. 979–981. Two engineering educators discuss professional and non-professional opportunities of the young engineer and length of course justified in preparing him for service. Projecting Professional Ideas Into Business, by Frederic Bass; Visioning the Opportunity of the Engineer, Hale Sutherland.

ENGINEHOUSES

Cold-Climate. Novel Engine Facilities for a Cold Climate. Ry. Age, vol. 71, no. 22, Nov. 26, 1921, pp. 1049–1051, 2 figs. Describes rectangular enginehouse containing turntable, at Hoornepayne, Ont., constructed by Can. Nat. Ry. Co.

F

FACTORIES

Efficiency and Fuel Consumption. Efficiency and Fuel Consumption of Factory Plants (Wirkungsgrad und Brennstoffverbrauch von Fabrikanlagen), Karl Meller. Werkstattstechnik, vol. 15, no. 19, Oct. 1, 1921, pp. 565–575, 18 figs. Investigation shows present efficiency of German plants averages only 30 per cent. Study of conditions on which efficiency depends and measures to be adopted for increasing efficiency and thereby reducing consumption of coal.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FANS, CENTRIFUGAL

Design. The Design and Construction of Fans—XIII and XIV, F. G. Whipp. Mech. World, vol. 70, nos. 1818 and 1822, Nov. 4, and Dec. 2, 1921, pp. 370–372 and 440–441, 2 figs. Discusses cased fans and calculation of area and pressure; gives table of losses due to friction, design and calculation.

Molding and Machining. Making Centrifugal Fans, G. W. Brown. Machinery (Lond.), vol. 19, no. 479, Dec. 1, 1921, pp. 261–263, 8 figs. Describes molding and machining operations.

FATIGUE

Industrial. Methods of Reducing Fatigue in the Tool Rooms, F. B. and L. M. Gilbreth. Can. Machy., vol. 26, no. 21, Nov. 24, 1921, pp. 33 and 35, 2 figs. Discusses orderly arrangement of tools, shelves, light, etc. From paper read before Soc. Industrial Engrs.

Safety Work and. Fatigue Study. A First Step in Safety Work, Frank B. and L. M. Gilbreth. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 537–538. Authors show how fatigue can prove most useful in safety work, and that same methods and devices at present employed in factories and offices can be used effectively to do both types of work.

FLIGHT

Soaring. The Second Rhön Soaring Flight Contest (Der zweite Rhön-Wettbewerb), Werner v. Langsdorff. Luftfahrt, vol. 25, no. 9, Sept. 1921, pp. 151–156, 13 figs. Part I: Account of flight performances and description of participating machines. Part II: Technical remarks, by Roland Eisenlohr.

FLOORS

Flat-Slab. Calculation of Flat-Slab Floors (Zur Berechnung der Pilzdecke), K. Hruban. Beton u. Eisen, vol. 20, nos. 16 and 17–18, Oct. 5 and Nov. 4, 1921, pp. 187–188 and 200–202, 8 figs. Investigation of calculations heretofore used and description of new method in which variability of height of plate is taken into consideration.

FLOW IN PIPES

Hot Gases. Flow of Hot Gases in Pipes (Expériences très simples au sujet des mouvements des gaz chauds dans des tuyaux), J. Seigle. Révue de l'Industrie Minerale, no. 19, Oct. 1, 1921, pp. 607–611, 10 figs. Describes experiments in connection with circulation of hot gases and smoke in furnaces.

FLOW OF STEAM

Nozzles. Note on the Flow of Air and Steam in Nozzles, Gerald Stoney and Norman Elce. Engineering, vol. 112, no. 2918, Dec. 2, 1921, pp. 750–751. Notes on discharge coefficients which afford evidence that no condensation takes place before throat with wet or saturated steam, and that saturated steam acts down to throat as a perfect gas with adiabatic-index of 1.3.

FLUIDS

Properties at Critical Point. Theoretical Study of the Properties of Fluids at About Their Critical Points (Étude théorique des propriétés des fluides au voisinage du point critique), G. Bruhat. Journal de Physique et le Radium, vol. 2, no. 10, Oct. 1921, pp. 303–316, 1 fig. Mathematical rendering of the hypothesis of the continuity of the liquid and gaseous states and properties defining critical point; etc.

FLUE-GAS ANALYSIS

Apparatus. Improvements in Flue-Gas Investigating Apparatus (Neuerungen an Rauchgasuntersuchungsapparaten), H. v. Ihering. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 37 and 38, Sept. 16 and 23, 1921, pp. 291–293 and 299–301, 9 figs. Details and experiences with flue-gas testing apparatus known as Ranarex, and the Moeller-Gerdien flue-gas analyzer constructed by Siemens-Schuckert Works.

Solid and Liquid Fuels. Flue-Gas Compositions for Solid and Liquid Fuels (Rauchgaszusammensetzungen für feste und flüssige Brennstoffe), E. Kraemer. Feuerungstechnik, vol. 10, nos. 1, 3 and 4, Oct. 1, Nov. 1 and 15, 1921, pp. 3–6, 21–25 and 34–37, 7 figs. Charts are developed for rapid testing of flue-gas analyses for fuels, especially coal of variable composition.

FLYING BOATS

Dornier. The Dornier "Dragon Fly" Flying Boat. Flight, vol. 13, no. 42, Oct. 20, 1921, pp. 685–686, 6 figs. Small, low-powered, three-seater monoplane; 50–60-hp. Siemens-Halske engine, 5-cylinder radial air-cooled; almost entirely constructed of metal, especially duralumin. Gives data.

FOREMEN

Training of. How to Educate Foremen, V. M. Palmer. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 321–324. Importance of giving them systematic training and method of accomplishing this.

The Foreman's Place in Industry, Ralph W. Immel. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 340–342, 2 figs. Author claims that object should be not to educate foreman, but to get him to apply knowledge he already possesses. Shows two types of form used by foreman for job analysis.

FORGING

Flow of Metal. The Flow of Metal During Forging, Harold F. Massey. Mech. World, vol. 70, nos. 1820, 1821, and 1822, Nov. 18, 25 and Dec. 2, 1921, pp. 408–410, 424–425 and 444–447, 33 figs. Results of a number of experiments, particularly to study the relation between the action of forging by pressure and by blows. Paper read before Manchester Assn. of Engrs.

FOUNDRIES

Charging Platform. Charging Floor with Undercover Storage, Edwin A. Hunger. Iron Age, vol. 108, no. 23, Dec. 8, 1921, pp. 1459–1462, 7 figs. Details of new foundry and machine shop of Duplex Printing Press Co., Battle Creek, Mich. Notable feature is big charging platform, entirely under cover, with storage capacity for 5000 tons of metal and ten carloads of coke at one time. Raw materials unloaded in single operations. Core making expedited with special cement boxes.

Conveyors for. Decreasing Foundry Costs Through the Mechanical Handling of Materials, J. M. Macrae. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 257–259, 3 figs. Describes application of complete conveyor system installed in the Kelsey Wheel Co. foundry, Detroit, Mich.

Malleable-Iron. The Malleable Iron Foundry, Its Organization (La fonderie de fonte malléable, son organisation), Christian Kluytmans. La Fonderie Moderne, no. 9, Sept. 1921, pp. 241–253, 11 figs. Gives general plan for foundry and describes the various operations with samples of record cards used for routing work.

Material-Handling Equipment. Solves Material Handling Problems in Design of New Foundry, H. R. Simonds. Iron Trade Rev., vol. 69, no. 21, Dec. 15, 1921, pp. 1545–1549, 10 figs. Electrically controlled cars for raw materials, storage-battery lift trucks for ladles and castings, and monorail system speed operations in new casting plant in Springfield, Mass. Molding floor routine is flexible. Wood block floor used in all operating departments.

Systematizing Production. Systemising Foundry Production, Hubert Bentley. Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 631–632, 2 figs. Describes efficient system capable of general application in foundry. Deals with regulation of supply of castings, method of ordering storage, and recording of work in hand.

FOUNDRY PRACTICE

Metal Casting. Problems Involved in Casting Metal, Thomas Turner. Foundry, vol. 49, no. 3, Dec. 1, 1921, pp. 926–933, 6 figs. With good foundry practice sound castings can be obtained from any metal provided there are no reactions which lead to formation and evolution of gas. (Abstract.) Paper read before Inst. of Metals.

FUELS

Economy. A Few Notes on the Fuel Economy Institute (Eenige korte medeelingen over het Instituut voor Brandstoffeneconomie), F. C. J. M. Wirtz. Ingenieur, vol. 36, no. 46, Nov. 12, 1921, pp. 905–907. Reviews similar organizations in other countries and describes scope of Dutch Institute.

Research. Fuel Research Developments, C. F. Kettering. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 291–296 and 343–344, 15 figs. Discusses multi-cylinder distribution and chemical constitution of mixtures, anti-knock substances, ignition point, future fuel research, etc.

Sawdust. Sawdust Burned with Aid of Steam Jets. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 914–917, 3 figs. Large industrial plant at Cleveland, Ohio, burns both sawdust and coal under same boilers. Automatic control speeds up stokers when sawdust supply becomes low.

Smokeless. Low Temperature Carbonisation. Eng. & Indus. Management, vol. 6, no. 16, Oct. 20, 1921, p. 445. Describes new retorts patented by Low Temperature Carbonisation, Ltd., Baruch, England, by means of which, it is claimed, production of smokeless fuel, "coalite," together with all valuable by-products, is now a commercial proposition.

[See also PULVERIZED COAL.]

FURNACES, BOILER

Gas-Fired. The Continuous Thermotechnical Control of Gas Firings in Metallurgical Plants (Die fortlaufende wärmetechnische Ueberwachung der Gasfeuerungen in Hüttenbetrieben), Hermann Wolf. Stahl u. Eisen, vol. 41, no. 45, Nov. 10, 1921, pp. 1611–1614, 5 figs. Details of two measuring houses and equipment, one, for continuous control of boiler plant and the other for control of blast supply.

Heat Conservation. Thermotechnology of Boiler Furnaces (Wärmetechnisches von Dampfkesselfeuerungen), H. Schulte. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 40, Oct. 7, 1921, pp. 319–324, 4 figs. Deals with use of low-grade fuels; mechanical draft; furnace losses; mechanical stokers; traveling grates, etc.

Lining. Lining Fire Boxes With Refractory Brick (Revestimiento de hogares con ladrillos refractarios), James F. Hobart. Ingenieria Internacional, vol. 6, no. 6, Dec. 1921, pp. 354–356, 4 figs. Discusses lining of various kinds of boiler furnaces.

Turbine Patent. The Turbine Patent Furnace. Eng. Production, vol. 3, no. 60, Nov. 24, 1921, pp. 489–490, 4 figs. Details of forced-draft unit for boilers.

Wood-Waste-Fired. Novel Boiler Installation for Burning Wood Refuse, C. W. Smith. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1196–1197, 5 figs. Gases from separate Dutch oven furnace are conducted through tunnel to stoker furnace and boiler.

FURNACES, HEATING

Automatic Grates. Automatic Grates and Their Application in High-Temperature Combustion Chambers (Les grilles automatiques dans leurs applications aux chambres de combustion a haute température), F. Verdeaux. La Techoique Moderne, vol. 13, no. 10, Oct. 1921, pp. 414–417, 3 figs. Discusses heating furnaces in particular; relation between temperature at fire bridge and fuel consumption; operations at high temperatures.

FURNACES, HEAT-TREATING

Springs. Furnaces for Heat Treatment of Springs. Forging & Heat Treating, vol. 7, no. 11, Nov. 1921, pp. 568–572, 18 figs. Stationary and continuous furnaces; types and arrangement.

FURNACES, HOT-AIR

Testing. Air Measurement in Furnace Testing, A. C. Willard, A. P. Kratz and V. S. Day. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 8, Nov. 1921, pp. 797–812, 11 figs. Describes air-weighing plant for calibration purposes, and the Wahlen gage for measuring small air pressures.

FUSION WELDING

Steel. The Fusion Welding of Steel, S. W. Miller. Iron Trade Rev., vol. 69, nos. 21 and 22, Nov. 24 and Dec. 1, 1921, pp. 1316–1319 and 1422–1426, 17 figs. Advantages and limitations of oxy-acetylene, electric and thermit processes. Low-carbon steel best adapted to welding. (Abstract.) Paper presented at Am. Iron & Steel Inst.

G

GAGES

Circular, Allowances with. Compound Allowance Systems and the Economical Selection of Gages with Circular Allowances (Verbundpassungssysteme und wirtschaftliche Lehrenauswahl bei Rundpassungen), K. Gottwein. Werkstattstechnik, vol. 15, no. 19, Oct. 1, 1921, pp. 579–581, 21 figs. Discusses general properties of compound systems which, with comparatively few gage classes, attain many classes of fits.

Go and Not-Go. The Need of Gauging for Modern Manufacturing, A. C. Wickman. Can. Machy., vol. 26, no. 17, Oct. 27, 1921, pp. 33–36, 3 figs. Discusses limits in the tapped hole, go and not-go gages, limit of microscopic magnification.

GAS ENGINES

Manufacture. Famous British Works. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, pp. 434–435, 4 figs. Describes works of the Campbell Gas Engine Co., Ltd., Kingston, Halifax.

Schneider. Notes on the Schneider Gas Engine, H. A. A. Dombrain. Electrician, vol. 87, no. 2270, Nov. 18, 1921, pp. 643–646, 4 figs. Made in four types, viz., single cylinder, twin single cylinder, tandem, and twin tandem, the last giving as high as 6,000 hp. They are all horizontal and four stroke.

Wood-Refuse Suction. 400-Hp. Wood Refuse Suction Gas Engine. Engineer, vol. 132, no. 3438, Nov. 18, 1921, p. 547, 4 figs. partly on p. 540. Details of engine to work on gas derived from producer fired with wood refuse. It has four cylinders, each 17-in. diam. by 24-in. stroke.

GAS PRODUCERS

Calculations of Gas in. Calculations Regarding Gas in Gas Generator With Steam Added to Air Blowing (Calculs comparatifs au sujet des gaz de gazogène, dans le cas d'addition de vapeur d'eau a l'air soufflé), J. Seigle. Révue de Métallurgie, vol. 18, no. 9, Sept. 1921, pp. 608–618, 7 figs. Discusses calorific power per cubic meter, calorific power of the volume of gas from 1 kg. of coal, etc.

Central. Ten Years' Experience with Central Producer Plant in the Municipal Gas Works of Vienna (10 Jahre Zentralgeneratorenbetrieb in den Wiener städtischen Gaswerken), Ernst Kaudela and Josef Pretsch. Gas- u. Wasserfach, vol. 64, no. 37, Sept. 10, 1921, pp. 601–606, 3 figs. Advantages of central producers are summarized.

Ebelmen. The Fused Ash Gas Producer (Le gazogène à fusion des cendres), A. Fichet. Le Génie Civil, vol. 79, no. 16, Oct. 15, 1921, pp. 329–332, 2 figs. Describes Ebelmen system principally, also the Rehmann system.

Lignite Briquets for. Using Lignite Briquettes in Gas Generators (Essais d'utilisation de briquettes de lignite pour le chauffage de fours à gazogène), De Groote. Chaleur et Industrie, vol. 2, no. 18, Oct. 1921, pp. 661–666. Describes favorable experiments with a battery of three Morgan generators; composition of briquettes used, heat balance, ash, composition of gas, etc.

Pulverized-Coal. Producers for Pulverized Coal (Kohlenstaubvergaser), H. Gwosdz. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 38, Sept. 23, 1921, pp. 297–299, 2 figs. Discussion of Marconnet and Hirt types and possibilities of improvements.

GEARS

Helical. Cutting Helical Gears on Automatic Machine, H. A. Wilson. Can. Machy., vol. 26, no. 19, Nov. 10, 1921, pp. 29–33, 13 figs. Various operations on automatics, including making of stud; dust cap cutting helical gears; chart showing tools used; machine equipped with rear end threading attachment.

Herringbone. Double Helical or Herringbone Gears, Howard H. Talbot. Iron Age, vol. 108, nos. 23 and 24, Dec. 8 and 15, 1921, pp. 1469–1473 and 1531–1533, 17 figs. Dec. 8: Elements of design to combine adequate strength with smooth and continuous action and minimum of friction of contact surfaces. Dec. 15: Use of long addenda in pinion and short addenda in driven gear, to increase the "follow through."

Maag. Maag Gearing, L. J. Le Mesurier. Engineering, vol. 112, no. 2919, Dec. 9, 1921, pp. 801–805, 20 figs. Describes system of gearing and methods of production developed by Maag Gear Co., Zurich, Switzerland, with which means have been found which enable straight-tooth spur gears to be employed successfully under conditions demanding highest possible peripheral speeds and loads per unit width of tooth. Describes entirely novel grinding process. (Abstract.) Paper read before North-East Coast Instn. Engrs. & Shipbuilders.

GRINDING

Milling vs. Milling Versus Grinding (Fräsen oder

Schleifen-), Carl Krug. Werkstattstechnik, vol. 15, no. 19, Oct. 1, 1921, pp. 575–576. Presents table showing relative working conditions with milling and grinding machines, showing economy of latter.

Steel Billet. Modern Method of Steel Billet Grinding, R. H. Cannon. Forging & Heat Treating, vol. 7, no. 11, Nov. 1921, pp. 557–559, 3 figs. Advantages of grinding over chipping in relation to wheel cost, labor cost and overhead. Making grinding wheel test

H

HANDLING MATERIALS

Factories. An Organized Transportation Department, John A. MacCrea. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 327–329, 4 figs. Describes briefly organization and principal features of operation of department for moving of material.

Trucks as Conveyors. Making the Truck an Asset in Management, Edward H. Tingley. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 267–271, 9 figs. How special types may be used to save floor space, provide effective storage and minimize moving time between operations.

Waste Elimination. Material Handling an Important Factor in the Elimination of Industrial Waste, H. V. Coes. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 803–804 and 825. Points out opportunities in almost every branch of industry to reduce large wastes in material handling. Examples of savings effected, and how to arrive at best method.

HANGARS

German Airship. Large German Airship Stations, J. Sabatier. Aerial Age Weekly, vol. 14, no. 6, Oct. 17, 1921, pp. 128–130. Discusses general plans, construction details, hangar accessories, maneuvering fields, hydrogen works, etc. Translated from L'Aeronautique.

HARDNESS

Measurement of Steel Balls. Schleroscope Hardness of Steel Balls, Arthur L. Collins. Iron Age, vol. 108, no. 22, Dec. 1, 1921, pp. 1391–1393, 5 figs. Widely varying results on different sizes. Explanation of cause and suggested remedy.

Testing. The Hardness Testing of Metals. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, pp. 436–440, 11 figs. Discussion of modern methods. (Abstract). Progress report of Committee of Eng. Div. of U. S. Nat. Research Council.

The Use of the Scleroscope on Light Specimens of Metals, Fred S. Tritton. Metal Industry (Lond.), vol. 19, no. 19, Nov. 4, 1921, pp. 361–364, 4 figs. Describes experiments undertaken to find out whether errors existed when using ordinary methods of support, and, if so, to find some method of support that would eliminate them.

HEAT TRANSMISSION

Air Spaces. Air Space Transmission, Percy Nicholls. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 8, Nov. 1921, pp. 783–790, 3 figs. Includes abstract of paper by H. C. Dickinson and M. S. Van Dusen on the testing of thermal insulators, and presents table prepared by Bur. of Standards, separating values for radiation and convection.

HEATING, ELECTRIC

Development, Switzerland. The Development of Electric Heating in Switzerland (Die Entwicklung der elektrischen Heizung in der Schweiz). Gesundheits-Ingenieur, special no., July 1921, pp. 18–27, 15 figs. Describes arrangements developed by Sulzer Bros., Winterthur, Switzerland, in reconstruction of existing hot-water installations, steam and hot-water central-heating plants for use of electricity.

Hot-Water. The Electric Pumping Hot-Water Heating System in the Repair Shop for Electric Locomotives of the Swiss Federal Railway in Bellinzona (Die elektrische Pumpen-Warmwasserheizung in der Reparaturwerkstätte fur elektrische Lokomotiven der Schweiz. Bundesbahnen, in Bellinzona). Schweiz. Elektrotechnischer Verein Bul., vol. 12, no. 10, Oct. 1921, pp. 270–274, 4 figs. Describes electric heating installation believed to be largest of its kind.

HEATING, FACTORY

Ventilation and. Heating and Ventilation of Factories, H. H. Angus. Contract Rec., vol. 35, no. 50, Dec. 14, 1921, pp. 1085–1088. General outline of principles involved and methods adopted to maintain satisfactory working temperatures and atmospheric conditions. Paper before Toronto Branch Am.Soc.Mech.Engrs.

HEATING, STEAM

Central-Station. The Economy of Large Central Heating Plants (Ueber die Wirtschaftlichkeit grosser Fernheizungsanlagen). Gesundheits-Ingenieur, special no., July 1921, pp. 27–32, 8 figs. Based on operating results in two Westphalian provincial sanitariums.

HELIUM

Airships. Helium for Airships. Aviation, vol. 11, no. 22, Nov. 28, 1921, p. 635. Discusses available supply, cost of production, repurification plant, etc.

HYDRAULIC TURBINES

Breakdown. Investigation of Breakdown of 30,000-Kw. Turbine. Power, vol. 54, no. 21, Nov. 22, 1921, pp. 788–793, 13 figs. Account of accident in Schuylkill plant of Philadelphia Elec. Co. and conclusions from investigation. Points out that abrupt changes of section and formation of sharp angles in design of bucket wheels should be avoided.

Design. Certain Features Relating to Hydraulic Turbine Design and Settings, E. W. Burbank. Proc. La. Eng. Soc., vol. 7, no. 4, Aug. 1921, pp. 150–173, 8 figs. Discusses formulas and terms used, reaction and impulse types of turbines and their operation.

Efficiency. Influence of Turbine Efficiency on Yield of Hydroelectric Plants (Einfluss des Turbinen-Wirkungsgrades auf den Ertrag von Wasserkraftanlagen), H. Leiner. Elektrotechnische Zeit., vol. 42, no. 39, Sept. 29, 1921, pp. 1089–1093. Equations are developed for determination of efficiency of turbines from economical and technical viewpoint.

Impulse. Largest Impulse Turbine Units in Caribou Station, W. M. White. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 923–926, 7 figs. Two of largest impulse-wheel-driven units in world, rated at 30,000 hp. each and operating under 1008-ft. heat at 171 r.p.m. have been installed. Unit consists of two independent wheels, one on either side of generator.

Sand-Removing Plant. Wear in Hydraulic Turbines and How to Avoid It (L'usure des turbines hydrauliques, ses consequences et les moyens d'y parer), H. Dufour. Bulletin Technique de la Suisse Romande, vol. 47, no. 22, Oct. 29, 1921, pp. 253–256, 6 figs. Describes sand-removing plant at Monthey works of Societé pour l'Industrie Chimique à Bâle.

HYDROELECTRIC DEVELOPMENTS

Dutch East Indies. Water Power Construction Work and Prospects in the Dutch East Indies (Verrichtingen en verwachtingen op waterkrachtgebied in Ned.-Indië), A. Groothoff. Ingenieur, vol. 36, no. 48, Nov. 26, 1921, pp. 945–953, 17 figs. Discusses resources and plants in Java, Sumatra, Borneo and Celebes.

Queenston-Chippawa. The Chippawa-Queenston Power Canal. Can. Engr., vol. 41, no. 23, Dec. 8, 1921, pp. 1 and 10, 6 figs. Big Ontario power development practically completed. Canal is 12$^1/_2$ mi. long with max. depth of 145 ft.; available gross head, 315 ft.; width of concrete section, 48 ft.; depth of water, 35–40 ft.; total earth excavation, 13,299,000 cu. yd.; total rock excavation, 4,182,000 cu. yd.; max. capacity of each turbine, 60,000 hp.; total weight of each complete generating unit, 1,853,000 lb.

St. Lawrence River. Hydro Report on St. Lawrence River. Can. Engr., vol. 41, nos. 21, 22, 23 and 24, Nov. 24, Dec. 1, 8 and 15, 1921, pp. 1, 4–5; pp. 1,4, 5, 9 and 10, 5 figs.; pp. 4–5; and 9–10. Suggests three alternative schemes for power development and gives cost of each. Study of physical conditions. Ontario Hydroelectric Commission's engineering report to Int. Joint Commission.

The St. Lawrence Power Development. Can. Engr., vol. 41, no. 22, Dec. 1, 1921, pp. 1, 10, 11 and 12, 4 figs. Salient features of report by Hugh L. Cooper to Int. Joint Commission on navigation and power in St. Lawrence River. Recommends Croil Island as site for main dam and power plant.

Seattle, Wash. Progress on the Skagit River Power Project. Eng. News-Rec., vol. 87, no. 23, Dec. 8, 1921, pp. 948–949, 3 figs. 23-mi. railroad and construction power plant completed in Seattle. Work on 2-mi. main tunnel is under way.

World. Hydro-Electric Developments—II and III, F. Rowlinson. Beama, vol. 9, nos. 4 and 5, Oct. and Nov. 1921, pp. 351–359 and 451–458, 3 figs. Oct.: Discusses undertakings in Scandinavia, Canada, Australia, India, Switzerland, Spain, Italy, etc. Nov.: Developments in Austria, United States, Sweden and Formosa.

HYDROELECTRIC PLANTS

Lausanne, Switzerland. Electric Plants of the Town of Lausanne (Les installations électriques de la ville de Lausanne), M. Cauderay. Bulletin Technique de la Suisse Romande, vol. 47, nos. 19 and 21, Sept. 17 and Oct. 15, 1921, pp. 217–223 and 241–248, 16 figs. Describes reservoirs, conduits, canals, turbines, electrical installations, etc., in connection with hydroelectric plant and its enlargement.

220,000-Volt. First 220,000-Volt Station Completed. Elec. World, vol. 78, no. 23, Dec. 3, 1921, pp. 1115–1119, 12 figs. Describes Big Creek No. 8 Station built by Southern Cal. Edison Co.; has 22,500 kw. vertical reaction turbine; lines are operated at 150,000 volts and will be at 220,000 volts ultimately.

I

INDUSTRIAL MANAGEMENT

Assembling Methods. Saving Time in Assembling, Albert A. Dowd and Frank W. Curtis. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 296–300, 6 figs. Examples showing savings resulting from investigation of assembling methods.

Executive Control Charts. Comparability of Executive Control Charts, Arthur R. Burnet. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 283–288, 7 figs. Fundamental requirement of the "Z" chart and how it may be secured.

Factory Investigations. How Factory Investigations Reduce Costs. Machinery (Lond.), vol. 19, no. 476, Nov. 10, 1921, pp. 149–154, 7 figs. Discusses handling of materials, inspection and salvage, manufacturing a fly-wheel pulley, savings effected by use of punch press, etc.

Financial Control. The Parallel Line of Control in Business, Frederic H. Leland. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 348–350, 1 fig. Points out that there are two scales of parallel lines of business control, a major scale, which shows correctly amount of money involved in principal activities of business; and minor scale which shows money involved in greater detail than is shown on major scale.

Financial Leaks. Seven Leaks We Have Stopped, A. H. Cubberley. Factory, vol. 27, no. 6, Dec. 1921, pp. 743–747, 2 figs. Analysis of principal financial leaks and how to stop them. Practice at E. I. du Pont de Nemours Co. works.

Future of. Scientific Management—XXXIII, Henry Atkinson. Eng. & Indus. Management, vol. 6, no. 19, Nov. 10, 1921, pp. 529–531. Future of scientific management. (Concluded.)

Gantt Charts. The Gantt Chart—IV, Wallace Clark. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 279–282, 3 figs. Its application to plant load.

Improved Methods. Exhibit by the Siemens-Schuckert Works of Practical Examples of Scientific Management (Die Siemens-Schuckertwerke auf der Betriebstechnischen Wanderausstellung), C. W. Drescher. Betrieb, vol. 4, nos. 1 and 2, Oct. 8 and 22, 1921, pp. 1–9 and 11–14, 16 figs. Examples of improvements of working methods by use of up-to-date tools, time and motion studies, standards for cutting tools, toolroom organization, comparison of separate and belt electric drive. Psychotechnical adaptability tests.

Managers, Training. What Constitutes a Good Manager?, N. H. Daniels. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 329–332. How a large engineering firm trains men to deal successfully with public.

Measuring Effectiveness. Measuring the Effectiveness of Management, William B. Ferguson. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 335–340, 1 fig. Study of proportions management resources as: Organization 35 per cent, technical 20 per cent, utilization 45 per cent.

Planning Department. Fundamental Principles for Modern Workshop Precalculation (Unterlagen für moderne Werkstattvorkalkulation), R. Wiekop. Betrieb, vol. 4, no. 2, Oct. 22, 1921, pp. 29–39, 11 figs. Practical recommendations for job analysis. A new premium system.

Planning in Large Contract Plants, George H. Shepard. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 268–270, 1 fig. Organization of department for planning progress of work through shop.

Production Control. Humanizing Production Control, Howell B. May. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 341–344. How new spirit of team-work in industry is being put in practice. Explains idea of coöperative inter-relationship in factory for purpose of educating foremen and workers and giving ambitious ones an opportunity to advance.

Production, Fluctuation in. Applying "Moving Average" Charts to Industry, A. L. DeLeeuw. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 343–348, 9 figs. Discusses fluctuation in production and how it is reduced.

Production Methods. Modern Production Methods—XXIV, W. R. Basset. Am. Mach., vol. 69, no. 23, Dec. 8, 1921, pp. 950–955, 7 figs. Setting piece rates. Points out that incentive factor is as important as securing results for wage given. Examples of rate derivation. Why piece rates should not be cut.

Productive Ways and Means, H. Darbyshire. Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 618–621, 4 figs. Writer deals with number of essential details with which management and supervising staff of any industrial organization should become familiar.

Progress Department. Estimating and Handling Output of "Modifications." Eng. & Indus. Management, vol. 6, no. 21, Nov. 24, 1921, pp. 601–603. Describes progress organization of factory, where, although lines are standardized and produced upon more or less repetition basis, these lines may be modified time and again to meet specific requirements of customers.

Record Sheets. Systematizing and Control of Workshop Jobs (Systematisierung und zwangläufige Kontrolle von Werkstatt-Aufträgen), Carl Redtmann. Der praktische Maschinen-Konstrukteur, vol. 54, no. 36, Sept. 8, 1921, pp. 289–292, 8 figs. Describes record sheet system for carrying out workshop jobs used successfully in machine factory employing 400 to 500 workers.

Workpiece Record Cards (Die Operationslaufkarte), A. Roth. Betrieb, vol. 4, no. 2, Oct. 22, 1921, pp. 44–48, 9 figs. Discusses use of record sheets in machine construction on which all necessary operating data are recorded and which accompany workpiece through all operating stages until delivery into storkroom.

Records for Electrical Department. Efficient Record System for Industrial Electrical Department, J. Elmer Housley. Elec. World, vol. 78, no. 21, Nov. 19, 1921, pp. 1015–1018, 1 fig. Gives forms for motors, lamps, trucks, etc., and describes how to use them.

Simplification. Why We Invested $7,000,000 in "Simplification," Harvey S. Firestone. Factory, vol. 27, no. 6, Dec. 1921, pp. 739–743, 8 figs. Describes policy, developed into specific plan, which has eliminated manufacturing wastes, cut labor costs 20 per cent, and improved quality of product.

Storing Materials. Management Problems of the Small Factory, Ernest Cordeal. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 334–340, 7 figs. How materials are effectively handled and stored.

Toolroom Organization. Organising Tool Production. Eng. Production, vol. 3, no. 59, Nov. 17, 1921-

pp. 462–466, 13 figs. Procedure in the works drawing office and toolroom.

[See also TIME STUDY.]

INDUSTRIAL ORGANIZATION

Engineering Department. Organization of an Engineering Department. W. E. Irish. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 357–361, 1 fig. Author shows plan of organization found suitable to requirements of large steel company and gives account of its working.

Knitting Mills. The Organisation of Knitting Mills, Carle M. Bigelow. Management Eng., vol. 1, nos. 5 and 6, Nov. and Dec. 1921, pp. 261–265, 7 figs. and pp. 359–364, 6 figs. Nov.: Standardizing physical conditions. Deals with plant layout and routing. Dec.: Standardizing control of material.

INDUSTRIAL RELATIONS

Construction Industries. Development of Satisfactory Relationship Between Employer and Employe in Construction Industry, Ernst T. Trigg. Eng. & Contracting, vol. 56, no. 21, Nov. 23, 1921, pp. 479–481. (Abstract.) Paper presented before joint meeting of Acad. Political Sci. and Am. Indus. Relations Assn. See also Contract Record, vol. 35, no. 47, Nov. 23, 1921, pp. 1021–1023.

Human Factor. The Human Factor in Industry—III, Clarence H. Northcott. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 363–369. Deals with psychology, instincts and tendencies of worker.

Open-Shop Foundry. The Transition to an Open-Shop Foundry, Paul R. Ramp. Iron Age, vol. 108, no. 22, Dec. 1, 1921, pp. 1395–1398. Methods used with success in training molding-machine workers, with view to increased output.

Training Executives. Training the Industrial Relations Executive, Edward S. Cowdrick. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 329–330. Notes on college courses in industrial relations.

Works Council. Industrial Democracy in Great Britain, Clarence H. Northcott. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 295–297. Deals with establishment of a works council; qualifications for membership and voting, and how council is organized.

INSPECTION

Systems. Inspectors' Reports, Examples and Methods. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 570–573. Discussion of certain systems of inspection, with view to demonstrating their efficiency under given conditions.

INTERNAL-COMBUSTION ENGINES

Marine. Internal Combustion Engines in Marine Service—II, Charles Edward Lucke. Jl. Am. Soc. Mar. Draftsmen, vol. 8, no. 3, Oct. 1921, pp. 47–57, 10 figs. Compares new standards of turbine steamer and motorship machinery. Paper read before Franklin Inst.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; OIL ENGINES, SEMI-DIESEL ENGINES.]

IRON

Electrodeposition of. The Industrial Future of Electro-Deposited Iron, W. E. Hughes. Chem. Age (Lond.), vol. 5, no. 124, Oct. 29, 1921, pp. 521–523, 4 figs. Discusses results of research work and microscopic examination of structure of deposited iron. Sees good future for its application.

Electrolytic. Commercial Production of Electrolytic Iron, C. P. Perin and Donald Belcher. Min. & Metallurgy, no. 180, Dec. 1921, pp. 17–18, 2 figs. Describes French process consisting of electrolyzing a concentrated solution of ferrous chloride at temperature of 75 deg. cent. Anodes are of cast iron, cathode is a rotating mandrel of steel. With this process tubes and sheets of any desired gage can be made.

IRON AND STEEL

Chemical Industries, Relations to. Relations of the Iron and Steel and Chemical Industries, James M. Camp. Iron Age, vol. 108, no. 21, Nov. 24, 1921, pp. 1329–1331, 1 fig. Notes on chemicals consumed by steel makers; steel used by chemical plants; role of by-products from coke. Paper read before Am. Iron & Steel Inst.

Sweden. The Swedish Iron and Steel Industry. Raw Material, vol. 4, no. 10, Oct. 1921, pp. 344–348, 8 figs. Historical review of its development.

IRON, PIG

Calculating Foundry Value of. Calculating a Foundry Iron Value, Y. A. Dyer. Iron Age, vol. 108, no. 24, Dec. 15, 1921, pp. 1547–1548. Unit valuation of elements in foundry pig irons. Silicon, manganese and phosphorus considered as metalloids. Carbon and sulphur grouped as Fe.

L

LABOR

Classes to be Avoided. Three Classes of Labor to Avoid, H. A. Haring. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 370–373. Discusses prejudices and habits displayed by men in certain occupations, and describes effects of certain classes of employment upon individual's fitness for modern industrial work.

LATHE TOOLS

Automobile Forgings. Cost-reducing Tooling Equipments, Ralph E. Flanders. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 301–305, 13 figs. Employed for machining steering knuckles and other automobile forgings at high rate of production.

LATHES

Automatic. The Pratt & Whitney Automatic Lathe. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 282–284, 6 figs. Equipped with headstock, tailstock, magazine for holding work, and automatic work-handling and control mechanism.

Automobile Work on Turret. Automobile Production Work on Turret Lathes, Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 261–264, 7 figs. Time-saving and cost-reducing methods developed for use in engine department of motor car plant.

Large. The Evolution of the Large Lathe. British Machine Tool Eng., vol. 1, no. 12, Nov.-Dec. 1921, pp. 413–419, 9 figs. Discusses development of T. Shanks & Co.'s type of lathes to the present 123-in. center double-bed type, which swings 18 ft. 6 in. diameter over saddles.

Turret. "Apollo" $2^{3}/_{4}$ In. Hollow Spindle Turret Lathe. Engineering, vol. 112, no. 2918, Dec. 2, 1921, pp. 758–759, 29 figs. partly on supp. plate. Details of new model of hollow-spindle or bar lathe brought out by Pollock & Macnab, Ltd., having a hollow spindle, $3^{1}/_{8}$ in. in internal diam., intended for work $2^{3}/_{4}$ in. in diam. and up to 36 in. in length. Heating of centers is $9^{1}/_{2}$ in. and length of bed 8 ft. 9 in.

LIGHTING

Industrial. Good Lighting Increases Production, J. M. Hickerson. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 325–328, 2 figs. Summary of major facts brought out by survey of industrial lighting conditions.

Illuminating Engineering: The Future Field, J. H. Asdell. Eng. & Indus. Management, vol. 6, no. 16, Oct. 20, 1921, pp. 441–444. Practical notes on planning an efficient scheme of lighting for industrial purposes, together with simple formula for calculation of illumination in general practice.

Metal-Working Plants. Lighting Metal-Working Plants to Increase Production, A. L. Powell. Elec. World, vol. 78, no. 22, Nov. 26, 1921, pp. 1069–1072, 7 figs. Proper intensities, spacings and fixtures for benches, machine tools, sheet-metal work, assembling, painting, etc.; general or "localized-general" system of illumination is satisfactory in most cases.

LIQUIDS

Combustible, Atomizers for. Atomizers for Combustible Liquids (Sui polverizzatori del combustibile liquido). L'Industria, vol. 35, no. 17, Sept. 15, 1921, pp. 389–390, 6 figs. Describes apparatus with four orifices; gives table of pressures and oil atomized.

LOCOMOTIVES

Air Tanks. Fabricating Tanks From Heavy Plate, C. E. Lester. Boiler Maker, vol. 21, no. 11, Nov. 1921, pp. 313–315, 2 figs. Air locomotive tanks built for 800 lb. pressure fitted with special heads.

Belgian. Belgian State Railway Locomotives Type 33 (Locomotives type 33 etat Belge), O. Lepersonne. Révue Universelle des Mines, vol. 11, no. 2, Oct. 15, 1921, pp. 176–181, 3 figs. A compound, four-cylinder, superheater, 2–6–2 locomotive; tractive effort 12,500 kg. Data and description.

Caledonian Railway. Recent Locomotive Practice on the Caledonian Railway, E. C. Poultney. Engineer, vol. 132, nos. 3436 and 3437, Nov. 4, and 11, 1921, pp. 474–476, and 499–500, 9 figs. partly on supp. plate and p. 501. Describes four new classes of locomotives, comprising engines for passenger and goods traffic as follows: Passenger service—outside-cylinder six-coupled, 4–6–0 type; inside-cylinder four-coupled, 4–4–0 type; outside-cylinder six-coupled side-tank engines, 4–6–2 type. Goods service—inside-cylinder six-coupled, 0–6–0 type.

Feedwater Heating. Feedwater Heaters for Locomotives (Speisewasservorwärmer), H. Gunther. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 47, Nov. 19, 1921, pp. 1205–1209, 12 figs. Describes heaters with special closing of headers for high water velocities and a live by-pass valve for prevention of cold feeding. Operating experiences with scale formation and elimination. Experimental results with new, cleaned and heavily incrusted heaters.

Feedwater Treatment. Water Treatment From an Investment Standpoint, L. F. Wilson. Ry. Rev., vol. 69, no. 19, Nov. 5, 1921, pp. 602–604. Discusses external and internal treatment of locomotive feedwater.

Fuel Consumption. The Effect of Grade on Locomotive Coal Consumption, George S. Chiles. Ry. Rev., vol. 69, no. 22, Nov. 26, 1921, pp. 715–719, 2 figs. Actual operation of modern equipment illustrates influence of ascending and descending grades.

Hornblocks, Machining. Machining Locomotive Hornblocks. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, p. 451, 4 figs. Describes operation on horizontal milling machine.

Missouri Pacific R. R. New Mountain, Pacific and Switching Locomotives for the Missouri Pacific Railroad. Ry. & Locomotive Eng., vol. 34, no. 9, Sept. 1921, pp. 242–244, 3 figs. Built by American Locomotive Co. 0–6–0 type switching engines: tractive power, simple, 39,100 lb.; working pressure 100 lb. 4–8–2 mountain type engines: tractive power, simple, 53,500 lb.; working pressure, 210 lb. 4–6–2 Pacific type engines: tractive power, simple, 39,500 lb.; working pressure, 193 lb.

Modern Design. Modern Locomotive Engine Design and Construction—LXXV. Ry. Engr., vol. 42, no. 502, Nov. 1921, pp. 421–424 and 439, 3 figs. Discusses coupling-rod design and construction, coupling-rod stresses, etc.

Oil-Burning. The Lentz Hydraulic Drive for Heavy-Oil Locomotives (Das Flussigkeitsgetriebe von Lentz für Schwerölllokomotiven), H. Wittfeld. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 45, Nov. 5, 1921, pp. 1160–1163, 4 figs. Discusses efforts heretofore made for rendering internal-combustion engines for heavy oil feasible for locomotive drive with aid of the Lentz hydraulic drive; and gives operating results with trial of first heavy-oil locomotive with such drive.

Steam Production and Use. On the Question of Economic Production and Use of Steam on Locomotives, G. J. Churchward. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1527–1538, 1 fig. Abstract of replies to questions on superheated steam, superheater engines and non-superheater engines, feedwater treating, and special arrangements, water-tube boilers, etc. Appendix describing Riegel water-tube locomotive boiler.

Steam-Turbine. An Early Steam Turbine Locomotive. Engineering, vol. 112, no. 2917, Nov. 25, 1921, p. 728, 4 figs. on p. 730. Details of Belluzzo steam-turbine locomotive constructed in 1908 by Societa Anonima Officine Meccaniche, Milan, and recently dismantled.

The Zoelly Steam-Turbine Locomotives with Use of Condensation (Zoelly-Dampfturbinen-Lokomotive mit Kondensation). Glasers Annalen, vol. 89, no. 8, Oct. 15, 1921, pp. 88–89, 2 figs. Describes steam piston locomotive built for Swiss Federal Railway. In front of smokebox two enclosed turbines are installed, one for running forward and the other for running backward. Advantages: Saving of at least 20 per cent of coal; elimination of scale formation through use of condensed feedwater, thus considerably increasing life of boiler and reducing cost of operation; insensibility of steam turbine to highly superheated steam.

Stoker-Fired. The Locomotive Stoker As An Operating Factor, Frank P. Roesch. Ry. Rev., vol. 69, no. 21, Nov. 19, 1921, pp. 685–687. How stoker-fired locomotives can be operated to obtain maximum operating efficiency with minimum expense.

Performance of the Hanna Locomotive Stoker on the Norfolk & Western Railway. Ry. & Locomotive Eng., vol. 34, no. 11, Nov. 1921, pp. 308–310, 1 fig. Describes special trial trips showing efficiency of this stoker. Particulars of firebox conditions, etc.

Superheater. Superheater Practice in American Locomotives. Boiler Maker, vol. 21, no. 11, Nov. 1921, pp. 301–305, 12 figs. Describes most successful methods developed for handling superheater work by railroads.

Transportation without Dismantling. Locomotives for Belgian State Railways. Ry. Gaz., vol. 35, no. 19, Nov. 4, 1921, pp. 690 and 697, 5 figs. partly on pp. 691–692. Describes arrangements by Armstrong, Whitworth & Co. for delivering locomotives to Belgium without dismantling for transport.

Trucks. On the Question of Bogies (Trucks), Axle and Springs of Locomotives, George Hughes. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1589–1674, 84 figs. Includes appendixes containing tabular statements on kinds of bogies used by various companies, method of fixing springs for driving and coupled wheels, springing, cylinders, heating surfaces and particulars of two-wheel trucks.

2-8-2 Mikado. 2–8–2 Type Locomotives for the Nickel Plate. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921, pp. 737–738, 4 figs. Design based on U.S.R.A. light Mikado with improvements in details. Booster handles 22 per cent additional tonnage.

2-10-2 and Pacific Types. American Locomotives for the Philippines. Ry. Rev., vol. 69, no. 23, Dec. 3, 1921, pp. 756–769, 11 figs. Describes 2–10–2 and Pacific-type locomotives delivered by American Locomotive Co. to Manila Railroad; tractive effort 35,700 and 28,600 lb.

LUBRICATING OILS

Capillary Properties. Testing of Lubricants for Determination of Their Capillary Properties (Zur Schmierölprüfung auf die kapillaren Eigenschaften der Schmiermittel), Richard von Dallwitz-Wegner. Petroleum, vol. 17, nos. 24 and 25, Aug. 20 and Sept. 1, 1921, pp. 849–854 and 885–887, 4 figs. Demonstrates necessity, when testing oils, of investigating their capillary properties and describes apparatus therefor.

Recovery from Anthracite Tar. The Recovery of Viscous Lubricating Oils from Anthracite Tar (Gewinnung viskoser Schmieröle aus Steinkohlenteer), F. Schreiber. Zeit. für angewandte Chemie, vol. 34, no. 65, Aug. 16, pp. 425–426, 3 figs. Describes process of recovery developed and perfected in Germany during recent years, and discusses properties and economic advantages of product known as "Ess" oil, to distinguish it from other tar oils.

Removal from Condensation Water. The Removal of Oil from Water of Condensation Through Electrolysis (Die Entölung von Kondenswässern durch Elektrolyse), Fritz Hoyer. Feuerungstechnik, vol. 10, no. 4, Nov. 15, 1921, pp. 33–34. Describes process and apparatus.

LUBRICATION

Automobile Chassis. Various Methods of Chassis Lubrication, Cornelius T. Myers. Automotive Industries, vol. 45, no. 22, Dec. 1, 1921, pp. 1067–1069. Compares lubricating materials and discusses various methods and devices. Condensed from paper read before Soc. Automotive Engrs.

Prime Movers. The Lubrication of Prime Movers, C. H. Bromley. Mech. World, vol. 70, no. 1821, Nov. 25, 1921, pp. 428–429. Discusses oils for steam turbines, emulsion and sludge, Diesel-engine lubri-

cation, etc. (Abstract). Paper read before System Operators' Assn.

LUMBER

Care in Storage. The Care and Protection of Lumber in Storage, H. A. Sackett. Ry. Age, vol. 71, no. 24, Dec. 10, 1921, pp. 1133–1136, 9 figs. Sanitary precautions to prevent decay; building of piles; and protection against fire.

M

MAGNESIUM ALLOYS

Electron Metal. The Magnesium Alloy "Electron," S. Beckinsale. Metal Industry (N. Y.), vol. 19, no. 11, Nov. 1921, p. 433. Gives chemical analysis of three specimens; hardness and compression tests; microscopic examination; machining properties.

MACHINE SHOPS

British. Famous British Works. Eng. Production, vol. 3, no. 59, Nov. 17, 1921, pp. 458–460, 7 figs. Works of Ruston & Hornsby, Ltd., Lincoln, known as Sheaf Iron Works, Wood Works, Motor Works, Boiler Works, and Steam Navy Works.

Design. The Design and Construction of Engineering Workshops—XXIV, Ernest G. Beck. Mech. World, vol. 70, no. 1817, Oct. 28, 1921, pp. 342–343, 6 figs. Discusses orientation of roofs; glare, glazing, screening, ventilation, etc. (To be continued).

MACHINE TOOLS

Automatic. Automatic Machine Tools in Relation to Production Problems, Henry Baker. Machinery (Lond.), vol. 19, no. 477, Nov. 17, 1921, pp. 181–185. Application of mathematical methods to tool setting; idle time; stoppages; economy of extra tools or extra machines.

Cooling-Water Pumps for. Cooling-Water Pumps for Machine Tools (Kühlwasserpumpen für Werkzeugmaschinen), Alfred Schacht. Fördertechnik u. Frachtverkehr, vol. 14, no. 21, Oct. 14, 1921, pp. 258–259, 2 figs. Describes motor-driven Elmo machine-tool cooling pumps patented by the Siemens-Schuckert Works, for which both direct and alternating current can be used.

Improving Details. Tool Details that Improve the Finish of Work in a Machine Shop. Eng. & Indus. Management, vol. 6, no. 21, Nov. 24, 1921, pp. 586–589, 12 figs. Gives practical advice on raising standard of quality of work, and details for improving machine tools, together with explanatory diagrams.

Operation Control. Some Notes on the Operating Control of Machine Tools, N. F. Stockbridge. British Machine Tool Eng., vol. 1, no. 12, Nov.-Dec. 1921, pp. 406–412, 11 figs. Discusses the various adjustments of the radial drilling machine up to 4 ft. 6 in. radius.

MALLEABLE CASTINGS

Annealing. Annealing Malleable Cast Iron (Le recuit de la fonte malléable), Christian Kluytmans. La Fonderie Moderne, no. 8, August 1921, pp. 209–218, 2 figs. Shows that on annealing depends the success or failure of malleability, if composition is correct.

MARINE STEAM TURBINES

Drive. Stal's New Marine Turbine Drive (Stal:s nya turbomekaniska fartygsmaskineri), O. A. Wiberg. Teknisk Tidskrift, vol. 51, no. 9, Sept. 28, 1921, pp. 89–95, 10 figs. Describes turbine and propeller arrangements and gives tables showing saving effected.

METAL SPRAYING

Schoop Process. Metal Spraying by the Schoop Process, Sidney Mornington. Compressed Air Mag., vol. 26, no. 11, Nov. 1921, pp. 10293–10295, 5 figs. Promises to be of great industrial value for applying zinc or lead to bridges, pontoons, railway cars, and other equipment exposed to action of the elements or exhaust gases.

METALS

Elasticity. Testing Machine Indicating the Elastic limit and the Modulus of Elasticity of Metals (Machines d'essais, donnant la limite élastique et le module d'élasticité des métaux), R. Guillery. Comptes Rendu des Séances de l'Académie des Sciences, vol. 173, no. 20, Nov 14, 1921, pp. 907–909, 1 fig. Describes new method and apparatus.

Fatigue. An Investigation of the Fatigue of Metals, H. F. Moore and J. B. Kommers. University of Illinois Bul, vol. 19, no 8, Oct 24, 1921, 185 pp., 46 figs. Report of investigation conducted by Engineering Experiment Station in coöperation with Nat. Research Council, Engineering Foundation, and Gen. Elec. Co. Concludes that phenomenon known as fatigue under repeated stress might better be called progressive failure of metals. Most probable explanation seems to be that such failure is progressive spread of microscopic fractures. Bibliography. See also Eng. & Contracting, vol. 56, no. 26, Dec. 28, 1921, pp. 593–596, 5 figs.

Hardening. On the Theory of the Hardening of Metals, Kotaro Honda. Chem. & Met. Eng., vol. 25, no. 22, Nov. 30, 1921, pp. 1001–1003. Thinks that hardness in metals is due in part to forces between atoms and in part to an interlocked, strained crystalline structure.

Light and Extra Light. Light and Extra Light Metals (Les Métaux blancs légers et ultra légers), R. de Fleury. La Fonderie Moderne, no. 10, Oct. 1921, pp. 294–298. Discusses alloys with aluminum or magnesium base, compares light and heavy metals casting of aluminum; treatment of light metals; alloys of aluminum.

MILLING

Problems. Some Miller Problems—How They Were Solved, H. A. Wilson. Can. Machy., vol. 26, no. 20, Nov. 17, 1921, pp. 33–34, 4 figs. Milling steel parts to within limits of .002 in. at the rate of 600 per hour; milling four tables at one time; value of gang milling.

MILLING CUTTERS

Action of. On the Art of Milling, John Airey. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 783–789 and 798, 17 figs. Account of investigation undertaken at University of Michigan for purpose of finding rational basis for action of milling cutter. It is shown that metal is removed more efficiently with thick than with thin chips; thus, under usual conditions, cutter with fewest teeth gives greatest efficiency. Formulas for determining number of teeth for known diameter of cutter and for determining depth are included.

MOLDING METHODS

Jarring Machines. Germans Jar Molds Mechanically, U. Lohse. Foundry, vol. 49, no. 23, Dec. 1, 1921, pp. 934–938, 8 figs. Compares different methods of packing sand in molds; mechanical jarring machines, both with and without shock absorbers are described in detail. (Abstract). Stahl und Eisen, Sept. 1, 1921.

MOTOR-TRUCK TRANSPORTATION

Costs. A Formula Covering Costs of Heavy Motor Trucking, Charles Hine. Ry. Age, vol. 71, no. 22, Nov. 26, 1921, pp. 1045–1046, 1 fig. Shows superiority of time basis over ton-miles or truck-miles for computing expenses.

MOTOR TRUCKS

British Types. Engineering Features of British Truck Models, M. W. Bourdon. Automotive Industries, vol. 45, no. 20, Nov. 17, 1921, pp. 958–963, 14 figs. Describes new design features in the 6-ton Maudslay, 4-ton Dennis, and other trucks.

Electric vs. Gasoline. Electric Vehicle Operation Cheaper than Gasoline Truck, Walter R. Metz. Elec. World, vol. 78, no. 24, Dec. 10, 1921, pp. 1173–1174, 2 figs. Operating costs of electric trucks in government service in Washington, D. C., compared with cost of gasoline trucks under similar conditions; electric trucks superior for city requirements.

Vibration, Reduction of. Reducing Destructive Vibration in Equipment. Elec. Traction, vol. 17, no. 11, Nov. 1921, pp. 805–809, 9 figs. Discusses crystallization and fatigue, experience in motor-truck field, use of ball and roller bearings, cushioning shocks, types of cushion wheels, etc..

N

NICKEL STEEL

Invar. Properties and Uses of Invar Metal (Les propriétes et les applications de l'invar et de l'invar), Ch.-Ed. Guillaume. Bulletin de la Société Industrielle de Mulhouse, vol. 87, no. 6, June-July-August 1921, pp. 291–318, 13 figs. Discusses nickel-steel alloys and their magnetic properties; expansion of invar, which name is derived from "invariable;" also "elinvar" metal, having an invariable modulus of elasticity. Used for watch compensation, etc.

NOZZLES

Measurement of Flow. Use of Nozzles for Measuring Flow, W. Trinks. Power Plant Eng., vol. 25, no. 21, Nov. 1, 1921, pp. 1044–1045, 4 figs. Methods of reducing fluctuations in flow to and from air compressors and steam engines.

O

OIL ENGINES

Function of. Function of the Heavy Oil Engine in Connection with the General Supply of Electricity, Geoffrey Porter. Petroleum World, vol. 13, no. 254, Nov. 1921, pp. 466–470. Discusses fuels available, compares steam and oil engine stations; local versus bulk electricity supply; etc. (Abstract). Paper read before Diesel Engine Users Assn.

Marine. Worthington Airless-Injection Oil-Engine. Motorship, vol. 6, no. 11, Nov. 1921, pp. 872–875, 12 figs. Details of a new marine motor for small commercial vessels developed at Blake Works, East Cambridge; successful tests run on regular steam-boiler fuel oil with low-consumption results.

Two-Cycle. A Two-Cycle Oil Engine. Engineer, vol. 132, no. 3438, Nov. 18, 1921, p. 544, 3 figs. Describes two-stroke hot-bulb type constructed by Marshall, Sons & Co., Ltd., Gainsborough.

OIL FUEL.

Textile Mills. Oil Fuel for Textile Works, J. Veen Stevens. Eng. & Indus. Management, vol. 6, no. 21, Nov. 24, 1921, pp. 597–598. Tests for standardizing quality. Paper read before British Assn. of Mgrs. of Textile Works.

OPEN-HEARTH FURNACES

Coke-Oven Gas in. Using Coke Oven Gas in Martin Furnaces (Utilisation du gaz de fours a coke pour le chauffage des fours Martin), Jean Dupuis. Révue de L'Industrie Minérale, no. 20, Oct. 15, 1921, pp. 627–633. Discusses combustion using rich gas, rich and poor gas without mixing, and rich and poor mixed, and experiments carried out.

Ports, Improving. Improving Ports of Open Hearths, John W. Kagarise. Iron Trade Rev., vol. 69, no. 22, Dec. 1, 1921, pp. 1417–1421 and 1426, 6 figs. Various types of water-cooled ports are described. Using by-product coke-oven gas introduces difficulty. Paper read before Am. Iron & Steel Inst.

Improvements in Open-Hearth Port Construction, John W. Kagarise. Iron Age, vol. 108, no. 21, Nov. 24, 1921, pp. 1324 and 1326–1329. Early types; water-cooled ports; the McKune system and the Venturi and Egler furnaces with some results. Paper read before Am. Iron & Steel Inst.

OXY-ACETYLENE WELDING

Mild Steel. A Survey of Oxyacetylene Welding, Lorn Campbell, Jr. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 320–321 and (discussion) 321–322. Discusses the subject as a factor of efficiency in manufacturing; gives reasons why rivets should be replaced by welds; outlines mild steel welding and describes apparatus.

P

PAINTS

Drying. Artificial versus Natural Means of Drying Paint and Varnish, R. E. Lippert. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 335–340 and (discussion) 340–343, 13 figs. Describes process for drying coats of paint and varnish by adding heat and moisture simultaneously to air surrounding siccative coatings through employment of mechanical devices; also describes several humidifying devices.

PATTERNMAKING

Layout and Equipment. Pattern-making Lay-out and Equipment, James Edgar. Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 624–625. Practical advice covering essential features of organization. Notes on type of vice, position of machines, and sawing machine.

PATTERNS

Storage. The Organization of a Pattern Stores, H. Varley. Eng. & Indus. Management, vol. 6, no. 19, Nov. 1921, pp. 522–525, 10 figs. Describes storage method and manner of running stores which is claimed to be common-sense application of systematic routine reduced to its simplest terms.

PETROLEUM

Refining. Modern Oil Refineries (Moderne oliefabricksinstallatie), F. C. Huygen. Ingenieur, vol. 36, no. 43, Oct. 22, 1921, pp. 842–847, 12 figs. Describes equipment and operations of plant of Atrecht Machine Works, including hydraulic, chemical and electrolytic methods; hydrogenations; etc.

PIGMENTS

Paint and Rubber. A Photomicrographic Method for the Determination of Particle Size of Paint and Rubber Pigments, Henry Green. Jl. Franklin Inst., vol. 192, no. 5, Nov. 1921, pp. 637–666, 13 figs. Describes method of determining "diameter" of paint and rubber pigments, by first taking a photomicrograph of sample, at carefully ascertained magnification, and again enlarging by means of a stereopticon and then measuring particles on projecting screen.

PIPE, CAST-IRON

Centrifugal Casting. Manufacture of Cast Iron Pipe by Centrifugal Methods, F. W. Hudson. Contract Rec., vol. 35, no. 48, Nov. 30, 1921, pp. 1038–1039, 2 figs. Describes the DeLavaud process and machinery. Comparison of centrifugal product with sand-cast pipe.

PIPE, STEEL

Protective Covering. Protective Covering for Steel Pipe, L. M. Klauber. Gas Age-Rec., vol. 48, nos 14 and 15, Oct. 22 and 29, 1921, pp. 478–484 and 514–516, 21 figs. Oct. 22: Describes method of covering pipe for protection in corrosive soils used by San Diego Consolidated Gas & Elec. Co. The clean pipe is dipped into hot asphalt, wrapped with chemically and electrically resistant asbestos felt redipped in asphalt and wrapped spirally with burlap. Oct. 29: Tests with some coverings, materials for wrapping, life of pipe, etc.

PISTONS

Machining Bosses. Machining Piston Bosses. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, p. 450, 3 figs. Describes method for intensive production.

PLANERS

Helical-Geared Drive. The New Gray Planer. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 285–289, 6 figs. Machine with helical-geared table drive, designed to render maximum service under modern requirements.

POWER

Costs. How to Follow Up Power Costs—II, N. A. Craigue. Indus. Management, vol. 62, no 6, Dec. 1921, pp. 354–356, 1 fig. Discusses various methods of distribution, such as by estimated percentages, by metered amounts, and unit cost or cost constant method.

Hydraulic, Storage of. Mechanical Storage of Power in Italy, G. Müller. Power, vol. 54, no. 21, Nov. 22, 1921, pp. 804–805, 2 figs. Discusses storage of hydraulic energy by using surplus power during periods of high water or low demand, to pump water from tailrace back to higher level for use during peaks or periods of drought. Notes on the Viverone plant,

Funghera mechanical storage plant and a large one under construction.

POWER GENERATION

By-Product Recovery. The Generation of Power with Recovery of By-Products (Krafterzeugung mit Gewinnung von Wertstoffen), H. Kreyssig. Gas- u. Wasserfach, vol. 64, no. 35, Sept. 3, 1921, pp. 557–560. Study of methods for the complete utilization of coal in connection with generation of electrical energy. Merits of gas and oil turbines.

Fuel Economy. Fuel Economy by the Adoption of Scientific Management in Steam Power Generation and Utilisation, David Brownlie. Eng. & Indus. Management, vol. 6, nos. 17, 18, 19, 20, 21 and 22, Oct. 27, Nov. 3, 10, 17, 24 and Dec. 1, 1921, pp. 473–475, 516–520, 549–552, 559–562, 593–594 and 626–630 and 637, 31 figs. Oct. 27: Boiler feedwater meters. Nov. 3: Steam meters. Nov. 10: Steam meters and feedwater regulators. Nov. 17: Feedwater regulators and coal weighing. Nov. 24: Coal weighing. Dec. 1: Economizers.

POWER PLANTS

Code on Definitions and Values. Code on Definitions and Values. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 805–810 and 821. Preliminary draft of fourth in series of 19 codes in preparation by A.S.M.E. committee on power tests codes.

Design. Developments in Power Station Design. Engineer, vol. 132, nos. 3447, 3438, 3439 and 3440, Nov. 11, 18, 25 and Dec. 2, 1921, pp. 502–504, 5 figs; 530–532, 8 figs., 558–559, 4 figs., and 600–601, 7 figs. Nov. 11: Lopulco pulverized-coal feeders and equipment. Nov. 18: Self-cleaning multiple-retort stokers, ash-removal equipments. Nov. 25: Coal-storage system of Ed. Bennis & Co., Ltd., and ash removal from boiler houses. Dec. 2: Pneumatic coal-handling plant at Bankside electric generating station, London.

Oiling Systems. Central Oiling Systems for Power Plants. Power House, vol. 14, no. 21, Nov. 5, 1921, pp. 32–33. The treatment of oil for continuous use; correct lubrication; impurities, precipitation; filtration, entrained water; action of heat; filtering materials, separation of water.

Operation. Refinements of Practice in Modern Power Plants, I. L. Kentish-Rankin. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1190–1192. Turning steam into cold pipe lines; handling hot water; precautions for instrument piping; flue dusts and their chemical actions; moisture in superheated steam lines.

Records and Accounting. Power Plant Records and Accounting, Einar Winholt. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1193–1196, 6 figs. Discusses total cost of operating power plant, distribution of cost, and gives forms.

Waste in. Waste in Industrial Power Plants, David Moffat Myers. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 370–371. Notes on how to determine efficiency of operation.

POWER TRANSMISSION

Waves. Wave Transmission of Power. Steamship, vol. 33, no. 389, Nov. 1921, pp. 142–154, 13 figs. Theoretical discussion by G. Constantinesco. Discusses power transmission by waves through liquids and its application to rock drills, riveters, etc. made by W. H. Dorman & Co., Shafford, Eng.

PRODUCER GAS

Coke-Oven Heating. Producer Gas for Coke Oven Heating. Colliery Guardian, vol. 122, no. 3177, Nov. 18, 1921, pp. 1403–1404, 5 figs. Discusses trend of progress in coke industry. Notes on Koppers regenerative coke oven and regenerative gas oven.

PULVERIZED COAL

Assay Muffles. Firing Assay Muffles with Pulverized Coal, E. H. Hamilton. Min. & Metallurgy, no. 180, Dec. 1921, p. 24, 2 figs. Describes satisfactory burning of pulverized coal in assay furnaces of U. S. Smelting Refining & Mining Co., Midvale, Utah.

Boiler Equipment. Burning Anthracite Mine Waste Efficiently, O. M. Rau. Power, vol. 54, no. 22, Nov. 29, 1921, pp. 828–832, 8 figs. Results of tests obtained by burning pulverized anthracite coal in Philadelphia Rapid Transit Co.'s power plant. Pulverizing equipment installed for ten boilers.

Costs, Arizona. Experience with Powdered Coal in Arizona, J. B. Johnson. Elec. World, vol. 78, no. 23, Dec. 3, 1921, pp. 1121–1123, 1 fig. Costs less than fuel oil per B.t.u. in this case; detailed costs of pulverizing given.

Firing with. Firing With Powdered Coal (Het stoken met kolenpoeder), I. Franco. Ingenieur, vol. 36, no. 45, Nov. 5, 1921, pp. 875–892 and (discussion) 892–894, 50 figs. Notes on consumption of anthracite and other fuels, pulverized-coal installations, pulverizers, etc. Discusses advantages, application in locomotives, etc.

Power-Plant Equipment. Burning Pulverized Anthracite Mine Waste, O. M. Rau. Elec. Ry. Jl., vol. 58, no. 22, Nov. 26, 1921, pp. 915–919, 8 figs. Results of tests obtained by burning pulverized anthracite coal in Philadelphia Rapid Transit Company's power plant; pulverizing equipment installed for ten boilers.

PUMPS

Air-Lift. Air-Lift in Theory and Practice, A. W. Allen. Min. & Sci. Press, vol. 123, no. 21, Nov. 19, 1921, pp. 711–712. Discusses essentials for air lifting, design of rising main, elevating solids by air lift, elasticity, and advantages and disadvantages of air lift.

Rotary. Inbye Pumping, with Special Reference to the Feuerheerd Pump, S. H. Cashmore. Colliery Guardian, vol. 122, no. 3172, Oct. 14, 1921, pp. 1073–1074, 5 figs. Comparison of various types of pumps, describes the Feuerheerd pump which is claimed to have a great future. Read before South Staffordshire and Warwickshire Inst. Min. Engrs.

PUMPS, CENTRIFUGAL

Impellers. Open vs. Closed Impellers in the Brockton Sewage Pumping Plant, H. S. Crocker. Eng. News-Rec., vol. 87, no. 21, Nov. 24, 1921, pp. 851–856. Experience at Brockton, Mass., shows that open type impeller properly designed will give greater output and higher efficiency than enclosed one for small high-speed pumps.

PYROMETERS

Féry. The Measurement of Temperature—XV, P. Field Foster. Mech. World, vol. 70, no. 1819, Nov. 11, 1921, pp. 382–383, 8 figs. Describes the Féry radiation pyrometer.

High-Temperature Measurement. The Measurement of High Temperatures with the "Ardometer" and the Holborn-Kurlbaum Pyrometer (Die Messung hoher Temperaturen mit Ardometer und Holborn-Kurlbaum-Pyrometer), Georg Keinath. Siemens-Zeit., vol. 1, nos. 9 and 10, Sept. and Oct. 1921, pp. 331–340, and 358–364, 20 figs. Describes two instruments, one measuring by contrast between a hot lamp filament and the hot body; and other concentrating heat from hot body upon a small thermocouple the e.m.f. of which is measured on millivoltmeter calibrated in degrees. They give desired reading within a few seconds with accuracy of ±10 deg. cent.

Recording and Non-Recording. Pyrometer Solves Temperature Problems, John P. Goheen. Foundry, vol. 49, no. 23, Dec. 1, 1921, pp. 938–939. Discusses non-recording and recording pyrometers and their application, temperature control of furnaces, etc. Paper to be read before Am. Inst. Min. & Met. Engrs.

R

RADIOMETALLOGRAPHY

Industrial Applications. Industrial Applications of Radiometallography (La Radiometallographie, sa pratique et ses applications industrielles). Le Génie Civil, vol. 79, no. 16, Oct. 15, 1921, pp. 321–323, 6 figs. Describes equipment of X-ray testing laboratory.

RAILWAY ELECTRIFICATION

Boston-Washington. Plan for Electrifying Sections of Eleven Railroads. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921, pp. 739–743, 9 figs. Superpower report provides for consolidation of power supply in region between Boston and Washington.

Brazil. The Paulista Railway Electrification, S. B. Cooper. Ry. & Locomotive Eng., vol. 34, no. 11, Nov. 1921, pp. 304–306, 3 figs. Discusses new line of Companhia Paulista de Estradas de Ferro, between Jundiahy and Campinas, Brazil. Baldwin-Westinghouse electric locomotives, type 2–4–0+0–4–2 for passenger service, and 0–6–0+0–6–0 for freight.

Chile. Chile Starts on Extensive Electrification Program. Elec. Ry. Jl., vol. 58, no. 23, Dec. 3, 1921, pp. 991–993, 5 figs. First zone of State Railways, comprising 144 miles, which includes Valparaiso-Santiago line, to be completely electrified at 3,000 volts d.c.

France. Electrification of French Railways and American Experience (L'Electrification des chemins de fer Français et l'experience Americaine), A.-R. Garnier. La Technique Moderne, vol. 13, nos. 4, 5, 7 and 8, Apr., May, July and Aug. 1921, pp. 167–173, 209–217, 305–315 and 346–356, 19 figs. Apr.: Gives tabulation of efficiency of single- and three-phase systems; cost of installation; American and Canadian lines; etc. May: Reviews French, Swiss, Italian, German and American electrification; power, substations and their equipment, motor generators, locomotives, etc. July: High- and low-tension apparatus, direct control for fast trains, auxiliaries, transmission systems, etc. Aug.: Practical results obtained in Europe and America; tables of power consumption etc. of various lines; further electrification projects by French roads. (Concluded.)

RAILWAY OPERATION

Automatic Train Control. An Automatic Mechanical Train Controller. Engineer, vol. 132, no. 3437, Nov. 11, 1921, pp. 520–521, 4 figs. Details of device for automatically giving warning in cab of locomotive of position of signals on line, and for simultaneously applying brakes.

Automatic Train Control, North Eastern Railway. Ry. Gaz., vol. 35, no. 21, Nov. 18, 1921, pp. 765–767, 5 figs. Describes system which has been in use for many years, and is applicable to engines and stock fitted with Westinghouse, Westinghouse and vacuum combined, or vacuum brakes alone.

The "Daniels" Automatic Train-Stop. Ry. Gaz., vol. 35, no. 19, Nov. 4, 1921, pp. 683–685, 5 figs. New, exclusively mechanical, train stop, designed to give warning at distant signal and to cause a partial application of brakes, and at stop signals, should they be passed at "danger," to cause a further positive brake application, and to shut off steam. Apparatus provides for a distinct audible indication as a "clear" signal of either type is passed.

Lackawanna. Lackawanna Success the Result of Supervision, Charles W. Foss and James G. Lyne. Ry. Age, vol. 71, nos. 22 and 23, Nov. 26 and Dec. 3, 1921, pp. 1027–1032 and 1097–1102, 24 figs. Nov. 26: Notes on service, elimination of grades and curvature, locomotives, freight and passenger cars, and handling of coal. Dec. 3: Details of handling of coal and manifest freight.

Light Railways. On the Question of Operation of Light Railways, Working Rules and Regulations, F. Level. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1471–1482. Summary of replies from 106 administrations to questions regarding classes of tickets, issuing, collecting, checking, etc.

Safety Appliances. On the Question of Safety Appliances on Light Railways, A. Bonnevie. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1539–1588. Gives tabulation of lines in various countries and the length, gage, gradients, curve radii, maximum load, brakes, couplings, speeds, number of trains, track, signals, etc.

Standardization. Railway Standardization and Operation (Normung und Wartung), H. Mattersdorff. Verkehrstechnik, vol. 38, no. 24, Aug. 25, 1921, pp. 363–369, 8 figs. Notes on present status of standardization and its limitations; relations between standardization and operation; and advantages to be gained by a standardized operation.

RAILWAY REPAIR SHOPS

Modern. Modern Railway Shops and Repair Shops (Neuzeitliche Eisenbahn-Betriebs- und Ausbesserungswerke), M. Osthoff. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 44 and 45, Oct. 29 and Nov. 5, 1921, pp. 1131–1134 and 1187–1191, 13 figs. Describes following plans: (1) Railway shop for dismantling of locomotives, equipped with a traveling wide-gage grab slewing crane, and connected with which is an efficient repair shop and a cattle-car cleaning house; (2) railway repair shop without traveling platform, in which locomotives, tenders and boilers can be mounted in either vertical or horizontal position.

RAILWAY SHOPS

Operations and Apparatus. Railroad Shop Operations and Apparatus, Frank A. Stanley. Am. Mach., vol. 55, no. 23, Dec. 8, 1921, pp. 922–923, 9 figs. Describes "home-made" acetylene gas generator; cutting continuous threads on staybolts; systematic arrangement of tools.

RAILWAY SIGNALING

Liverpool Overhead Railway. The Re-Signalling at the Liverpool Overhead Railway. Engineer, vol. 132, no. 3436, Nov. 4, 1921, pp. 488–489, 3 figs. Signaling is arranged on a 2-min. service, but actually is based on interval between trains of 100 sec. Notes on overlaps; light signals; color-light signals; track transformers, relays, etc.; train stops; and emergency cross-over roads.

Track Circuits, A.C. Shunting Characteristics of the Relay in an A-C. Track Circuit Employed in Railroad Signaling, C. F. Estwick. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 12, Dec. 1921, pp. 919–925, 5 figs. Study of various characteristics of track circuit particularly in connection with shunting action of relay.

RAILWAY TIES

Wooden. Wooden Ties (Holzschwellenbeschaffung), E. Stephan. Verkehrstechnik, vol. 38, special no., Sept. 1921, pp. 408–410. Discusses relative economy of treated and untreated ties.

RAILWAY TRACK

Crossings. Railroad Crossings and Crossing Signs, R. S. Messenger. Elec. Ry. Jl., vol. 58, no. 17, Oct. 22, 1921, pp. 744–745. Suggests standardization to reduce accidents. (Abstract). Paper read before National Safety Council.

RAILWAY YARDS

Shunting Cars. Suggestions for the Most Economical Shunting of Railway Cars on Private Sidings (Welche Mittel gibt es, um das Rangieren der Eisenbahnwaggons auf den Privatanschulssgleisen auf möglichst billige Weise zu erledigen-), Ernst Varenkamp. Fördertechnik u. Frachtverkehr, vol. 14, no. 22, Oct. 28, 1921, pp. 274–277. Rope shunting installations and shunting winches.

REFRACTORIES

Research. Report of the Refractories Materials Committee. Gas World, vol. 75, no. 1943, Oct. 15, 1921, pp. 322–324 and (discussion) 324–325, 1 fig. Notes on jointing materials, including softening-point of mixtures of silica brick and clay firebrick, and mixtures of fireclay with fireclay grog; research.

REFRIGERATION

Total-Heat Diagram. Solving Refrigerating Problems by the Total Heat Diagram. Power, vol. 54, no. 22, Nov. 29, 1921, pp. 839–841, 3 figs. Describes use of Mollier diagram or total heat chart based on Goodenough's table of the properties of ammonia.

REFUSE DISPOSAL

Smelting. The Utilization of Refuse Through Smelting (Die Müllverwertung durch Schmelzung), Hermann Koschmieder. Gesundheits-Ingenieur, vol. 44, no. 35, Aug. 27, 1921, pp. 429–432. Refers to unsuccessful results of tests with smelting of refuse in Berlin according to Wegner system, and describes new process which, it is claimed, gives promise of better results.

ROLLING MILLS

Electrically Driven. Motor Equipment for Main Drive of Rolling Mills. Electrician, vol. 87, no. 2270, Nov. 18, 1921, pp. 647–653. List of particulars of electrically-driven rolling mills.

The Future of the Electrically Driven Rolling Mill, L. Rothera. Electrician, vol. 87, no. 2270, Nov. 18, 1921, pp. 632–633. Discusses cost of production and electric drive, influence of power

factor, and the chance for the gas engine with available gas supplied from blast furnaces and coke ovens.

Flywheel Engines. Flywheel Rolling-Mill Engines (Ueber Schwungrad-Walzenzugmaschinen), K. Möbus. Stahl u. Eisen, vol. 41, no. 46, Nov. 17, 1921, pp. 1649–1653, 7 figs. Discusses different types of single-cylinder steam engines in capacity of rolling-mill engines, particularly in connection with central condensation plants; and describes and recommends special type of machine, consisting of a combination of steam and gas engine.

Motors, Size of. Factors which Influence the Size of Rolling Mill Drives, L. Rothera. English Elec. Jl., vol. 1, no. 7, July-October 1921, pp. 291–297, 8 figs. Discusses power demand for rolling various sections, output required and methods of rolling, as factors in determining size of motor.

ROPE

Manila. Results of Some Tests of Manila Rope, Ambrose H. Stang and Lory R. Strickenberg. U. S. Bur. of Standards Technologic Papers, no. 198, Sept. 15, 1921, 11 pp. Summary of results of tensile tests of 368 specimens of rope, all of which were 3-strand, regular lay manila rope having diameters from 1/2 in. to 4 1/2 in. are given in tables and graphically. Gives formula for determining average breaking load as function of diameter of rope. Ropes showed continually varying modulus of elasticity and no well-defined proportional limit.

RUBBER

Aging. The Aging of Rubber, Andrew H. King. Chem. & Met. Eng., vol. 25, no. 23, Dec. 7, 1921, pp. 1039–1042. Aging tests and aging hypothesis; acceleration of oxidation; depolymerization; comparison between still and active aging.

Microsectioning. Recent Development in the Art of Rubber Microsectioning, Henry Green. Jl. Indus. & Eng. Chem., vol. 13, no. 12, Dec. 1921, pp. 1130–1132, 11 figs. Describes chemical method as an alternative to freezing method. Paper read before Am. Chem. Soc.

Vulcanization. The Relation between Coefficient of Vulcanization and Mechanical Properties of Vulcanized Rubber, O. de Vries. Jl. Indus. & Eng. Chem., vol. 13, no. 12, Dec. 1921, pp. 1133–1134. Results of investigations showing that the natural accelerator or accelerators in rubber cause an increase in coefficient of vulcanization for fixed mechanical properties which amounts to about 0.5 for all types of quick-curing rubber, independent of their composition.

S

SAFETY

Inspection. Safety Inspectors and Inspections, John A. Dickinson. Am. Mach., vol. 55, no. 22, Dec. 1, 1921, pp. 887–869. Different types of inspection. Importance of standardizing safeguards. Advantages of helping inspectors.

SCALES

Inspection and Maintenance. Inspection and Maintenance of Weighing Scales, Herbert T. Wade. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 289–294, 10 figs. Describes scale-inspection department of the Scovill Mfg. Co., Waterbury, Conn. Scale service organizations.

Locomotive. Locomotive Weighing Plant of Large Capacity, Carl C. Bailey. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921, pp. 749–750, 3 figs. Heavy scale is housed in special building with equipment for determining all wheel loads at one time.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT; TAYLOR SYSTEM.

SEAPLANES

Deck-Landing Amphibian. The Supermarine "Seal," Mark II. Flight, vol. 13, no. 44, Nov. 3, 1921, pp. 713–715, 5 figs. Has cruising radius of five hours; total military load, including fuel is 1790 lb. Describes details of construction as far as public, of this deck-landing amphibian fleet-spotter.

German. Some New German Seaplanes, Erik Hildsheim. Aviation, vol. 11, no. 21, Nov. 21, 1921, pp. 594–596, 11 figs. Describes L.F.G. commercial seaplanes, new Dornier flying boats, and gives table of data.

Gliders. Hydroplanes (Gliders) With Multiple Redans and Air Screws (Sugli idroplani (glisseurs) a redans multipli ed elica aerea), Dino Giuliani. Revista Marittima, vol. 54, no. 10, Oct 1921, pp. 169–183, 5 figs. Describes existing types of flying boats, hydroplanes, etc. and gives formulas for calculations.

SEMI-DIESEL ENGINES

Beardmore. Construction of Internal-Combustion Engines. Shipbldg. & Shipg. Rec., vol. 18, no. 22, Dec. 1, 1921, pp. 703–708, 9 figs. Describes the Beardmore semi Diesel oil engines.

SHAPERS

Use in Production Work. Production Shaping. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 272–276, 9 figs. Use of shapers in production work in machine-tool building plants.

SILICA BRICK

Manufacture and Use. Manufacture and Use of Silica Brick, Jefferson Middleton. Cem., Mill & Quarry, vol. 19, no. 9, Nov. 5, 1921, pp. 25–27. How material is ground and washed. Burning brick in circular down-draft kilns. Used for purposes where temperatures are high. (Abstract). Mineral Resources of U. S.

STANDARDIZATION

Germany. Industrial Standardization in Germany. Automotive Industries, vol. 45, no. 23, Dec. 8, 1921, p. 1127. Discusses national standardization as developed in Germany under post-war conditions.

Industrial Standardization in Germany, P. G. Agnew. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 8, Nov. 1921, pp. 794–796. Describes advanced state of industrial standardization in Germany. 144 approved standards sheets have been issued and over 500 others have been developed Notes on organization and methods of work.

Industrial. Industrial Standardization. Jl. Soc. Automotive Engrs., vol. 9, no. 6, Dec. 1921, pp. 359–435, 66 figs. A number of articles on standardization, including standardization in Germany, S.A.E. standardization, automobile standardization in Great Britain, decreasing production costs through standardization, and reports of divisions to A.S.E. Standards Committee.

Inter-works. Standardisation and Assimilation, H. Varley. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 554–556. Writer advances plea for wider adoption of inter-works standardization and explains where and how it can be performed and applied.

STANDARDS

German N.D.I. Report. German Industry Committee on Standards (Normenausschuss der Deutschen Industrie). Betrieb, vol. 4, no. 1, Oct. 8, 1921, pp. 1–9, 8 figs. Proposals of the Board of Directors for blank hexagonal nuts, blank washers, low dimensions for drills and countersinks, diameters of core drills; sink-water traps with openings and with covers. Proposed standards for copper and brass.

German Industry Committee on Standards (Normenausschuss der Deutschen Industrie). Betrieb, vol. 4, no. 2, Oct. 22, 1921, pp. 17–24, 9 figs. Proposed standards for offset and straight-arm hand cranks; brass; vector designations; permissible stresses in building material (mild steel and wood); terminology for cast iron, malleable iron, steel castings.

Importance of. Executives Should Foster Use of Standards, Herbert Chase. Automotive Industries, vol. 45, no. 23, Dec. 8, 1921, pp. 1101–1107, 2 figs. Proper use of standard specifications, fittings and dimensions tends to eliminate waste, save time and cut expenses. Engineers know value of standards, but executives have, in general, failed to realize their importance and encourage their use.

STEAM-ELECTRIC PLANTS

Superpower System. Steam-Electric Central Stations Retained for the Superpower System, Arthur R. Wellwood. Power, vol. 54, no. 25, Dec. 20, 1921, pp. 969–972, 5 figs. Existing steam-electric stations retained represent 80 per cent of all such stations in Superpower Zone, and were chosen as result of detailed analysis and study based upon their 1919 performance. Operation of retained plants.

STEAM ENGINES

Exhaust. Simplification and Reduction of Operating Costs of Exhaust-Steam Engines by Simultaneous Utilization of Furnace Waste Heat (Vereinfachung und Betriebsverbilligung von Abdampfkraftanlagen durch gleichzeitige Ausnutzung von Ofenabwärme), Ernst Blau. Fördertechnik u. Frachtverkehr, vol. 14, no. 8, Apr. 15, 1921, pp. 88–90, 4 figs. Describes "Gefa" patented process for operation of exhaust-steam storage plants.

Heat Utilization. The Utilization of Heat in Steam Engines (Wärmeausnutzung bei Kraftmaschinen), K. Heilmann. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 40, Oct. 7, 1921, pp. 315–319, 6 figs. Discusses relations between exhaust-steam utilization and power generation.

STEAM PIPES

Flow in. Machinery and Pipe Arrangement Calculations—XIII, C. C. Pounder. Mech. World, vol. 70, no. 1819, Nov. 11, 1921, pp. 386–388, 1 fig. Continues discussion of safety-valve springs and gives examples and calculations; also discusses weight flow of steam through pipes.

Steam Flow in Pipes, F. M. Van Deventer. Power Plant Eng., vol. 25, no. 22, Nov. 15, 1921, pp. 1096–1098, 1 fig. Steam flow chart for superheated steam and table of pipe sizes.

STEAM POWER PLANTS

Heat-Balance Systems. Heat Balance in Steam Power Plants. Mech. Eng., vol 43, no. 12, Dec. 1921, pp. 790–796 and 825, 8 figs. Particulars of systems employed in three large modern stations, namely, Delaware Station of Philadelphia Elec. Co., by E. L. Hopping; Hell Gate Station, by J. H. Lawrence and W. M. Keenan; and Colfax Station, by C. W. E. Clarke.

Sanitarium. Steam for Battle Creek Sanitarium. Power Plant Eng., vol. 25, no. 23, Dec. 1, 1921, pp. 1131–1138, 14 figs. Mechanical coal and ash handling, automatically controlled underfeed stokers, special water treatment and graphic record system.

STEAM TURBINES

Critical Speeds. Simplified Approximations of Critical Speeds, G. Arrowsmith. Engineering, vol 112, no. 2917, Nov. 25, 1921, pp. 717–720, 8 figs. Points out that critical speeds can in very many cases be obtained without resource to tedious graphical constructions of bending moment and deflection diagrams.

Efficiency Calculations. Turbine Efficiency Calculations, Paul F. Christopher. Power Plant Eng., vol. 25, no. 21, Nov. 1, 1921, pp. 1039–1042, 3 figs. Use of heat-enthropy diagram in calculation of efficiency; estimating power load to meet demands for exhaust steam.

Steam Consumption. A Simple Method of Finding Steam Consumption of Small Turbines. Power, vol. 54, no. 23, Dec. 6, 1921, pp. 895–896, 3 figs. Presents curves for determining water-rate factor for any turbine at any load.

STEEL

Alloy. See ALLOY STEELS.

Carburizing. Present Theories of Carburizing Steel H. B. Knowlton. Forging & Heat Treating, vol. 7, no. 11, Nov. 1921, pp. 543–548, 14 figs. Application of theories to commercial problems; effect of different temperatures on per cent and distribution of carbon in the case.

Chrome. See CHROME STEEL.

Composition and Properties. Principal Steels and Their Characteristics and Uses (Les principaux aciers de construction, leurs caracteristiques et leurs emplois), P. Dejean. La Houille Blanche, vol. 20, no. 55–56, July-August 1921, pp. 149–154, 3 figs. Gives tables of composition and properties. Discusses carbon steels, mild steels, cementation steels, corrosion resistant steels, etc., and their uses.

Ingots, Defects in. Defects in Ingots and Methods for Remedying Them (Les défauts des lingots et les methodes pour y remedier), Sigma. La Metallurgie, vol. 53, no. 47, Nov. 24, 1921, pp. 2185–2186. Summarizes results of investigations by L. Guillet, including piping, cracks, segregation, etc.

Low-Carbon, Strain Lines in. Strain Lines in Low Carbon Steel, A. Fry. Iron Age, vol. 108, no. 22, Dec. 1, 1921, pp. 1401–1402, 10 figs. New German etching method revealing effects on metal which has been stressed. Origin and character of lines. Translated from Stahl u. Eisen, Aug. 11, 1921.

Magnetic Analysis. Magnetic Analysis of Steel, R. L. Sanford. Am. Mach., vol. 55, no. 21, Nov. 24, 1921, pp. 836–839, 7 figs. Uses of electric current for inspection. Apparatus and method of operation; relation of magnetic to mechanical properties of steel. Advantages and difficulties.

Stainless. Stainless Steel and Its Engineering Applications. Mech. World, vol. 70, no. 1817, Oct. 28, 1921, pp. 346–348, 3 figs. Describes tests made with stainless-steel turbine blades at works of Th. Firth & Sons, Sheffield, showing that the blades remained absolutely unaffected. Also discusses manufacture of stainless steel and its properties.

STEEL CASTINGS

Welding. The Welding of Steel Castings (Das Schweissen von Stahlguss), L. Treuheit. Giesserei-Zeitung, vol. 18, nos. 29–30 and 31, Nov. 1 and 8, 1921, pp. 389–392 and 404–408, 19 figs. Discusses application of the different processes, with special consideration of electric arc and antogeneous welding.

STEEL, HIGH-SPEED

Heat Treatment. Proper Heat Treatment for High Speed Steel, J. L. Thorne. Can. Machy., vol. 26, no. 19, Nov. 10, 1921, pp. 36–37 and 53. Gives instances of improper heat treatment, object of high temperature furnace; quenching the tool; heating cutting edges.

Tool Steel. Action of Internal Stress on Tool Steel, C. Neil Greenwood. Forging & Heat Treating, vol. 7, no. 11, Nov. 1921, pp. 560–563. Discusses origins of internal stresses in pure metals and alloys, due to cold working and to suppression of phase changes by rapid cooling; volume changes taking place during heating and cooling. (Abstract). Paper read at joint meeting of Faraday Soc. with other institutions.

Tungsten Content. Measures Tungsten in Tool Steel, Arthur S. Townsend. Iron Trade Rev., vol. 69, no. 24, Dec. 15, 1921, pp. 1551–1553. New method determines content of this element in high-speed steel by specific gravity. Results show that accurate data can be obtained without chemical analysis. Tests are made in few minutes.

STEEL INDUSTRY

Research in. Research in the Steel Industry, John A. Mathews. Min. & Metallurgy, no. 180, Dec. 1921, pp. 11–13. Discusses ways in which research department of steel company may function in order to contribute to success.

STEEL WORKS

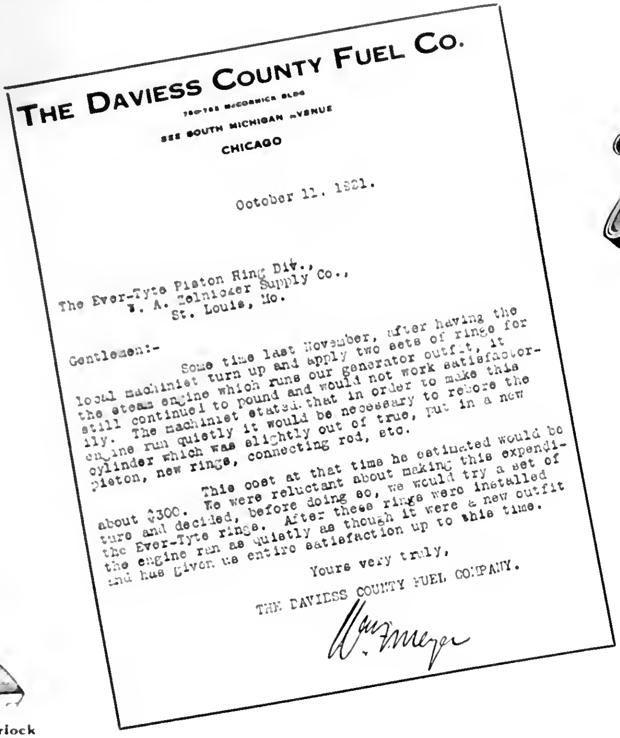
Brazil. Electric Iron and Steel Plant for Brazil, N. A. V. Paulson. Chem. & Met. Eng., vol. 25, no. 23, Dec. 7, 1921, pp. 1057–1061, 8 figs. This installation, first of its kind, includes two Swedish-type pig iron furnaces, two bessemer converters, a Ludlum steel furnace and two merchant mills, all driven by electric power and heated by electric energy.

English. Methods in a Modern Steel Works. Eng. Production, vol. 3, no. 62, Dec. 8, 1921, pp. 545–548, 9 figs. Describes plant and equipment of Thos. Firth & Sons, Ltd., Sheffield.

Heat Economy in. Improving the Economy of Heat in Metallurgical Works (Zur Verbesserung der Wärmewirtschaft der Hüttenwerke), Gustav Neumann. Stahl u. Eisen, vol. 41, no. 44, Nov. 3, 1921, pp. 1561–1569, 3 figs. Deals with storage of excess blast-furnace gas in air heaters and its useful possibilities; utilization of waste heat from furnaces; preheating of combustion air and gas; utilization of producer steam for generation of mechanical energy; improvement in design of air heaters from thermo-technical standpoint.

Lorraine, France. The Rombas Steel Works Near

It's what the USER says that counts



THE DAVIESS COUNTY FUEL CO.
750-752 McCORMICK BLDG
332 SOUTH MICHIGAN AVENUE
CHICAGO

October 11, 1921.

The Ever-Tyte Piston Ring Div.,
W. A. Zelnicker Supply Co.,
St. Louis, Mo.

Gentlemen:-

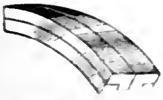
Some time last November, after having the local machinist turn up and apply two sets of rings for the steam engine which runs our generator outfit, it still continued to pound and would not work satisfactorily. The machinist stated that in order to make this engine run quietly it would be necessary to rebore the cylinder which was slightly out of true, put in a new piston, new rings, connecting rod, etc.

This cost at that time he estimated would be about $300. We were reluctant about making this expenditure and decided, before doing so, we would try a set of the Ever-Tyte rings. After these rings were installed the engine ran as quietly as though it were a new outfit and has given us entire satisfaction up to this time.

Yours very truly,

THE DAVIESS COUNTY FUEL COMPANY.

Wm. F. Meyer



The right-angled interlock is your safeguard

Mr. Meyer SAVED $215.00 on installation alone!

The ultimate saving resulting from higher efficiency, greater power output, lower fuel and oil consumption and reduced maintenance charges will be many times this amount.

Order On Trial

EVER-TYTE PISTON RING DIVISION **ST. LOUIS**
(Wellston District)

Send for Evidence Booklets—12 Volumes

Representatives Wanted

ENGINEERING INDEX (Continued)

Metz [Les aciéries de Rombas, pres Metz (Moselle)], Ch. Dantin. Le Génie Civil, vol. 79, no. 19, Nov. 5, 1921, pp. 385–393, 13 figs., partly on supp. plate. Describes works of Société Lorraine des Aciéries de Rombas, blast furnaces, Cowper apparatus, blowers, electric power station, rolling mills, etc.

STOKERS

Automatic. Use of Automatic Stoking in Industries (L'Emploi des foyers automatiques dans l'industrie), H. Drouot and F. Verdeaux La Technique Moderne, vol. 13, nos. 8 and 9, Aug. and Sept. 1921, pp. 337–343 and 376–383, 37 figs. Aug.: Discusses the various arrangements of grates and stokers, including those by Wackernie, Forney, Leach, Wilkinson, Godillot, Grieve, Babcock & Wilcox, Hotchkiss, Coxe, Ill. Stoker Co.; Green's ash conveyor. Sept. Discusses underfeed stokers and describes apparatus by Donneley, Jones, Riley and Combustion Eng. Corp.

Underfeed. A New Underfeed Stoker (Eine neue Unterschubfeuerung), H. Pradel. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, no. 37, Sept. 16, 1921, pp. 289–291, 7 figs. Details of new stoker of the Berlin-Anhalt Machine Constr. Corp. for a double-flue boiler.

STREET RAILWAYS

Track Reconstruction. Reconstruction of Toronto Street Railway System on Large Scale. Contract Rec., vol. 35, no. 47, Nov. 23, 1921, pp. 1009–1014, 15 figs. Track rehabilitation carried out by methods designed primarily for speed. Notes on steam-shovel grading, rapid pavement breaking and batch-transfer method of concreting.

STRESSES

Analysis of Internal State of. The Geometry of Progress in Structural Engineering or Euclidian Principles Applied to Stress Analysis and Volumetric Measurement of Mechanical Intelligence, C. A. P. Turner. Cem. & Eng. News, vol. 33, no. 12, Dec. 1921, pp. 19–25, 3 figs. Writer claims that during past 20 years the structural engineer has advanced little in precise knowledge of internal states of stress in elastic materials of constructing upon which their strength or resistance depends. Refers to idiosyncracies of building code provisions for shear, and inconsistencies of research work, etc., which point to backward rather than forward trend of theoretical progress.

Eyebars. The Calculation of Stresses in Eyebars (Beitrag zur Berechnung der Spannungen in Augenstäben), Josef Beke. Eisenbau, vol. 12, no. 9, Sept. 16, 1921, pp. 233–214, 7 figs. Method of calculating stress in eyebars for bridge and machine construction.

Steel Construction. Consideration of Alternating Stresses in the Proportioning of Cross-Sections in Steel Construction (Ueber die Berücksichtigung des Spannungswechsels bei der Querschnittbemessung im Eisenbau), W. Schachenmeier. Bauingenieur, vol. 2, nos. 9 and 10, May 15 and 31, 1921, pp. 33–36 and 37–38, 5 figs. Reply to inquiry addressed to German Soc. for Civil Eng. by German Industry Committee on Standards as to why, in determination of strength of bars in steel construction, alternating stresses are generally not considered.

STRUCTURAL STEEL

I-Joists. Using Steel Lumber in Building, Thomas J. Foster. Iron Trade Rev., vol. 69, no. 21, Nov. 24, 1921, pp. 1350–1352 and 1359, 5 figs. Light steel I-joists, with cross bridging, metal lath and steel accessories have been developed to take place of wood. Light weight and fire-resisting properties are chief advantages. (Abstract). Paper read before Am. Iron & Steel Inst.

Impact Tests. Fractures in Structural Steels and the Krupp Continuous Impact Tests (Dauerbrüche an Konstruktionsstählen und die Kruppsche Dauerschlagprobe), Fr. Rittershausen and P. Fischer. Stahl u. Eisen, vol. 41, no. 47, Nov. 24, 1921, pp. 1681–1690, 23 figs. Nature of permanent stress and fracture formation of a number of specimens of fractures are explained. Based on results of about 3500 separate tests on the Krupp continuous impact-testing machine, the relations between resistivity of a steel against permanent stresses and its limit of elongation, which reflects its maximum limit of elasticity, are described.

SUPERHEATED STEAM

Industrial Heating. Superheated Steam for Heating Only. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1199–1200, 1 fig. Describes 3,000-hp. boiler plant of Lever Bros. Co., East Cambridge. Mass.; generates high pressure steam for industrial purposes only.

T

TAYLOR SYSTEM

Civil Engineering. Organization in Public Building Work (L'organisation des travaux publics), C. Andreae. Bulletin Technique de la Suisse Romande, vol. 47, no. 24, Nov. 26, 1921, pp. 277–281, 2 figs. Discusses Taylor system and scientific management for civil engineering as against mechanical, in factories, etc.

TERMINALS, LOCOMOTIVES

Pere Marquette Ry. New Engine Terminal Facilities for the Pere Marquette Railway, at Saginaw, Mich. Ry. Rev., vol. 69, no. 24, Dec. 10, 1921, pp. 783–789, 12 figs. Details of design and construction of cinder pits and roundhouse, etc.

TERMINALS, RAILWAY

Freight. New Freight Terminal for the N.Y., N. H. & H. R. R. in Providence, R. I. Ry. Rev., vol. 69, no. 22, Nov. 26, 1921, pp. 707–711, 9 figs. Has approximate standing capacity of 4,000 cars, with yard trackage of 55 miles.

Passenger. On the Question of Terminal Stations for Passengers, A. S. Baldwin. Bul. Int. Ry. Assn. vol. 3, no. 10, Oct. 1921, pp. 1483–1526, 14 figs. Discusses arrangements for reducing movements of locomotives and empty rolling stock at passenger terminals; types of terminals: stub, through, loop and combinations; their capacity, track curvature, etc. Appendix.

TEXTILE MILLS

Electricity in. Electricity in Textile Mills. Elec. Jl., vol. 18, no. 11, Nov. 1921, pp. 486–517, 53 figs. The Central Station and the Textile Mill by F. S. Root; Modernized Plant of Prudential Worsted Co. by J. B. Parks; The Textile Industry in the South, John Gelzer; The Design of Induction Motors for Textile Service, O. C. Schoenfeld; Individual Motor Drive for Spinning and Twister Frames, George Wrigley; Motors for Textile Finishing Plants, Warren B. Lewis; Central Station Power for Textile Mills, John H. Fox; Adjustable Speed Motors and Control in Finishing Plants, C. W. Babcock; Silk Throwing and Electric Drive, C. T. Guilford; Day and Night Lighting in Textile Mills, Samuel G. Hibben.

TIDAL POWER

Installations. Tidal Power Installations (Installations marémotrices), André Defour. L'Electricien, vol. 52, no. 1287, Nov. 1, 1921, pp. 488–494, 9 figs. Describes French plant at Rotheneuf, Ille-et-Vilaine, and gives cost calculation per hp. for the different types of equipment.

TIME STUDY

Economy of Human Effort. Economy and Human Effort in Industry, E. Farmer. Eng. & Indus. Management, vol. 6, no. 19, Nov. 10, 1921, pp. 535–537. Deals with alternative choices, namely, unreconcilable hostility to study; approval of its present form; and scientific inquiry into its possibilities. (Abstract). Paper read before British Assn.

Metallurgical Analysis. Time Studies in Metallurgical Analysis, W. F. Dietrich. Min. & Sci. Press, vol. 123, no. 21, Nov. 19, 1921, pp. 708–710 Preliminary report on application of detailed time studies to instruction in metallurgical analysis in department of mining and metallurgy of Stanford University.

TOOL MAKING

Raw Material for. The Economical Size and Accurate Cost of Raw Material used in Tool Manufacture. Machinery (Lond.), vol. 19, no. 476, Nov. 10, 1921, pp. 155–159. Discusses correct diameter and length of blank, its weight, and cost per lb. of material. Gives table of weights for high-speed steels.

TRACTORS

Machining Methods. Production Methods in a Tractor Works. Eng. Production, vol. 3, nos. 57 and 58, Nov. 3 and 10, 1921, pp. 421–425, and 443–446, 22 figs. Details and equipment of factory recently laid out by Wallace (Glasgow), Ltd., for manufacture of the Glasgow tractor. Details of tractor and machining process.

TRANSPORTATION

Factory. The Analysis and Control of Factory Transportation, F. A. Pope. Factory, vol. 27, no. 6, Dec. 1921, pp. 747–751, 6 figs. Describes plan providing both for internal transportation service and that of road trucks in outside work.

TUNGSTEN

Uses. Tungsten and Its Industrial Alloys (Le tungstène et ses alliages industriels), J. Hebert. La Technique Moderne, vol. 13, no. 11, Nov. 1921, pp. 458–468. Discusses tungsten ores and extraction; ore analysis; uses of tungsten metal; ferro-tungsten; magnetic steels; high-speed steels, their properties, composition and analysis.

V

VOCATIONAL TRAINING

Germany. Industrial Training and Vocational Guidance, M. Morley. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 568–569. Outlines manner in which these are being developed in Germany as basic step towards decasualization. Most interesting of German plans is said to be the organized direction of workers from overcrowded or decaying industries to industries where their services are in demand.

W

WAGES

French and American Methods. Modern Theory of Salary (La théorie du salaire moderne), F. Bayle. La Technique Moderne, vol. 13, no. 5, May 1921, pp. 218–220. Discusses American and French methods and how they are arrived at

Reduction, Effect of. Cutting Wages the Sure Way to Retard Business Resumption, E. W. Hulet. Am. Mach. vol. 55, no. 23, Dec. 8, 1921, pp. 930–931. Study of business conditions for forty years. It is claimed that careful management makes high wages better for all.

Systems, Comparison of. Time, Piece-Rate and Premium Wage Systems (Zeitlohn, Stücklohn und Prämiensystem), H. Frydrychowics. Schiffbau, vol. 23, no. 4–5, Oct. 26-Nov. 2, 1921, pp. 105–110, 3 figs. Discusses advantages and disadvantages of different systems in shipyards and recommends a new system.

WASTE HEAT

Installation at Cement Plant. Waste Heat Installation at Cement Plant. Rock Products, vol. 24, no. 23, Nov. 5, 1921, pp. 13–17, 14 figs. Trinity Portland Cement Co., Dallas, Texas, erects waste-heat power plant at cost of over half a million dollars. Entire plant run by waste heat from kilns.

Utilization. Heating, Hot-Water Supply and Drying with Waste Heat (Heizung, Warmwasserbereitung und Trocknung durch Abfallwärme), F. Frenckel. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 45, Nov. 5, 1921, pp. 1164–1168, 15 figs. Sources of Heat. (1) Exhaust steam: Winding engines, compressors, pumps, steam hammers; advantages gained by installation of exhaust steam storage; economical utilization of exhaust steam and heating plants. (2) Cooling water: Internal-combustion engines, gas coolers, compressors. (3) Waste Heat: Internal-combustion engines, boiler plants, coke plants, industrial furnaces. Utilization of waste heat. Reconstruction of live-steam into exhaust-steam furnaces. Air heating with exhaust steam and vacuum.

WASTE UTILIZATION

Western Electric Co.'s Practice. More Dollars from Salvaged Material. Factory, vol. 27, no. 6, Dec. 1921, pp. 766–767, 3 figs. Describes how Western Elec. Co. saves $60,000 a year by changing its waste into by-products.

WASTES

Industrial, Salvaging. Salvaging Industrial Wastes, J. A. Smith. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 797–798. Notes on salvage work in metal wastes and in maintenance and repairs.

WELDING

Metallography Applied to. Principles of Metallography as Applied to the Industry of Welding, W. H. Ludington. Jl. Eng. Inst. Can., vol. 4, no. 12, Dec. 1921, pp. 611–615, 5 figs. Outline of principles of metallography as applied to electric arc, thermit and oxy-acetylene welding.

[See also ELECTRIC WELDING; FUSION WELDING; OXY-ACETYLENE WELDING.]

WELDS

Testing. A Standard for Testing Welds. Ry. Jl. vol. 27, no. 10, Oct. 1921, pp. 14–19, 14 figs. Report of committee appointed by Am. Welding Soc. Discusses shop, commercial and research standards of tests, test specimens and machines.

WELFARE WORK

Mines. Bathhouse, Hospital and Heating Arrangements. Provided For Employees of Lynch Mine in Kentucky, Howard N. Eavenson. Coal Age, vol. 20, no. 17, Oct. 27, 1921, pp. 676–678, 4 figs. Describes general offices and washhouses for accommodation of 1,500 men.

WINCHES

Pneumatic. Comparative Tests on Pneumatic Winches (Vergleichende Versuche an Presslufthaspeln), M. Schimpf. Glückauf, vol. 57, no. 35, Aug. 27, 1921, pp. 833–837, 9 figs. After describing a number of modern rotary and piston winches, an experimental arrangement for determination of efficiency, air consumption, etc. is described. From results of tests relative values for practicability and economy of different types of winches are derived.

WIRE ROPE

Fracture. The Fracture of Wire in Steel Ropes, E. M. Horsburgh. Engineering, vol. 112, no. 2916, Nov. 18, 1921, pp. 707–711, 13 figs. Fundamental principles are discussed, and attempt is made to deal with some problems in steel ropes in which general agreement has not yet been reached. Results of some of writer's experimental observations on wire ropes. Paper read before British Assn.

WOOD PRESERVATION

Car Sills, etc. The Preservative Treatment of Car Lumber, H. S. Sackett. Ry. Age, vol. 71, no. 23, Dec. 3, 1921, pp. 1079–1080, 3 figs. Discusses advantages of creosoting, decking, roofing, car sills, etc. and advocates extension of this practice.

WINDMILLS

Calculation. Application of the Elementary Turbine Theory to the Calculation of Windmills (Anwendung der elementaren Turbinentheorie auf die Berechnung der Windräder), C. Pfleiderer. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 3, June 1921, pp. 180–188, 6 figs. Application of streamline theory, originally developed by G. Zeuner, to windmill conditions. Writer seeks to fashion shape of blade in such a manner that from a given wheel surface a maximum output can be obtained.

Electricity Generation. The Wind Turbine and Its Use for the Generation of Electricity (Die Windturbine und ihre Verwendung zur Elektrizitätserzeugung), H. Liebe. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 42 and 43, Oct. 15 and 22, 1921, pp. 1083–1086 and 1113–1115, 7 figs. Properties and power of wind. Design and efficiency of wind turbines. Generation of electricity with small separate plants. Generation of direct and three-phase current; production of electric heat. Possibilities for development of large wind-power plants.

MECHANICAL ENGINEERING

Volume 44 March, 1922 Number 3

The Vertical Triple-Expansion Pumping Engine

A Study of the Pumping-Engine Installations at Cleveland, Ohio, During the Past 65 Years—A New Record Performance at the Division Avenue Pumping Station

By L. A. QUAYLE,[1] CLEVELAND, OHIO, and E. H. BROWN,[2] MILWAUKEE, WIS.

Cleveland, Ohio's, installations during the past sixty-five years make an interesting study of both the improvement which has been made in the economy of pumping engines, and the increase in energy available to the engine which has resulted from successive increases in steam pressure and temperature. These installations also cover the period of the introduction of stoker firing and the operating records show their effect on the overall economy.

In 1917 Cleveland's new Division Avenue Pumping Station was put into service. The results of recent tests of the units of this station are given in detail in the present paper, as well as results of the official tests of all of the nine other vertical triple-expansion pumping engines in service in the Cleveland Water Works.

The authors' investigation leads them to believe that the Division Avenue station contains at least one and possibly four engines whose duty record and thermal efficiency have never been equaled by any other steam-driven pumping engine, namely 211,000,000 ft-lb. of work per 1000 lb. of steam used and 24.3 per cent thermal efficiency. They consider that the development which has led to such high efficiency in water-works steam pumping engines that require in general a maximum of not over 1500 hp., has been largely the result of the practice, instituted by water-works engineers, of making economy tests on all installations.

THE crank-and-flywheel vertical triple-expansion pumping engine originated from the designs of high-duty pumping machinery made under the direction of the late Edwin Reynolds. The first engine of this type was installed in the Milwaukee Water Works in 1886, is still in constant service, and differs but little in appearance and general design from the most modern unit. The high mechanical and thermal efficiencies of Reynolds' design were early recognized, and many elaborate and accurate tests were made on different installations. The first which attracted general attention were made by R. C. Carpenter and published in the Transactions of the Society in 1893.[3] The Reynolds design has been adopted by water-works engineers as a standard for American practice, and has been extensively copied abroad.

The introduction and adoption for general water-works service of this slow-piston-speed type of unit with its resulting enormous weight per unit of power, at a time when the whole tendency of prime-mover development was toward high speed and moderate unit weight, as evidenced by the extensive use of the Holly Gaskill type of pumping engine, the Porter-Allen high-speed general-service engine, and also the introduction of the Parsons turbine for small-generator drive, would have been impossible were it not for the very high efficiency over wide variations of capacity and head, and the great reliability inherent in pumping units of this type.

So far as the authors know, there is no record of any triple-expansion pumping engine having been wrecked or broken beyond standard commercial repair, and there are records available of engines of this type having run continuously with only a few hours' shutdown for adjustment and minor repairs for a period of over ten years.

Cleveland, Ohio's installations during the past 65 years make an interesting study of both the improvement which has been made in the economy of pumping engines, and the increase in energy available to the engine which has resulted from successive increases in steam pressure and temperature. These installations also cover the period of the introduction of stoker firing and the operating records show their effect on the overall economy.

From the standpoint of engine and boiler depreciation, the engine longest in service was Cornish No. 2, which was put in operation at Division Avenue in 1856, moved to Fairmount Station in 1885, and taken out of service in 1905, making a total of 49 years from the date of first operation until it was permanently shut down because of obsolescence. Worthington engine No. 3 was installed in 1884 and is still in service at Fairmount Station, a total of 37 years to date. The boilers longest in the Water Department service were the Cornish purchased for Division Avenue in 1872, moved to Fairmount Station in 1894, and finally dismantled in 1905, making a total of 33 years from the time of purchase until they were dismantled with the Cornish engines because of obsolescence.

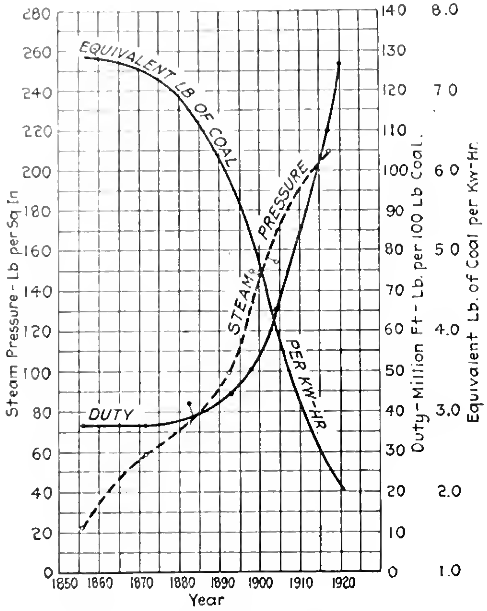


Fig. 1 Steam Pressure and Economy, Cleveland's Pumping Stations, 1856–1921, No Economizers

The effect of increased steam pressure, improvement in boiler and stoker efficiencies, and the changes in pumping-engine design have been summarized graphically in Fig. 1, which shows the steam pressure, together with the duty obtained from the different installations, plotted as a function of the time in years. It is interesting to observe that the increase in steam pressure from 22 lb. in 1856 to 80 lb. in 1883, did not result in higher duties owing to the fact that Cleveland purchased duplex pumps with the first increase in steam pressure. The purchase of this type of pump probably resulted from the low prices due to the adoption of the duplex direct-

---

[1] Chief Mech. Engr., Cleveland Water Dept. Mem.Am.Soc.M.E.

[2] Engineer, Allis-Chalmers Mfg. Co. Mem.Am.Soc.M.E.

[3] Trans. Am.Soc.M.E., vol. 14, p. 426.

Abridgment of paper presented at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

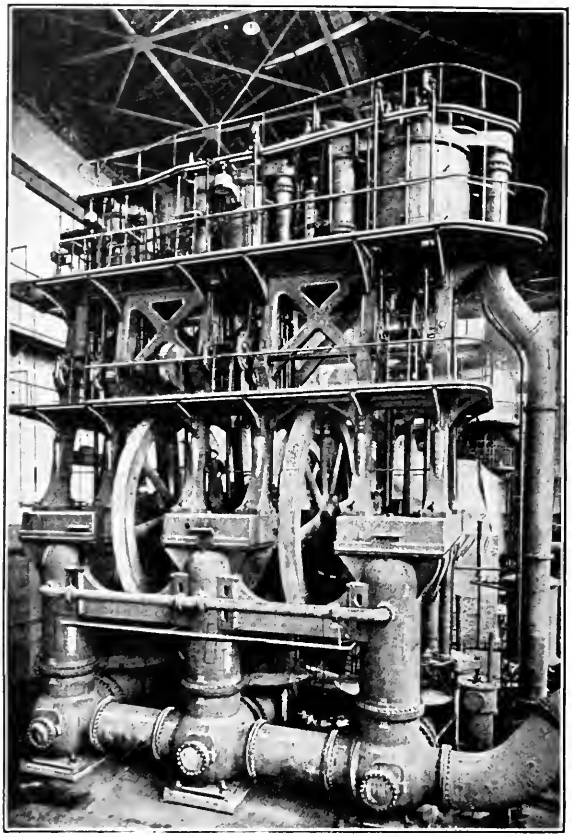


Fig. 2 Allis-Chalmers Engine No. 3 with Lagging Removed

acting Worthington design by a large number of pump builders following the expiration of the basic patents.

It is interesting to note in connection with boiler-room obsolescence that at the Division Avenue Station in 49 years of active service (1856 to 1905) there were 14 different boiler installations, making a total of 53 boilers of six different types. This station started out in 1856 with the same number of boilers (six) for a pumping-station capacity of 8,000,000 gal per day as the new station is now provided with for a capacity of 150,000,000 gal. per day.

In 1901 Kirtland Pumping Station was put in service using 155 lb. gage boiler pressure and 120 deg. superheat, and with a greatly improved boiler plant which resulted in an increased station duty per 100 lb. of coal of approximately 47 per cent as compared with the best Division Avenue Pumping Station records, although the engine duties per 1000 lb. of steam were not greatly increased, as is shown by the official duty tests listed as Item No. 71 in columns Nos. 10, 11, 14, 15, and 16 of Table 2. Eight years of progress in pumping-engine design are reflected in the increase in duty of Holly engines Nos. 6 and 7 of about 9 per cent when tested under approximately the same pressure and superheat as Holly engines Nos. 2 and 3, a portion of the gain resulting from a better vacuum due to the use of water-works-type surface condensers instead of the jet type with which Holly engines Nos. 2 and 3 were equipped.

In 1917 Cleveland's new Division Avenue Pumping Station was put into service. As far as the authors have been able to determine, the average duty of this station with a performance equivalent to 127,000,000 ft-lb. of work per 100 lb. of coal fired is not exceeded by any other coal-fired pumping plant in which the normal low cost of coal does not warrant investment in economizers. This low coal consumption is due to the use of efficient boiler and stoker equipment operated under constant engineering supervision and the use of highly efficient triple-expansion engines working under 210 lb. steam pressure and 120 to 150 deg. superheat.

Our investigation also leads us to believe that this station contains at least one and possibly four engines whose duty record and thermal efficiency have never been equaled by any other steam-driven pumping engine. The best economy obtained on any one of these four engines—211,000,000 ft-lb. of work per 1000 lb. of steam used and 24.3 per cent thermal efficiency—is compared in Table 1 with a summary published in Kent[1] of the most notable high-duty pumping-engine records.

It is instructive to compare the thermal efficiency (including auxiliaries) of 24.3 per cent obtained on the 1400-hp. vertical triple-expansion pumping engine with 24.8 per cent, the maximum thermal efficiency (excluding auxiliaries) of the Interborough Rapid Transit 45,000-hp. cross-compound turbo-generator; with 24.1 per cent, the maximum thermal efficiency obtained by any one of four 40,000,000-gal.-per-day low-head 300-hp. Humphrey gas pumps at Chingsford, England; and also with the 24.1 per cent thermal efficiency obtained on a 1500-hp. natural-gas-engine generating unit of the American Locomotive Co. at Allegheny, Pa., as it shows that these four distinctly different types of units have all reached a point of development at about the same time at which they give practically the same thermal efficiency. This would seem to indicate that any large improvement in the future of any one type must call for a radical departure from the present trend of development.

The foregoing comparison of records made by different types of units emphasizes the relatively small horsepower of the pumping engine. The authors consider that the development which has led to such high efficiency in water-works steam pumping engines that require in general a maximum of not over 1500 hp., has been largely the result of the practice, instituted by water-works engineers, of making economy tests on all installations.

The rebuilding of Division Station which resulted in the economies referred to included the installation of three new Allis-Chalmers units, two of 25,000,000 gal. per day capacity against 250 ft. head and one of 20,000,000 gal. per day capacity against 380 ft. head.

TABLE 1 COMPARISON OF ECONOMY RECORDS AS GIVEN IN KENT'S HANDBOOK WITH DIVISION AVENUE STATION SPECIFICATIONS ADDED

Date of test	1899	1900	1900	1901	1906	1915	1918	1918
Locality	Wildwood, Pa.	St. Louis, Mo.	Boston, Chestnut Hill	Boston, Spot Pond	St. Louis, Bissell's Point	Cleveland, Division Ave.	Cleveland, Division Ave.	Cleveland, Division Ave.
Expansion	Quadruple	Triple	Triple	Triple	Triple	Triple	Triple	Triple
Figures based on	Test	Test	Test	Test	Test	Specifications	Test under specifications conditions	Test using receiver heater
Ft-lb. of work done per million B.t.u consumed	162.9	158.07	156.8	156.59	158.85	170	170.3	189.2
Corresponding thermal efficiency, per cent [1]	20.95	20.32	20.15	20.13	20.42	21.95	22.61	24.27
Equivalent B.t.u. per kw-hr.,[2] including all condenser and other auxiliaries	16280	16780	16930	16940	16700	15600	15070	14030

[1] The thermal efficiency in water-works practice is computed from an actual mean condensate temperature and not on the assumption that the condensate leaves the engine at the temperature of the exhaust steam, and also includes the power required for all the engine's auxiliaries.

[2] = 2,654,200 ÷ Ft-lb. of work done per million B.t.u. consumed.

---

[1] Mechanical Engineers' Pocket-Book, 9th Edition, p. 806.

The specifications for these units called for a duty for each of not less than 170,000,000 ft-lb. of work for each million heat units consumed when supplied with steam at 200 lb. gage pressure and 100 deg. fahr. superheat and with only exhaust steam used for feedwater heating.

The results of the tests of the new Division Avenue units are given in detail in the first four columns of Table 2. The other columns present the results of the official tests of all of the nine other vertical triple-expansion pumping engines in service in the Cleveland Water Works.

The economy of all the units covered in the test results in Table 2 is indicative of the efficiency of this type of engine when built in a wide range of sizes—the smallest being Holly engines Nos. 4 and 5 of 155 hp. and the largest, Allis No. 4 of 1400 hp.—and operated under greatly different steam conditions, and is also indicative of the excellence to which the design has been brought by the different builders.

The performance of Allis engines Nos. 2, 3, and 4, previously referred to can be taken as applying in general principle to the vertical triple-expansion type of pumping engine, and the following interesting developments which were brought out by an analysis of the test results bear on certain characteristics the authors believe are worthy of special consideration.

As the major loss in efficiency ratio is due to incomplete expansion in the low-pressure cylinder, it follows that the efficiency ratio should increase rapidly if this loss is reduced by increasing the exhaust pressure. This conclusion is confirmed by the results of a series of variable vacuum tests plotted in Fig. 3. These tests show that the efficiency ratio of the steam cylinders increased from 73 per cent at 0.725 lb. per sq. in. (28.52 in. vacuum) to 83 per cent at 1.75 lb. per sq. in. (26.44 in. vacuum). The thermal efficiency of the Rankine cycle has also been plotted for comparison with the theoretical thermal efficiency of a constant mean-effective-pressure (or incomplete expansion) cycle having a m.e.p. of 23 lb. per sq. in. This m.e.p. approximates the loading during the tests being discussed. The theoretical thermal-efficiency-ratio line on the diagram shows the effect of incomplete expansion on the efficiency ratio of a constant m.e.p. cycle and illustrates how closely the characteristics of the actual engine conform to those of the ideal.

The form of the efficiency-ratio exhaust-pressure curve in Fig.

TABLE 2 DIMENSIONS OF CLEVELAND'S 12 V.T.E. PUMPING ENGINES AND RESULTS OF 16 OFFICIAL TESTS

Engine	A.C. No. 4	A.C. No 4	A.C. No. 3	A.C. No 2	Allis No. 1	Kilby No. 1	Holly No. 1	Holly No. 6	Holly No 7	Holly No 2	Holly No. 3	Holly No. 4	Holly No 5	Kilby No 1	Holly No. 1	Allis No. 1
Station and Year Installed or Rebuilt	Division 1917		Division 1917	Division 1917	Division 1916	Division 1916	Division 1916	Kirtland 1912	Kirtland 1912	Kirtland 1903	Kirtland 1903	Fair-m'nt 1907	Fair-m'nt 1907	Old Division 1902	Old Division 1902	Old Division 1898
1. Number of steam cylinders	3		3		3	3	3	3		3		3				
2. Diam. of steam cylinders, in.	36-68-108		32-60-96		29.5-58-92	28-54-83	27-52-84	31-64-98		32-60-90		12.75-21-36		30-54-83	30-56.5-84	31-62-92
3. Diam. of piston rods, in	7¼-7¼-8¼		6¾-6¾-8¾		6¾-7-7	7¼-7-7	7¼-7-7	8		7.5		2 75		7	7	1¾-4¾
4. Stroke of steam pistons and water plungers, in.	66		66		64	64	48	66		60		24				
5. Net area of h.-p. steam piston, sq. in.	976 6		764 5		651.6	595 1	551 9	882.8		782.2		124.7		687.6	687 6	891.1
6. Net area of i.-p. steam piston, sq. in.	3590		2792		2604	2271	2104	3192		2805		449.4		2271	2488	3002
7. Net area of l.-p. steam piston, sq. in.	9133		7206		6608	5391	5523	7518		6340		1015		5392	5523	6630
8. Proportion of net area of pistons, ratio	1:3.68:9.35		1:3.63:9.38		1:40:10 15	1:3.81:9.06	1:3.81:10.0	1:3.616:8.52		1:3.60:8.11		1:3.60:8.14		1:3.30:7.84	1:362:8.03	1:3.37:7.14
9. No. of water plungers (single-acting)	3		3		3	3	3	3		3		3		Same as 1916	Same as 1916	Same as 1916
10. Diameter of each plunger, in.	31.63		34 75		34	33	22 88	34.75		36		9.875				
11. Area of each plunger, sq. in.	785.5		948 4		907.9	855 3	411 0	948 4		1018		76.59				
12. Displacement of one plunger per revolution, 1000 cu. in.	51 84		62 60		58.11	54.74	19.73	62 60		61 0		1.838				
13. Displacement of three plungers per revolution, 1000 cu. in.	155 5		187.8		174.3	164 2	59.19	187.8		183.1		5.514				
14. Displacement of three plungers per revolution, cu. ft.	90 01		108.7		100.9	95.03	34.25	108.7		106 0		3.19				
15. Displacement of three plungers per revolution, gal.	673.3		812.9		754.6	710.9	256 2	812.9		793.1		23.87				
16. No of valve chambers	6		6		6	6	6	6		6		6				
17. Diameter of each valve chamber, in.	47.25		47.25		63.5	63	47	59 75		59						
18. No. of valves in each cage and no. of cages per deck	28 7		35 7		35 7	35 7	15 4	15 6		15 6		37				
19. Diam. of valve openings, in.	3 25		3.25		3.0	3.0	3.75	3.75		3.75		2.75				
20. Area of valve openings, sq. in.	8 295		8.295		7.068	7.068	11.01	11.04		11.01		3.97				
21. Net area of waterway through set of valves, sq. ft.	8.166		10.21		7.656	7.656	3.39	10 0		10.0		1.020				
22. Ratio of net valve area to plunger area, ratio	1.497		1.55		1.212	1.289	1.189	1.518		1.415		1.918				
23. Diam. of air pump, in.	30		30		28	28	24	24		28		8				
24. Stroke of air pump, in.	66		66		64	48	48	66		60		24				
25. Type of condensers	Surface		Surface		Surf.	Surf.	Surf.	Surface		Jet		Surface		Jet	Jet	Jet
26. No. of condensers	1		1		1	1	1	2		1		1				
27. Diam. of condenser (inside), in.	62		62		62	62	53	60		.....		30 13				
28. No. of tubes in each condenser	790		790		790	790	572	603		.....		135				
29. Inside diam. of tubes in condenser, in.	1		1		1	1	1	0.87		.....		1 (O. D.)				
30. Length of tubes in condensers (between heads), ft.	10.5		8.667		6.959	6.959	7.25	6.417		.....		7 292				
31. Tube surface in condenser, sq. ft.	2200		1800		1450	1450	1100	1762		.....		250				
32. Diam. of main shaft at bearing, in.	20		20		18	18	16	20		17.5		7.5				
33. Diam. of main shaft at flywheels, in.	22 5		22.5		20.25	20.5	19	23.31		20 75		9				
34. Number of flywheels	2		2		2	2	2	2		2		2				
35. Diameter of flywheels, ft.	20		20		20	20	16	20		20		8 5				
36. Diameter of suction pipe, in.	42		48		36	36	30	48		48		14				
37. Diameter of discharge pipe, in.	42		42		36	36	30	42		42		12				
38. Weight of one flywheel, tons	37 5		32 5		32.35	.....	24	38		31.5		3 4				
39. Total weight of engine, tons	950		875		.....	.....	.....	970		970		110				
40. R.p.m. when pumping at rated capacity	20 61		21.35		18.45	19.53	27.10	21.36		21.89		58 18				
41. Piston speed at rated capacity, ft. per min.	226 7		234 9		196.8	208.2	216 8	234 9		218 9		232 7				
42. Piston speed at rated capacity, ft. per sec.	3.778		3.91		3.279	3 47	3.61	3.915		3 65		3.879				
43. Velocity of flow per second, through suction and discharge valves, ft.	1 267		1 262		1.347	1.347	1 52	2 58		2.58		2 022				
44. Velocity of flow ft. per sec. through suction pipe,	3 216		3 077		1.374	1.374	3.15	3 08		3 08		2.895				
45. Velocity of flow ft. per sec. through discharge pipe,	3.216		4.018		1 374	4 374	3 15	4 02		4 02		3.940				

3 is characteristic of the type of engine as well as of the particular unit tested. This characteristic is shown by the tests of seven Cleveland engines plotted in Fig. 4 in which the vacuum varied over a wide range.

The efficiency ratio of the high-pressure and intermediate-pressure cylinders combined, which operate, in effect, as a noncondensing compound, is 83 to 85 per cent, with the high-pressure cylinder alone attaining an efficiency ratio of 90 per cent. These high efficiencies result from the loss, due to incomplete expansion, which is so large in the low-pressure cylinder, being reduced to a minimum for the two higher-pressure cylinders, and from the use of an amount of superheat in the high-pressure cylinder which results in the steam being exhausted at approximately dewpoint.

The bleeding of approximately 8 per cent of the steam used from the second receiver at about atmospheric pressure, and its utilization for heating feedwater, increases the thermal efficiency of the unit approximately 7 per cent and is accomplished with no increase in steam consumption, for the reason that the loss of available energy of 3 per cent in the bled steam is offset by an increased efficiency of the cylinders due to the resulting better distribution of the work between them. This alteration in the efficiency characteristics is better visualized by considering that when the engine is operated without second-receiver bleeding, the intermediate-pressure cylinder is considerably underloaded and the low-pressure cylinder is heavily overloaded and that these conditions of cylinder loading are bettered by the withdrawal of steam from the second receiver for heating purposes.

The performance of the different elements of the steam end

Table 2 (*Continued*) — Test Data

Engine	A.C. No. 4	A.C. No. 4	A.C. No. 3	A.C. No. 2	Allis No. 1	Kilby No. 1	Holly No. 1	Holly No. 6	Holly No. 7	Holly No. 2	Holly No. 3	Holly No. 4	Holly No. 5	Kilby No. 1	Holly No. 1	Allis No. 1
Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date of test	10–14 1918	10–15 1918	10–5 1918	10–10 1918	11–7 1918	11–21 1918	11–15 1918	11–4 1912	11–13 1912	7-20&21 1904	7-13&14 1904	12–13 1907	12–5 1907	12–14 1902	11–7 1902	3–14 1899
Condensate heaters in service	Exh.	Exh., Rec.														
Duration of test, hr.	8	8	8	8	2	2	4	12	12	24	24	12	12	24	24	24 04
Average Pressure and Temperatures																
1. Steam pressure at throttle, lb. gage	206.3	207.1	203.8	208 4	195 8	200.2	199.3	162.9	164.8	149.1	146 8	152.3	149.7	153.9	152.0	149.4
2. Barometric pressure at 70 deg. fahr., in. Hg.	29.61	29.73	29.28	29 59	29.7	29.50	29.6	29.51	28 89	29 24	29.25	28.75	28.95	29.62	29.3	29.68
3. Barometric pressure (corrected to 32 deg. fahr.), lb.	14.48	14.54	14.32	14.47	14.51	14.43	14.48	14.49	14.18	14 38	14.39	14.13	14.20	14.49	14.35	14.52
4. Steam pressure at throttle, lb. abs.	220.8	221.7	218.1	222.8	210.3	214.6	213.8	177.4	179.0	163.5	161.2	166.4	163.9	168.3	166.4	164.0
5. Steam pressure in first receiver, lb. gage	33.7	35.8	34.6	34.0	35.5	38.0	33.3	27.64	27.85	28.24	29.35	26.14	26.13	33.70	25.88	23.86
6. Steam pressure in second receiver, lb. abs.	13.2	11.7	15.8	15.8	13.53	12.71	12.02	10.49	10.34	11.04	10.85	10.95	10.54	14.88	20.05	10.45
7. Vacuum in condenser referred to 30-inch barometer, in. Hg.	28 20	28 26	28.43	28 66	28.42	28.67	28.04	27.69	27.27	24.50	24.79	27.10	26.45	26.59	26.44	27.74
8. Temperature of steam at throttle, deg. fahr.	520.6	526.6	503.5	495.6	506.8	499.7	490	493.6	493.6	472.1	464.1	366.7	365.5	367.6	366.7	365.0
9. Degrees superheat at throttle, deg. fahr.	130.4	136.0	114.4	104.6	120.7	111.8	102.5	118.7	117.9	104.6	97.66	none	none	none	none	none
10. Temperature of exhaust steam, deg. fahr.	97.9	94.8	92.6	89.4	93.7	89.0	99.2	105.5	101.4	134.2	135 3	116.4	124	120	121	105
11. Temp. of main condensate entering exh. heater, deg. fahr.	67.4	72.9	70.0	68.9	62.5	60	60	.....	.....	.....	.....	70.73	88	.....	.....	.....
12. Temp. of main condensate leaving exh. heater, deg fahr.	94.8	92.8	89.3	86.9	90.4	85.3	96.5	.....	.....	.....	.....	103.9	112.6	.....	.....	.....
13. Temp. of main condensate leaving receiver heater, deg. fahr.	.....	199.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14. Rise of temp. through exhaust heater, deg. fahr.	27.4	19.9	19.31	17.97	27.94	25.3	36.5	.....	.....	.....	.....	33.14	24.6	.....	.....	.....
15. Rise of temp. through receiver heater, deg. fahr.	.....	106.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16. Temp. of jacket and drain water, deg. fahr.	207.9	161.8	210.3	210.9	190.7	211.0	189.9	164.5	161.0	190.2	184.9	189.1	186.8	222.2	183.7	.....
17. Temp. of water pumped, deg. fahr.	61.5	61.5	61.0	60.0	54	53	53	55	54	73.8	69.5	41.8	42 6	39.6	58	34
18. Water pressure in force main, lb.	167.0	169.9	115.5	114 6	110.7	106.6	168.2	96.89	97.48	73.38	71.46	183.0	180.7	76.87	170.4	85.34
19. Water pressure in suction main, lb.	2.29	3.86	3.42	3.79	6.58	5.78	5.03	.....	.....	.....	.....	6.0	5.63	.....	.....	.....
20. Elev. of suct. gage above disch. gage ft.	3.09	3.95	3.40	4.32	-7.58	-4.5	-6.25	.....	.....	.....	.....	.....	.....	.....	.....	.....
21. Disch. head above center line	388 7	393.2	269.5	267.5	.....	.....	.....	.....	.....	-.....	.....	.....	.....	.....	.....	.....
22. Suction head above center line of valve decks, ft.	11.54	16.03	14.14	15.89	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23. Total head pumped against, ft.	377.2	377.2	255.4	251.6	248 0	237 2	382.9	250.5	251.6	194 2	188.9	408.3	401 0	199.1	405.3	202.3
Total Quantities																
24. Total main condensate, 1000 lb.	91.94	82.87	78.06	77.66	14.96	11 29	24 28	123.4	127.5	218.9	210.6	19.76	19.21	190.8	194.9	.....
25. Total jacket and drain water, 1000 lb.	9.060	17.91	8.840	9.097	1.758	1 613	2.151	12.27	11.71	22.01	22.81	3.189	3.074	27.07	23.31	.....
26. Total dry steam used by unit, 1000 lb.	101 0	100.8	86.90	86.76	16.72	15 91	26.43	135.7	139.2	238.0	229.7	21.36	22.58	217.0	214.7	212.3
27 Per cent of total steam used by jacket and drain	8.97	17.77	10.17	10.48	10 51	10.14	8.14	9.04	8.41	9.27	9.96	14.31	13.4	11.43	10.87	.....
28. Total revolutions, 1000 rev.	10.09	10.05	10.35	10.42	2.221	2.148	6.512	15.46	15.94	33.18	32.27	43.12	44.87	29.77	41.75	27.02
29. Water pumped per revolution, lb.	5613	5613	6777	6778	6295	5930	2137	6780	6781	6603	6607	1992	1991	5932	2132	6296
30. Total water pumped, million lb.	56.64	56.39	70 16	70.60	13.98	2.74	13.92	104.8	108 1	219.1	213.2	8.589	8.934	176.6	89.00	170.1
31. Total water pumped, million gal.	6.795	6.765	8.416	8.468	1.676	1.527	1.668	12.57	12.96	26.32	25.59	1.029	1.071	21.16	10.67	20.39
Hourly Quantities																
32. Main condensate per hour, 1000 lb.	11.49	10 36	9 76	9.708	7.481	7 147	6.070	10 29	10 63	9.112	8.775	1.646	1.600	7.950	8.138	.....
33. Jacket and drain water per hour, lb.	1133	2238	1105	1137	879	806 5	537.8	1022	975.4	919.0	953	265.7	256.6	1128	972	.....
34. Dry steam used by unit per hour, 1000 lb	12 62	12.60	10.86	10.81	8.36	7.954	6.608	11.31	11.60	9.917	9.571	1.882	1.780	9.040	8.937	8.825
Heat Data																
35 Heat units above 32 deg. fahr. per lb. dry steam throttle, B.t.u.	1275	1278	1267	1262	1269	1265	1260	1264	1263	1262	1256	1194	1194	1195	1195	1195
36. Heat of liquid above 32 deg. fahr. per lb., temp. of jacket and drain, B.t.u.	175.9	129.7	178.3	178 9	158.6	179.0	157.8	154.7	151 3	158.3	153.0	157.1	154.8	192 2	151.7	.....
37. Heat of liquid above 32 deg. fahr. per lb. main condensate leaving final heater, B.t.u.	62.83	167.1	57.31	51 92	58.4	53.32	64.48	71.53	67.97	72.26	76.31	71.87	80 6	.....	.....	.....
38. Total heat, units above 32 deg. supplied in steam hr., million B.t.u.	16.10	16.10	13.76	13.69	10.61	10.06	8 327	14.29	14.65	12.51	12.02	2 257	2.150	10.58	10.75	10.20
39. Total heat units above 32 deg. fahr. returned in jacket and drain per hr, 1000 B.t.u.	199.2	290.2	197.0	203.5	139.4	144.4	81.86	158 0	147.5	145.9	146.2	41.91	39.79	215.9	147.9	.....
40. Total heat units above 32 deg. returned in main condensate per hr. 1000 B.t.u.	7221	1730	5592	533.2	437.2	381.1	391.4	735.8	722.2	650 2	650.2	118.5	129.2	531.7	468.1	.....
41. Total heat units above 32 deg. returned in jacket, drain and main condensate per hr., 1000 B.t.u.	9213	2021	756.2	736.7	576.6	525 4	476.3	893.8	869.7	796.1	796.4	160.4	169.0	733.4	615.4	.....

which enters into the characteristics summarized, can be estimated with accuracy from the test data for unit No. 4, and such an examination also discloses the effect of the second-receiver feedwater heater used during the October 15 test. This feature may be of general interest at present because of the attention the subject of stage heating of feedwater is receiving from central-station engineers. The steps followed in analyzing the tests of October 14 and 15, 1918 are described below.

The efficiency ratio of the high-pressure cylinder and jacket is obtainable from the indicated horsepower, the total steam used, the initial steam pressure and superheat and the first receiver pressure, which is the exhaust pressure for that cylinder. The average quality of the steam leaving the high-pressure cylinder and jacket with correction for estimated radiation is therefore known, but because of the arrangement of steam flow in which the condensed steam from the high-pressure jacket is discharged direct to the second receiver without being measured, the quality of the steam in the first receiver is not readily estimated. The high-pressure and intermediate-pressure cylinders' economy is estimated from the sum of their indicated horsepowers, the total steam used, the initial steam pressure and superheat and the second-receiver pressure. As all the steam is brought together again in the second receiver, the quality at this point, with allowance for radiation, is determined with accuracy.

The receiver volumes are very large and they become effective separators, as is evidenced by the large percentage of drain water discharged from the second receiver. An assumption of the complete separation in the second receiver affords a means of estimating the performance of the low-pressure cylinder and jacket, and any error involved in such an assumption has very little effect on computed efficiency ratio.

From the test data of October 15 (including the temperature rise of the condensate through the second receiver heater) the amount of steam withdrawn from the receiver for condensate-heating purposes is readily determined.

The economy of the different cylinders during the October 14 and 15 tests and the distribution of work between the cylinders are given in Table 3, with sufficient detail to illustrate the methods used in arriving at the different results. The results of the analysis of these two tests are also plotted in the form of a Mollier diagram in the complete paper.

The remarkable flatness of the efficiency curve of the vertical triple-expansion type of pumping engine under a great variation of conditions is shown by the curves in Fig. 5, in which the percentage of duty is plotted against variable speed and variable head. The loss in economy is only 5 per cent at half load and 6 per cent at half speed, with flat characteristics on the overload side also.

In view of the high efficiencies attained by this type of unit under all the operating conditions of steam pressure, superheat, vacuum, speed and load, it is felt that some particulars regarding the gen-

TABLE 2 (*Continued*)—Test Data

Engine	A C No. 4	A.C. No. 4	A C No. 3	A C No. 2	Allis No. 1	Kilby No. 1	Holly No 1	Holly No. 6	Holly No. 7	Holly No 2	Holly No. 3	Holly No. 4	Holly No. 5	Kilby No. 1	Holly No. 1	Allis No. 4
Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
42. Net heat units consumed by unit per hour, million B t u	15 18	14 08	13 00	12 95	10 03	9 536	7 850	13 40	13 78	11.72	11 22	2.096	1.981	9.846	10.14	....
43. Per cent of net units (heat) consumed by jacket and drain water	8 2	18 26	9 25	9.51	9.73	9 19	7.56	8 16	7 87	8 68	7.56	13.44	12.40	11 20	9 99	....
Speed																
44. Revolutions per minute	21.03	20 93	21 57	21 70	18 51	17.9	27.13	21 47	22 14	23.04	22.11	59 89	62.31	20 67	28 99	18.72
45. Piston speed, ft. per min	231 3	230 2	237.3	238 7	197.4	190 8	217.1	236 2	243 5	230.1	224 1	239 6	249.2	220 5	231.9	199.8
Power																
46. Ft-lb. of work done per hour, million ft-lb.......	2670	2659	2210	2220	1734	1510	1332	2188	2266	1773	1678	283.9	300.8	1464	1503	1428
47. Water horsepower	1349	1343	1131	1122	875.5	762 8	672.7	1105	1114	895.7	847.4	147.1	151.9	740 0	759.2	721.5
48. Hydraulic efficiency, per cent	97 98	98 26	....	....	....	....	....	....	....	98.9	95 7	....	....	....	....	....
49. Mechanical efficiency, per cent	97.35	96 47	....	....	....	....	....	....	....	93 85	95.11	....	....	....	....	....
50. Combined hydraulic and mechanical efficiency per cent	95.38	94.79	96 71	97.48	92.82	85.12	91 21	96.23	96.45	92.69	90.91	95.67	95 70	96 28	96 32	....
51. Average indicated plunger, horsepower	1377	1366	....	....	....	....	....	....	....	906.8	886.4	....	....	....	....	....
52. Average indicated horsepower	1411	1417	1170	1151	943 2	896.1	737.3	1119	1156	966.2	932.0	154.3	158.8	768 0	788 2	....
53. Horsepower lost in mechanical friction	37.53	50 61	....	....	....	....	....	....	....	59.45	45.60	....	....	....	....	....
54. Horsepower lost by water friction, etc	27 80	23 19	....	....	....	....	....	....	....	11.07	39.05	....	....	....	....	....
55. Total horsepower losses	65.33	73 80	38.5	28.99	67 72	133.3	61.59	13.1	11.8	70.52	84.65	7.22	6.83	28.6	29 0	....
56. Per cent of total i hp. developed in hp. cylinder	41 14	41.54	42.8	43.05	36.66	37.9	43.70	41 80	41.30	39.72	40.45	35.27	36.33	32.46	37.3	....
57. Per cent of total i.hp. developed in i-p. cylinder	24 08	28 14	25.3	23.47	27.72	23.3	22.65	31 78	32.15	32.63	31.65	32.89	33.64	31.21	31.35	....
58. Per cent of total i.hp. developed in h-p. cylinder.	34.78	30.32	31 9	33.18	33 63	38.8	33 65	26.42	26.55	27.65	27.90	31.81	30 03	36.33	28 25	....
Capacity																
59. Rate of pumpage, million gal. per 24 hours	20.38	20 29	25 25	25 10	20.11	18.32	10.01	25.14	25.91	26.32	25.59	2.059	2 112	21 16	10.67	20.35
60. Rated capacity, million gal. per 24 hr	20	20	25	25	20	20	10	25	25	25	25	2	2	20	10	20
61. Per cent of rated capacity developed	101.9	101.5	101.0	101.6	100 6	91.5	100 1	100.5	103 6	105 3	102.4	102.9	107 1	105 8	106.7	101.8
Economy and Efficiency																
62. Heat units consumed per w hp.-hr., 1000 B.t.u.	11 25	10.49	11.50	11 55	11.46	12 50	11.67	12.13	12.04	13.08	13 21	14.15	12.87	13.30	13.37	13.55
63. Heat units consumed per i.hp.-hr., 1000 B.t.u.	10.73	9.94	11.12	11.26	10.64	10.64	10 65	11.98	11.92	12.13	12.04	13.53	12.31	12.80	12 88	....
64. Thermal efficiency of entire unit, per cent	22 61	24 27	22.11	22.01	22.21	20 36	21.81	21 00	21.10	19.47	19.23	18.00	19.78	19.14	19.05	18.80
65. Thermal efficiency of steam cylinders, per cent.	23.71	25 60	22 89	22 61	23.93	23 91	23.90	21.24	21.35	20.98	21.14	18.85	20 68	19.80	19.78	....
66. Ratio of thermal effy of unit to that of ideal Rankine cycle	72.78	77 22	70 29	69 27	71.16	64 22	71.17	72.10	73.50	78 20	766	66.1	71.8	69.7	73.5	....
67. Ratio of thermal efficiency of steam cylinders to that of Rankine cycle	76 30	81.46	72.63	71.06	76.61	75.43	77.99	73.0	74 4	83 3	81 2	69.2	78.2	72.5	76.3	....
68. Pounds of steam consumed per w hp.-hr., lb.	9 36	9 38	9.60	9 67	9.55	10 43	9 82	10 23	10.14	11.07	11.29	12 75	11.71	12 23	11 72	11.81
69. Steam consumed per i.hp.-hr., lb.	8 93	8 89	9.29	9 43	8 86	8 875	8 96	10.11	10 03	10 26	10 27	12 20	11.21	11 77	11 31	....
Duty																
70. Ft-lb. of work per million heat units	175 9	188 7	172 2	171 4	172 8	158 4	169 7	163 3	161.5	151 4	149 6	140 0	153 9	145 9	151.2	146 0
71. Ft-lb. of work per 1000 lb. steam, million ft-lb.	211 5	211 0	206 2	204 8	207.4	189 9	201 6	193 5	193.4	178 8	175 4	155 3	169 0	162 0	168 2	167.4
72. Duty per million B t.u. correct. per test curves, million ft-lb.	173 8	186 0	171.3	171 1	....	....	....	....	....	....	....	....	....	....	....	....
73. Duty per million B t.u. correct. per Rankine cycle, million ft-lb	172 9	181 8	170 4	171 0	....	....	....	....	....	....	....	....	....	....	....	....
74. Guaranteed duty per million B.t u., million ft-lb.	170.0	....	170 0	170 0	....	....	....	....	....	....	....	....	....	....	....	....

eral features of cylinder construction and arrangement, the type of valve gear, and the system of steam flow through the engine will be found of interest.

The steam cylinders are jacketed, a jacket for each being supplied with steam at the initial pressure for that cylinder.

The high-pressure cylinder has Corliss admission and exhaust valves. The intermediate-pressure cylinder has Corliss admission valves and single-beat poppet exhaust valves. The low-pressure cylinder has single-beat poppet admission and exhaust valves. The valves for all cylinders are located in the cylinder heads with the poppet valves flush with cylinder-head surface when closed. The types of steam and exhaust valves used, Corliss and single-beat poppet, insure tightness when good workmanship and a detailed design that minimizes distortion under temperature changes are employed. The location of all steam valves in the cylinder heads reduces the cylinder clearance to a minimum, as may be judged from an inspection of Table 4.

The slow speed and great dimensions of the steam cylinders and receivers result in the exposure of a large cylinder and receiver surface per 1000 lb. of steam used, but as a result of the thorough covering with a high-grade non-conducting material and the enclosing sheet-metal lagging, the loss of radiation is very small. An estimate of this loss, using generally accepted coefficients of heat transmission, indicates that not more than 1 per cent of the total steam is condensed by radiation.

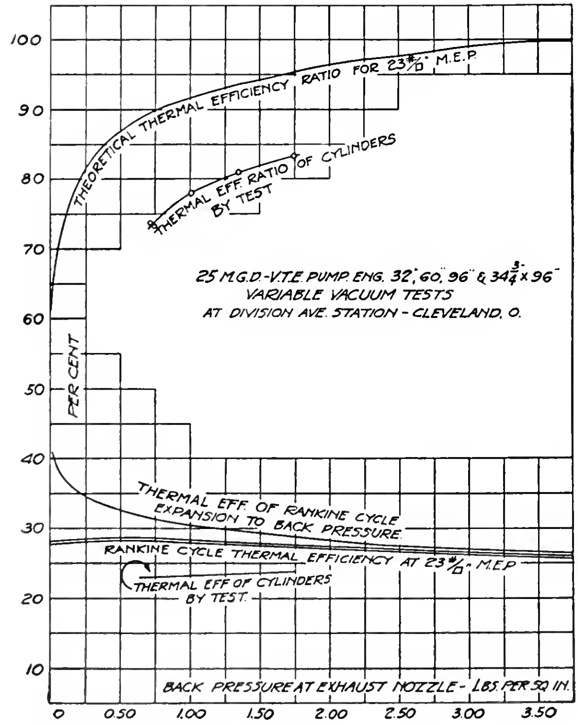


Fig. 3 Variable Vacuum Tests at Division Avenue Station, Cleveland, Ohio

The condensed steam from the high-pressure cylinder jacket is discharged through a trap to the second receiver space. The condensate drain from all the first receiver spaces and from the intermediate-pressure cylinder jacket is likewise discharged through a trap to the second receiver. All of the condensed steam from the second-receiver low-pressure cylinder jacket, and the second-receiver feedwater heater, when it is in service, is discharged through a single trap to atmospheric pressure. The temperature of the water thus discharged to the atmosphere does not at any time exceed 200 deg. fahr.

The steam exhausted from the low-pressure cylinder is condensed in a water-works type surface condenser (the steam flowing through the condenser tubes in two passes) located in the main suction pipe directly adjacent to the pump chambers.

The condensate is removed from the condenser by a single-acting bucket-type wet air-pump driven direct from the low-pressure plunger head and discharges into a tank from which it is pumped through the exhaust-steam heater to the station feedwater heater by a single-acting condensate pump direct driven from a main-pump plunger-head. The exhaust-steam heater is located in a by-pass connection of the main exhaust pipe just ahead of the condenser.

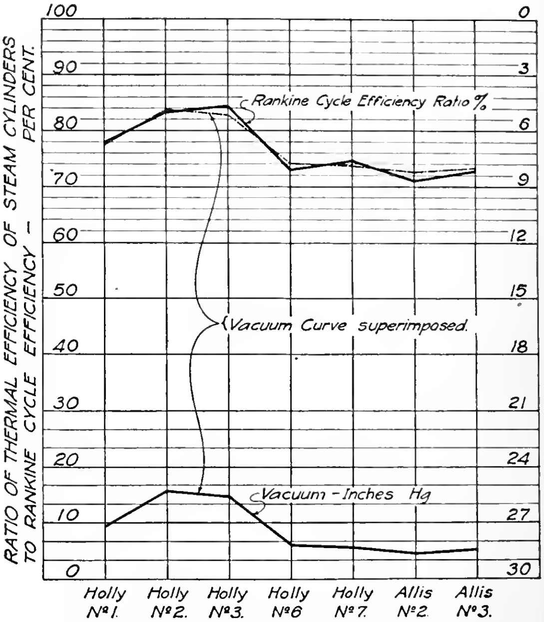


Fig. 4 Variation of Rankine-Cycle Efficiency Ratio with Vacuum on Seven Different Engines

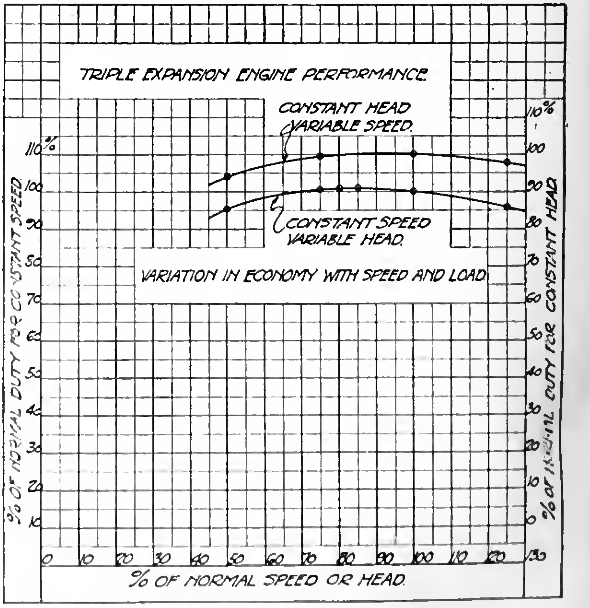


Fig. 5 Triple-Expansion-Engine Performance: Variation in Economy with Speed and Load

TABLE 3 ECONOMY ANALYSIS OF NO. 4 UNIT, DIVISION AVENUE STATION

(Cylinders 36 in., 68 in. and 108 in., stroke 66 in.)

Test date (1919)	Oct. 14	Oct. 15
Steam pressure, lb. abs.	221	222
Superheat, deg. fahr.	130	136
1st receiver pressure, lb. abs.	48.2	50.4
2d receiver pressure, lb. abs.	13.25	11.71
Exhaust pressure, lb. abs.	0.885	0.855
Energy Available, Rankine Cycle:		
To entire engine, B.t.u. per lb.	378	381
To high-pressure cylinder, B.t.u. per lb.	132.5	130.5
To high- and intermediate-pressure cylinders, B.t.u. per lb.	224.5	234.5
To low-pressure cylinder, dry steam initially, B.t.u. per lb.	169.5	163.0
To low-pressure cylinder theoretically, B.t.u. per lb.	153.5	146.5
Indicated Horsepower		
Entire engine	1117	1420
High-pressure cylinder	582	590
High- and intermediate-pressure cylinders	924	990
Low-pressure cylinder	493	430
Percentage of Power Per Cylinder.		
High-pressure cylinder, per cent	41.11	41.50
Int.-pressure cylinder, per cent	24.08	28.14
Low-pressure cylinder, per cent	34.78	30.32
Steam Withdrawn from Second Receiver for Heater:		
Temp. rise of condensate through heater, deg. fahr.	....	106.3
Latent heat at 2d receiver pressure, B.t.u. per lb.	....	977
Calculated refrigeration of condensed steam in heater, deg. fahr.	....	100
Heat given up in heater per lb. supplied, B.t.u.	....	1077
Condensate pumped through heater, lb. per hr.	....	10,359
Heat absorbed by condensate, B.t.u. per hr.	....	1,100,000
Weight of steam supplied heater from receiver, lb. per hr.	....	1020
Weight of steam from 2d receiver, low-pressure cylinder jacket and receiver heater, lb. per hr.	1133	2238
Weight of steam from 2d receiver and low-pressure cylinder jacket, lb. per hr.	1133	1218
Weight of condensate from condenser, lb. per hr.	11,492	10,359
Economy of High-Pressure Cylinder:		
Weight of total steam supplied high-pressure cylinder, lb. per hr.	12,625	12,597
Steam used per i.hp-hr., lb.	21.70	21.35
Efficiency ratio	0.885	0.915
Average quality at exhaust of high-pressure cylinder and jacket, including radiation	0.9817	0.9827
Economy of High- and Intermediate-Pressure Cylinders:		
Weight of total steam supplied cylinders, lb. per hr.	12,625	12,597
Steam used per i.hp-hr., lb.	0.830	0.853
Average quality at exhaust of cylinders in 2d receiver, including radiation	0.9325	0.9234
Economy of Low-Pressure Cylinders:		
Weight of total steam entering 2d receiver, lb. per hr.	12,625	12,597
Average quality of steam in receiver, including radiation loss, lb. per hr.	0.9325	0.9234
Moisture discharged from receiver, assuming complete separation, lb. per hr.	852	966
Dry steam withdrawn by receiver heater, lb. per hr.	....	1020
Net dry steam supplied low-pressure cylinder and jacket, lb. per hr.	11,772	10,612
Dry steam used per i.hp-hr., lb.	23.9	24.65
Efficiency ratio of low-pressure cylinder	0.628	0.634
Calculated weight of steam supplied cylinder jacket, lb. per hr.	280	253
Effect of Second Receiver Heater:		
Total steam used by high- and intermediate-pressure cylinders, lb. per hr.	12,625	12,597
Energy available to high- and intermediate-pressure cylinders, B.t.u. per lb.	224.5	234.5
Dry steam withdrawn for 2d receiver heater, lb. per hr.	....	1020
Total steam used by engine from 2d receiver, lb. per hr.	12,625	11,577
Theoretical quality in 2d receiver	0.900	0.887
Theoretical energy available to low-pressure cylinder, B.t.u. per lb.	153.5	144
Theoretical total energy available to engine	47,800,000	46,280,000
Difference in energy available between tests resulting from use of receiver heater and from different steam conditions, per cent	....	3.18

DISCUSSION OF PAPER ON VERTICAL TRIPLE-EXPANSION PUMPING ENGINE

AS SUPPLEMENTARY data Leonard A. Day[1] submitted the results of a more recent test on the Holly engine at Bissell's Point Station than that referred to in Table 1. The duty in ft-lb. per B.t.u. was 166.7, and this was raised to 169.3 by installing an exhaust heater. Assuming the ratio of the thermal efficiency of the unit to that of the ideal Rankine cycle not to vary for an increase in the steam conditions from those in the test to those of A. C. pump No. 4 of the Cleveland tests, then the increase in duty would be in direct proportion to the increase in the Rankine-cycle efficiency, an increase of 4.8 per cent. The resultant duty would be 169.3 × 1.048 = 177.5, or a duty comparable with that of the Cleveland A. C. pump No. 4. The overall thermal efficiency of the unit including exhaust heater is 21.8 per cent for the steam conditions of the test, and 22.8 per cent for the steam conditions of A. C. pump No. 4 of the Cleveland tests.

TABLE 4 AVERAGE CYLINDER CLEARANCES, DIVISION AVENUE UNIT NO. 4

Cylinder	Diameter, inches	Stroke, inches	Cylinder clearance volume, per cent of piston displacement
High-pressure	36	66	1.50
Intermediate-pressure	68	66	0.50
Low-pressure	108	66	0.25

E. E. Miller[2] said that some years ago he plotted a temperature-entropy diagram from an Allis-Chalmers engine in St. Louis during one of the official tests, which showed up very clearly the loss due to expansion in the low-pressure cylinder: that is, the fact that it could not be carried out as far as they would have liked to carry it out, as mentioned in the paper.

A. G. Christie[3] said that he did not believe any turbine-driven centrifugal pump could approach the 77 per cent overall Rankine-cycle efficiency given in item 66 of Table 2 for the Allis-Chalmers No. 4 pumping engine. Recently, at one of the largest pumping plants in the country he had seen an engine that had not been overhauled for extensive repairs since it was first put into service in the 70's. He doubted whether a turbine installation would operate for a similar length of time without rebuilding and considerable renewal of parts.

In reply to a question put by the chairman of the session, Past-President Jacobus, George A. Orrok[4] said that reciprocating engines and exhaust-steam turbines could be combined so as to give remarkably good results. The cost, however, would be another matter. The proposal had been made to put in a reducing gear between the turbine and the pump, and while in naval practice the reduction gear was said to be giving satisfactory service, there were nevertheless some who did not quite fancy its employment.

By and large, he would say that the best efficiency in pumping water would be gotten out of a reciprocating engine with the proper arrangement for using the heat in the receiver. As to money economy, that was different. Large pumping engines now cost from 8 to 8.5 cents per lb. and turbines all the way from 50 cents to $2 per lb. While ordinary centrifugal pumps cost about the same as engines, those of an efficiency approaching 90 per cent would probably cost from 25 to 30 cents per lb.

Referring to the paper, he regretted that the author had employed the Mollier diagram to show the performance of the engine instead of the better and simpler temperature-entropy diagram.

Frank L. Fairbanks[5] asked what the drop in efficiency of large-size water-works centrifugal pumps would be in a given period. He had had experience with centrifugal pumps in pumping refrigerating brines and salt water and knew that in such work the efficiency held up less than six months and that the average life of an impeller in salt water was less than a year. At Buffalo tests showed that in less than 18 months the drop was prohibitive, and in putting in new equipment the water-works company went back to the reciprocating type of equipment.

George H. Gibson,[6] replying to Mr. Fairbanks said that two large

(Continued on page 176)

---

[1] Engr. in Charge Operating Section, Water Div., 34 E. Grand Ave., St. Louis, Mo.

[2] Asst. Supt., Power Plants, Hackensack Water Co., Weehawken, N. J.

[3] Prof. M. E., Johns Hopkins Univ., Baltimore, Md.

[4] Cons. Engr., New York.

[5] Ch. Engr., Quincy Market Cold Storage & Warehouse Co., Boston, Mass.

[6] 70 Oakwood Ave., Upper Montclair, N. J.

Conservation of Timber Supply

Addresses Delivered at the A.S.M.E. Annual Meeting and Dealing with Reforestation for the Purpose of Community Perpetuation, and the Manufacture of Paper and By-Products from Southern Pine Refuse

Two important phases of the problem of conserving the timber supply of the country were discussed at the Forest Products Waste Session of the A.S.M.E. Annual Meeting in December, Thomas D. Perry presiding. David L. Goodwillie, chairman of the U. S. Chamber of Commerce Committee on Conservation and Reforestation, gave details of the reforestation plans that had been followed out at Bogalusa, La., whereby a continuous supply of stumpage is insured that will furnish the raw material needed to keep the industries of the town in active operation.

Mr. Goodwillie was followed by Joseph H. Wallace, of the firm of Joseph H. Wallace & Co., Industrial Engineers, New York City, who spoke on the wasteful methods that had hitherto obtained in the resinous pine districts of the South—and the particularly harmful practice of tapping turpentine from the living tree thereby probably causing its death—and told of a combination of processes involving distillation, extraction and paper making that had been developed and put into successful operation, whereby every part of the stump and logging refuse can be utilized in an efficient manner. The texts of these two interesting addresses immediately follow.

Reforestation to Conserve Industrial Investments

By DAVID L. GOODWILLIE,[1] CHICAGO, ILL.

Reforestation for the purpose of perpetuating our timber supply for future generations, for enhancing the beauty of our landscapes, for insuring a continuous supply of lumber for commercial uses and for preventing the denuding of lands and the consequent deterioration of their reproductive qualities, are well-known appeals of substantial merit.

Example of Long-Leaf Yellow Pine from 3 to 10 Years Old, Fenced About 10 Years; Natural Reproduction

The perpetuation of the timber supply for the purpose of conserving industrial and municipal investments is a new and forceful argument that is well exemplified by the far-seeing plans of the Goodyear interests at Bogalusa, Louisiana. Some sixteen years ago a man of vision, W. H. Sullivan, pitched a camp in the woods and as his vision crystallized into accomplishment, there grew the sawmill of the Great Southern Lumber Co., and the New Orleans, Great Northern Railroad connecting this sawmill with the market. A little later the Bogalusa Paper Company came into being, converting much of the sawmill and stump-land waste into Kraft paper and pulp-board.

In addition to the foregoing is a hardwood sawmill, a veneer mill, many miles of logging road and other associated and affiliated industries.

The visions of the founder of Bogalusa were clear enough to foresee the time when all of the above mentioned industrial developments, together with the homes and cottages, paved streets, parks, hotels, clubs, schools and churches, would disintegrate into a pine barren if proper provisions were not made for a continuing supply of stumpage that would furnish raw material to keep the wheels of Bogalusa's industries turning.

It has been one of the undisputed principles of American existence that until visions are entrenched behind economic facts they seldom materialize into actual accomplishments. A realization of this caused the Goodyear interests under the leadership of W. H. Sullivan, manager of the Great Southern Lumber Co., to begin early to solve, first, the problem of protecting the native seedling on cut-over lands from fire and hogs, and second, the best method of planting new varieties of trees. This was followed by experiments in transplanting both the nature-sown and hand-sown product, to determine how to produce merchantible lumber quickly. The result is seen in the twelve- and fourteen-year stands of pine shown in the accompanying illustrations where the young trees are approaching a point of usefulness for paper making and giving promise of merchantible sawmill timber in thirty to fifty years, according to variety.

"The growth of the most rapidly growing seedling tree," says Mr. Courtenay DeKolb in a recent article, "averages about half an inch in diameter per year, producing a four-inch tree in eight years, a fifteen-inch tree in thirty years, and a twenty-inch tree in forty years. During the period from germination to the eighth year the lands may be profitably occupied in grazing. It will take 30 years for most of the lumber companies on our line to cut out the present virgin tree crop, and by that time our fifteen-inch second-growth trees will be ready for the saw, thus insuring an uninterrupted continuation of our great wood industries."

The method of encouraging nature in her seed scattering is interesting. "Preceding the axe and saw," continues Mr. DeKolb, "goes the forestry man, and he selects and rings in white paint, at least three good seed trees to the acre. These marked trees are spared and preserved as the progenitors of our future forests. The undersize trees left by the sawmill make good pulp wood to start with. Under their genial sun, ample rain and almost uninterrupted growing season, the new growth comes along, and in eight years the land is ready to be culled for wood for pulp, leaving the extremely promising trees for lumber. Thus judicious thinning of the trees for pulp wood goes on until 75 or 80 excellent lumber trees are left on the acre."

Another incentive to tree culture, according to Walter S. Ayres, is being held out by a wise statute enacted in Louisiana which enables any one owning land suitable for reforestation and assessed at a valuation not in excess of $10 per acre to enter into a contract

---

[1] Chairman, U. S. Chamber of Commerce Committee on Conservation and Reforestation.

with the state for periods ranging from 15 to 40 years, as desired, whereby the landholder obligates himself to reforest under the general advice and direction of the Forestry Division of the State Department of Conservation, and the assessment valuation of such land then remains fixed during the period of the contract.

"Many years ago," says Mr. Ayres, "Louisiana enacted a law that should serve as a model for every Southern state. It permitted a reforestation contract that automatically fixed the valuation of such land at $1 per acre for the period of the contract up to 40 years. This law was in advance of the times and comparatively few took advantage of it. Among those who were wise enough to do so was Henry E. Hardtner of Urania. As the liberality of this statute was not appreciated, it was modified so that now the average fixed valuation under such a reforestation contract is $5 per acre. This is rather high. A return to the $1 basis would be better, accompanied by a soil survey when application for exemption is made, so that it should apply to lands more valuable for tree culture than for general farming."

The demonstration has gone far beyond the experimental stage, and has proved adequately that the obliteration of sawmill towns at the expiration of the cutting of virgin timber is an industrial waste that has no justification in the economies of modern life and the conservation of natural resources.

A wealth of useful information on the kinds and varieties of pine trees best suited to protection, planting and transplanting is now available and the harder and rugged varieties are known and used. The present worth of the millions invested in the industrial development of Bogalusa have increased over 50 per cent by the practical demonstration of these plans for perpetuating its raw-material supply.

We Americans are conspicuous for our wonderful visions, but we seldom reduce these visions to as useful or practical a plan as is evidenced in what the Goodyear interests have done at Bogalusa.

Progress of Reforestation by Natural Seeding; the Young Trees are Seedlings from the Parent Trees Seen in the Picture

Paper and By-Products from Southern Pine Refuse

By JOSEPH H. WALLACE,[1] NEW YORK, N. Y.

THE lumberman and naval stores operator have been for years destroying the resinous pines of the South with reckless extravagance. Only about one-third of the tree ever reaches the market in the form of lumber, lath, or shingles, while a few years of the wasteful American methods of tapping turpentine from the living tree are sufficient to cause its death.

For three-quarters of a century engineers, chemists, and business men have endeavored to devise means to unlock this storehouse of wealth. This effort of inventive genius has been directed along three distinct lines. The first to be undertaken was the destructive distillation of the stump and trash wood. This produced tar, pitch, and charcoal having sufficient value to offset a portion of the cost of clearing the land. These processes have recently developed and have become moderately profitable, particularly on account of the value of flotation oils for use in the mining industry.

The second scheme for reclaiming this wealth was the cutting of the wood into fine chips, then steaming them in a closed vessel under sufficient pressure to distill off the turpentine—the steamed wood then being dried and used for fuel. This became profitable when it was found that after steaming, the wood could be used as a source of supply of rosin by extraction with a solvent. This modified plan, known as the "steam and solvent process," is now operated successfully in many locations.

The third proposal was an undertaking to utilize the fiber of the wood for making pulp and paper. This could be done only with difficulty by the acid pulp methods common to the industry, because of the extremely resinous nature of the wood.

These three methods, each commercially successful, do not recover a large percentage of the potential wealth of the stump and logging waste. Both the destructive distillation and the steam and solvent methods result in the destruction of the fiber, on which the pulp and paper manufacture depends, whereas, the value of the fiber is as great as that of all the other products.

The above methods for utilization of this material have been combined in a well-balanced combination of processes, which will utilize every part of the stump and logging refuse in an efficient manner.

A preliminary treatment will take place in semi-portable field plants which will produce turpentine, pine oil, rosin, pyroligneous acid, and tar—as well as a main product—pulp chips, of a uniform moisture and resin content.

Pulp and paper plants may be located where manufacturing and labor conditions are most favorable and where conditions justify large outlay of capital investment.

At the field plants the chips will be sorted into—

- *a* Material suitable for pulp making
- *b* Material physically unsuitable for pulp making, either because of partial decay or containing too much knot or imperfect material, and including bark, sawdust, etc.

The material unsuitable for pulp manufacture (termed "trash") will be used as raw material for destructive distillation, producing in addition to the usual acid, flotation oils, etc., a fuel supply sufficient for all of the requirements of the field plant.

No more complicated apparatus is required than is found in the average sawmill, and no labor more skilled. The method involves only the performance of work. Turpentine, pine oil, and rosin of high grade are extracted from the pulp chip before it is delivered to the pulp mill, and incidentally the character of the main product, the chip, is so modified as to make it a new article—a Standardized Chip. A chip that is uniform in rosin content, acid content, and moisture content is now available for the first time in the history of chemical pulp manufacture. The use of a standardized material for pulp making will result in increased yield, and a superior quality and uniformity of pulp.

The average yield per acre of cut-over Southern pine lands in East Texas as determined by numerous surveys, is

$7\frac{1}{2}$ cords pulp wood
$4\frac{1}{2}$ cords trash wood.

As a result of the combined operations now proposed, and by methods hereinafter described, each acre of stump and woodlands cleared has a potential wealth shown in Table 1.

---

[1] Joseph H. Wallace & Co., Industrial Engineers.

Table 1 is based on actual quantities shown to be commercially available from material cleared from a typical acre of cut-over pine land, and on the average value of the products during the first half of 1921.

In taking a bird's-eye view of this prospective empire of industrial development, the thought naturally occurs that there are eleven competitive areas, each with an outlet through a deep-water port, viz., Wilmington, N. C., Charleston, S. C., Savannah and Brunswick, Ga., Jacksonville and Pensacola, Fla., Mobile, Ala., Gulfport, Miss., New Orleans and Lake Charles, La., and Beaumont, Sabine or Galveston, Texas.

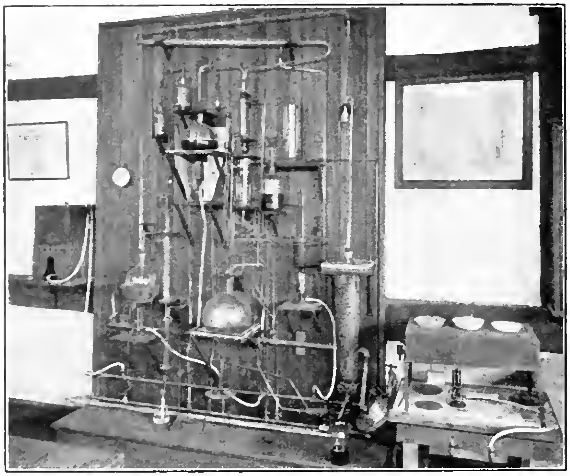


Fig. 1 Laboratory Extraction and Refining Plant

The project under consideration contemplates a preliminary treatment of material at or near the point of its origin for the extraction of by-products of a non-cellulose character, and it is believed that the cost of preparing the material for paper making, including the extraction of resinous material, would be commercially justified without regard to the utilization of trash wood or the land values necessarily increased by the removal of the wasted material therefrom.

TABLE 1 VALUE OF PRODUCTS ON AN AVERAGE ACRE OF CUT-OVER PINE LANDS IN THE SOUTHERN STATES

Pulp and Paper Plants		
Kraft, 3 125 tons at 120 (7½ cords, 4.18 tons of paper per cord)		$375.00
Extra tion Plant		
Turpentine, 49.2 gal. at $0.60 (6 cords, 8.2 gal. per cord)	$29.52	
Pine Oil, 40 8 gal. at $1 48 (6 cords, 6.8 gal. per cord)	60.38	
Rosin, 9.9 bbl. at $5.83 (6 cords, 1.65 bbl. per cord)	57.72	
		147 62
Distillation Plant		
Turpentine, 18.0 gal. at $0 57 (3 cords, 6.0 gal. per cord)	$10.26	
Pine Oil, 12.9 gal. at $1.30 (3 cords, 4 3 gal. per cord)	16.77	
Tar Oils, 6.19 gal. at $0.275. (3 cords, 2.73 gal. per cord)	1.70	
Pitch, 1755 lb. at $0.0395 (3 cords, 585 lb. per cord)	69.32	
		98.50
Total per acre		$620.67
Fuel and Solvent[1]		

[1] Values not incuded.

The locations for wood-preparing and extraction plants must have—

1 Suitable water supply
2 Transportation
3 Convenience to territory to be cleared and to existing sawmills.

By locating field plants at sawmill locations, the operations will be assured of large amounts of pulp material from slabs, edgings, etc., while the scheme for land development is under way.

Because of great variation in the oleoresin content there is much of the pine waste which cannot be profitably exploited either by destructive distillation or by extraction, but which can be economically converted into pulp. On the other hand, a considerable portion of the stumps and other pine waste, while rich in resin, is so damaged by fire and rot as to be unfit for use either in the pulp mill or extract plant. Fibers that are scorched or decayed are too weak to make good pulp, and the charcoal adhering to burnt wood darkens the color of the rosin obtained by extraction, making this product less valuable. There exist three classes of wood corresponding to the three methods of utilization:

1 Charred and rotten wood fit only for destructive distillation
2 Lean wood good for pulp but not profitable for extraction
3 Fat lightwood, rich in oleoresins, a good raw material for the steam and solvent process.

By a suitable coördination of the extraction with the pulping operation in which the latter assists in the recovery of solvent, it becomes possible to overcome the difficulty in extracting pulp-size chips, and to obtain both oleoresins and paper pulp from the fat lightwood. This combination answers the requirements set forth above. Pulp manufacture is the main object, and any additional revenue derived from the oleoresin products is pure "velvet."

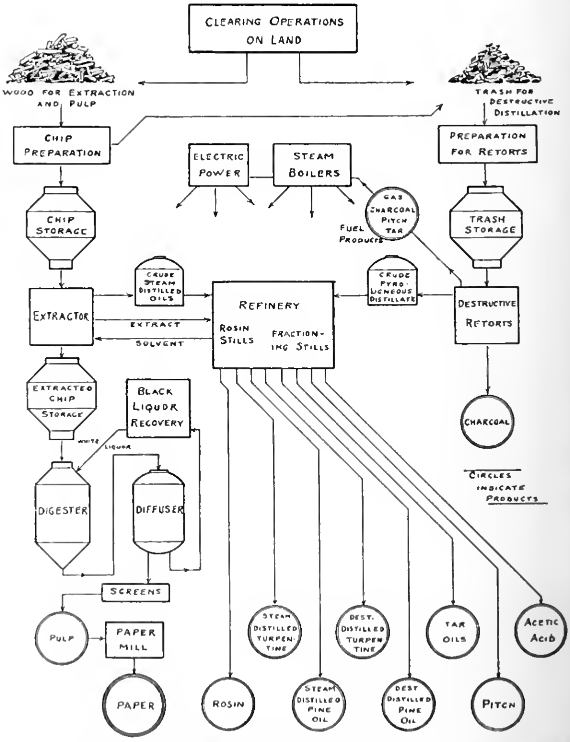


Fig. 2 Diagram Showing Manufacture of Pine Products from Waste of Cut Over Lands

One great advantage in choosing pulp and paper as the main product lies in the fact that this material can be sold on a generally stable market, while the naval stores market is notoriously speculative. So little capital is required to engage in turpentine operations that any rise in prices is quickly followed by an influx of small-scale operators, resulting in overproduction to the detriment of the trade.

In the experimental research work on the yellow-pine refuse, a miniature extraction and refining plant was first constructed from standard pieces of laboratory glassware, substantially as shown in Fig. 1.

After several modifications resulting from actual operation of this miniature plant, the process was sufficiently perfected to warrant tests on a larger scale. Accordingly a semi-commercial mill was built alongside the laboratory.

As a result of a series of tests in this miniature mill, the processes and methods mentioned have been thoroughly demonstrated.

Stresses and Deformation in Flat Circular Cylinder Heads

By GILBERT DUDLEY FISH,[1] NEW YORK, N. Y.

An analysis covering homogeneous elastic disks, where form and loading are symmetrical with respect to all diameters, where the loading is a combination of fluid pressures and of forces acting normally on concentric circles, where the thickness is uniform, and where all strains are within limits of true elasticity. Formulas applicable to all cases considered in the paper are developed, and equations are given for the constants of integration involved in the mathematical analysis. Two typical cases of the application of the principles involved have been analyzed and the results presented diagrammatically. To facilitate the computation of critical stresses and deflections in cases commonly occurring, simplified formulas are presented which may be solved by the use of charts from which certain terms are derived.

THIS paper is a mathematical analysis of stress and strain, and contains no discussion of the merits of the physical laws on which it is based. It adopts the conception of internal stress as a dependent function of strain, quite distinct from internal force which follows the laws of equilibrium; it considers that internal stress, as distinguished from internal force, is the criterion for resistance.

The field in which this analysis is intended to be useful is the design of large cylinder heads to withstand high pressures. Boiler practice, dealing with light plates and moderate pressures, provides no formulas or other guides which may be used properly in cases of pressures as high as one ton to the square inch, or of heads one foot or more in thickness. The futility of applying empiric formulas or other approximations of unknown latitude, in the design of a cylinder head which is to cost thousands of dollars, and the failure of which might cause immense damage, becomes apparent when it is discovered that in many familiar cases the values of critical stress, as given by various commonly employed methods or formulas, run as low as one-half or as high as double the values obtained by rigorous analysis.

A feature of this analysis which is thought to be of special importance is the treatment of a cylinder head having a central hole. Such a hole, even if small, has a tremendous effect on the critical stress.

While the study of the elastic deformation of a head is necessary preliminary to the determination of stresses, it is not for this reason alone that the analysis of deformation is important; the effectiveness of a gasket, depending as it does on residual gasket load, is directly related to the deflections of the head at the gasket circle before and after application of the working pressure.

It is thought proper to answer in advance an objection which may be raised against the formulas resulting from this analysis. In case it be attempted to check some of the stress formulas, by using them to calculate the maximum intensity of tensile or compressive stress in a plate or cylinder head which is known to have failed under a certain loading, a highly erroneous result is to be expected. This analysis is confined to the conditions existing in a body which is not strained beyond the limit of true elasticity at any point. The physical laws connecting strains and forces are not even approximately true outside the limits of elasticity, and the internal stresses, unlike those in a simple beam, are dependent on deformation. Therefore this analysis does not yield formulas whereby the ultimate resistance of a disk may be predicted. It is important that the strains in any cylinder head should not exceed the limits of elasticity, and it is consequently not essential to know what loading would cause it to crack or burst. In design, there must be established limiting intensities for stresses of tension, compression and shear, all well within the respective limits of elasticity for the material at whatever temperatures may be expected.

While it is not within the scope of this paper to make recommendations in regard to practice, it is thought proper to discourage the use of the ultimate strength of a material (whether in respect to tension, compression or shear) as a criterion for the maximum permissible stress in practice. Either the elastic limit or the fatigue limit is preferable as a criterion, especially in case of a special alloy steel or other material for which there exists no standard practice in regard to working stresses.

Attention is invited to the relatively large effect of detrusive (shearing) strain on the deformation of a thick head. Whereas, in the case of a boiler head, the deflections due to detrusive strain are minute in comparison with those due to flexure, they may even exceed those due to flexure in the case of a cylinder head designed to withstand several tons to the square inch, especially if there be a hole through the head.

Reference is made to the mathematical treatment of flat circular plates, by Prof. F. Grashof of Carlsruhe, published in his Elastizität und Festigkeit. There is believed to be no flaw in his analysis, and the present study, originally made without reference to his work and from a somewhat different method of approach, gives results identical with his, in so far as the same ground is covered by both. However, modern industrial apparatus involves conditions quite different in degree, if not in principle, from those contemplated by Professor Grashof, so that his formulas cannot, without a great deal of mathematical work, be extended so as to apply to actual cylinder heads. For example, it is necessary to analyze shear deflection, which was of no importance when pressures did not exceed a few hundred pounds to the square inch. Again, in the case of high pressure, surface application of load, as contrasted with distribution of load throughout the mass, appreciably reduces compressive stresses and deformation, and should be considered. The only special cases for which Professor Grashof published resulting formulas (i.e., formulas which can be used by direct substitution of numerical data), are very elementary cases which are never even approximately realized in the type of apparatus here considered. It will be found, therefore, that only a small part of this analysis is concerned with ground already covered in the work referred to. If part or all of the remainder duplicates anything previously published, the author can only plead ignorance.

Preliminary Explanation

Hooke's law, and Poisson's principle of constant ratio between lateral and longitudinal strains, are used as bases for this analysis. It is further presupposed that the elastic properties of the material are the same at all points and in all directions; also that elements (lines of particles), which in the absence of strain are straight and normal to the neutral surface, do not suffer curvature or obliquity due to flexure within the limits of elasticity, but do become curved and oblique to the neutral surface due to detrusion alone.

To define the general case to which this analysis is applicable, the initial presumptions are set down as follows:

a The head is of uniform thickness throughout

b The head is simply and uniformly supported around a circle. The familiar case of fastening by means of bolts, closely and uniformly spaced around a bolt circle, there being clearance between head and flange, is nearly a perfect realization of this assumption, except in respect to the unimportant direct stresses near the bolt circle; the shearing stresses at the bolt-circle section, which may be critical, are closely approximated by the formulas if the bolt-hole area be deducted from the gross area of the section. The design of a cylinder head may sometimes suggest fixation of the head at the support, as in the case of a head bolted tightly against a flange; however, in high-pressure work such fixation cannot actually exist, for no bolts are so inextensible as to prevent the slight angular strain which destroys fixedness, although a small degree of restraint may be imposed. Therefore fixed heads are ruled out of considera-

---

[1] Consulting Engineer, 101 Park Ave., formerly Major of Engineers, U. S. A.

Abstract of paper presented at the Annual Meeting, New York, December 5 to 9, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

tion as non-existent in fact, although it is not difficult to analyze the stresses and strains which would exist in such heads. Partially fixed heads are also excluded, for one reason because it is not possible to estimate the degree of fixedness in any given case, and for the other reason because such manner of support is considered bad practice, there being no known means for combining it with a gasket or other device so as to make a joint tight against high pressure.

c The head may be solid (i.e., have no perforations other than bolt holes); but, if not solid, it has only a single central hole of uniform circular bore, concentric with the bolt circle. If there be such a hole, no matter how it may be plugged, stuffed or capped, the head is considered unrestrained aroung the hole, for the same reasons for which it is considered simply supported around the margin, on the ground that no pipe, rod, cap or other device can have more than a slight restraining effect. Any slight degree of fixedness which may actually exist reduces slightly the direct stresses, and reduces still more slightly the deflections. See Fig. 1.

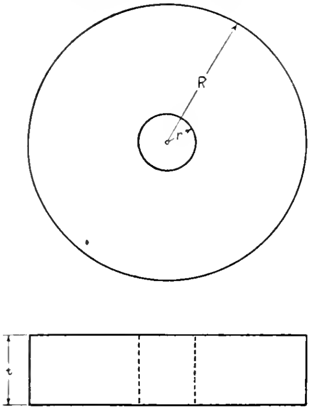


Fig. 1 Typical Head with Central Hole
(Any portion of head outside support circle not considered.)

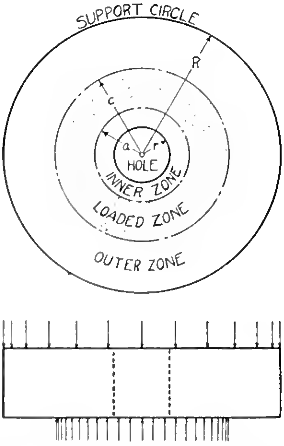


Fig. 2 Diagram of Typical Load
(Uniformly distributed over annular zone of radii *a* and *c*.)

d The loading is normal to the head, and may be so divided that each part is uniformly distributed over an annular zone. See Fig. 2. The three zones into which the head is divided by any such part of the loading will be called *inner zone, loaded zone* and *outer zone*. It is evident that this covers all cases of static fluid pressure in which the system is symmetrical with respect to all diameters. It covers also the case of a gasket load, for this may properly be regarded as uniformly distributed over a very narrow zone; in such a case, the width of the loaded zone is put equal to zero for the sake of convenience, although an absolute line contact is physically impossible. The same procedure as for a gasket load is applied, whenever there is a central hole, to a load concentrated around the edge of the hole, such as the force applied by an insert or plug. In any case where a load is treated as if concentrated on a circle, the loaded zone is considered not to exist. For the typical load, which is uniformly distributed over an annular zone, the total shearing force on any normal cylindrical section concentric with the zones (hereafter called circumferential section), having radius x, may be represented by $S = m + nx^2$, where m and n are constants pertaining to the zone cut by the section.

For the sake of convenience, the head will be regarded as horizontal. Although the loading may act partly upward and partly downward, the analysis contemplates only one part at a time, the joint effect of several loads being the aggregate of the several effects independently determined; it is therefore significant to distinguish between the opposite faces of the head as *tension face* and *compression face*, these terms having the same meaning as when applied to a simple beam.

Broadly considered, all loading is applied as normal external pressure, and causes an internal compressive force normal to the faces, throughout the loaded zone; the intensity of this force is equal to the intensity of applied pressure at the compression face, and decreases uniformly to zero at the tension face. If a load W be distributed over an annular zone of area $\pi(c^2 - a^2)$, the intensity of normal compressive force at the compression face is

$$q_n' = -\frac{W}{\pi(c^2 - a^2)}$$

the negative sign indicating compression. There are exceptions to this rule of surface application (for example, the dead weight of the head), but they are unimportant because any errors due to disregarding them are very minute in any actual case; if it be desired to take into account these exceptions, those terms in the resulting formulae which depend on the value of q_n' may simply be dropped.

NOTATION

The following notation is used throughout the paper:

R = radius of support circle. Positive. Unit = Distance

c = outer radius of loaded zone. Positive. Unit = Distance

a = inner radius of loaded zone. Positive. Unit = Distance

r = radius of central hole, if any. Positive. Unit = Distance

t = thickness of head. Positive. Unit = Distance

x = variable distance from center. Positive. Unit = Distance

y = variable deflection of neutral surface due to flexure alone. Positive. Unit = Distance

Y = variable deflection of neutral surface due to detrusion alone. Positive. Unit = Distance

z = variable vertical ordinate of a point in the head, measured from neutral surface. Positive if measured in some direction as load, negative if opposite. Unit = Distance

W = total load on loaded zone. Positive. Unit = Force

E = modulus of elasticity (Young's). Positive. Unit = $\frac{\text{Force}}{\text{Dist. squared}}$

λ = Poisson's Ratio. Positive. Pure Number

S = variable total vertical shearing force on a circumferential section. Positive. Unit = Force

s = variable intensity of vertical or horizontal shearing force in a vertical radial plane, at any point in the head. Positive. Unit = $\frac{\text{Force}}{\text{Dist. squared}}$

s_m = Value of s at any point in neutral surface.

The symbols for the intensities of internal stress and of internal force, other than shear, are given in the following table:

	Tension Face			Compression Face		
	Radial	Tangent	Normal	Radial	Tangent	Normal
Direct Stress..............	p_r	p_t	p_n	p'_r	p'_t	p'_n
Direct Force...............	q_r	q_t	q_n	q'_r	q'_t	q'_n

The quantities represented in this table are positive if tensile, negative if compressive. Their common unit is Force ÷ Distance squared. Direct stress intensity is defined as the rate of direct strain multiplied by E.

Although the deflections, which occur in the same direction as the load causing them, are considered positive, heed must be given

to the fact that separate loads, acting in opposite directions, cause opposite deflections. Both y and Y are considered zero at the support circle.

The neutral surface is everywhere midway between the two faces, but its distance from either face is slightly affected by diminution of the thickness t due to surface application of loading. However, this effect is so exceedingly small, that it will be considered in this analysis to be quite negligible. Therefore the deflection of either face, for any value of x, will be regarded as identical with the deflection of the neutral surface for that value of x. The fact that detrusive strains cause curvature of the normal elements does not invalidate this proposition. No proofs are given for the statements contained in this paragraph, for they are based on general theory and are not peculiar to the problem in hand.

EQUATIONS FOR FLEXURE AND DIRECT STRESS

Equations [1] through [15] provide means for determining flexure strains, direct internal forces and direct stresses at all points. Formulas for the constants of the integration are required and these are given for various physical conditions in Equations [16] through [45]. The derivation of these equations is given in the complete paper which may be procured from The American Society of Mechanical Engineers.

The shear deflections may be obtained from Equations [46] through [49].

Inner zone

$$y = \frac{3(1-\lambda^2)W}{4\pi E t^3}\left[A_1 \log_e x + B_1 - C_1 x^2\right] \qquad [1]$$

$$q_r = -q_r' = \frac{3W}{8\pi t^2}\left[-\frac{A_1}{x^2}(1-\lambda) + 2C_1(1+\lambda)\right] \qquad [2]$$

$$q_t = -q_t' = \frac{3W}{8\pi t^2}\left[+\frac{A_1}{x^2}(1-\lambda) + 2C_1(1+\lambda)\right] \qquad [3]$$

$$p_r = -p_r' = \frac{3(1-\lambda^2)W}{8\pi t^2}\left[-\frac{A_1}{x^2} + 2C_1\right] \qquad [4]$$

$$p_t = -p_t' = \frac{3(1-\lambda^2)W}{8\pi t^2}\left[+\frac{A_1}{x^2} + 2C_1\right] \qquad [5]$$

Loaded zone

$$y = \frac{3(1-\lambda^2)W}{4\pi E t^3}\left[A_2 \log_e x + B_2 - \frac{2a^2}{c^2-a^2}x^2 \log_e x - C_2 x^2 + \frac{x^4}{4(c^2-a^2)}\right] + \frac{\lambda W \cdot x^2}{2\pi E t(c^2-a^2)} \qquad [6]$$

$$q_r = -q_r' = \frac{3W}{8\pi t^2}\left[-\frac{A_2}{x^2}(1-\lambda) + \frac{4a^2}{c^2-a^2}\log_e x(1+\lambda) + \frac{2a^2}{c^2-a^2}(1+3\lambda) + 2C_2(1+\lambda) - \frac{x^2}{c^2-a^2}(1+3\lambda)\right] \qquad [7]$$

$$q_t = -q_t' = \frac{3W}{8\pi t^2}\left[+\frac{A_2}{x^2}(1-\lambda) + \frac{4a^2}{c^2-a^2}\log_e x(1+\lambda) + \frac{2a^2}{c^2-a^2}(3+\lambda) + 2C_2(1+\lambda) - \frac{x^2}{c^2-a^2}(3+\lambda)\right] \qquad [8]$$

$$p_r = -p_r' = \frac{\lambda W}{\pi(c^2-a^2)} - \frac{3(1-\lambda^2)W}{8\pi t^2}\left[-\frac{A_2}{x^2} + \frac{4a^2}{c^2-a^2}\log_e x + \frac{2a^2}{c^2-a^2} + 2C_2 - \frac{x^2}{c^2-a^2}\right] \qquad [9]$$

$$p_t = -p_t' = \frac{\lambda W}{\pi(c^2-a^2)} - \frac{3(1-\lambda^2)W}{8\pi t^2}\left[+\frac{A_2}{x^2} + \frac{4a^2}{c^2-a^2}\log_e x + \frac{6a^2}{c^2-a^2} + 2C_2 - \frac{3x^2}{c^2-a^2}\right] \qquad [10]$$

Outer zone

$$y = \frac{3(1-\lambda^2)W}{4\pi E t^3}\left[A_3 \log_e x + B_3 + 2x^2 \log_e x - C_3 x^2\right] \qquad [11]$$

$$q_r = -q_r' = \frac{3W}{8\pi t^2}\left[-\frac{A_3}{x^2}(1-\lambda) - 4\log_e x(1+\lambda) - 2(1+3\lambda) + 2C_3(1+\lambda)\right] \qquad [12]$$

$$q_t = -q_t' = \frac{3W}{8\pi t^2}\left[+\frac{A_3}{x^2}(1-\lambda) - 4\log_e x(1+\lambda) - 2(3+\lambda) + 2C_3(1+\lambda)\right] \qquad [13]$$

$$p_r = -p_r' = \frac{3(1-\lambda^2)W}{8\pi t^2}\left[-\frac{A_3}{x^2} - 4\log_e x - 2 + 2C_3\right] \qquad [14]$$

$$p_t = -p_t' = \frac{3(1-\lambda^2)W}{8\pi t^2}\left[+\frac{A_3}{x^2} - 4\log_e x - 6 + 2C_3\right] \qquad [15]$$

Solid head:

Inner zone

$$A_1 = 0 \qquad [16]$$

$$B_1 = \frac{3+\lambda}{1+\lambda}R^2 - (c^2+a^2)\left(\log_e R + \frac{3}{4} + \frac{1}{1+\lambda}\right) + \frac{1}{c^2-a^2}(c^4 \log_e c - a^4 \log_e a) - \frac{2 \cdot t^2}{3(1-\lambda^2)} \qquad [17]$$

$$C_1 = 2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} - \frac{2}{c^2-a^2}(c^2 \cdot \log_e c - a^2 \log_e a) + \frac{2}{1+\lambda} \qquad [18]$$

Loaded zone

$$A_2 = -\frac{a^4}{c^2-a^2} \qquad [19]$$

$$B_2 = \frac{3+\lambda}{1+\lambda}R^2 - (c^2+a^2)\left(\log_e R - \frac{1}{2} + \frac{1}{1+\lambda}\right) + \frac{c^4}{c^2-a^2}\left(\log_e c - \frac{5}{4}\right) - \frac{2\lambda \cdot t^2 c^2}{3(1-\lambda^2)(c^2-a^2)} \qquad [20]$$

$$C_2 = 2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} - \frac{c^2}{c^2-a^2}(2\log_e c + 1) + \frac{3+\lambda}{1+\lambda} \qquad [21]$$

Outer zone

$$A_3 = c^2 + a^2 \qquad [22]$$

$$B_3 = \frac{3+\lambda}{1+\lambda}R^2 - (c^2+a^2)\left(\log_e R - \frac{1}{2} + \frac{1}{1+\lambda}\right) \qquad [23]$$

$$C_3 = 2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} + \frac{3+\lambda}{1+\lambda} \qquad [24]$$

Head with central hole of radius r:

Inner zone

$$A_1 = -\frac{2r^2}{1-\frac{r^2}{R^2}}\cdot\frac{1+\lambda}{1-\lambda}\left[2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} - \frac{2}{c^2-a^2}\left(c^2 \log_e c - a^2 \log_e a\right) + \frac{2}{1+\lambda}\right] \qquad [25]$$

$$B_1 = (C_1+1)R^2 - (A_1 + 2R^2)\log_e R - (c^2+a^2)\left(\log_e R + \frac{5}{4}\right) + \frac{1}{c^2-a^2}\left[c^4 \log_e c - a^4 \log_e a + 2R^2(c^2 \log_e c - a^2 \log_e a)\right] - \frac{2\lambda \cdot t^2}{3(1-\lambda^2)} \qquad [26]$$

$$C_1 = \frac{1}{1-\frac{r^2}{R^2}}\left[2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} - \frac{2}{c^2-a^2}(c^2 \cdot \log_e c - a^2 \cdot \log_e a) + \frac{2}{1+\lambda}\right] \qquad [27]$$

Loaded zone

$$A_2 = -\frac{a^4}{c^2-a^2} - \frac{2r^2}{1-\frac{r^2}{R^2}}\cdot\frac{1+\lambda}{1-\lambda}\left[2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} - \frac{2}{c^2-a^2}(c^2 \log_e c - a^2 \log_e a) + \frac{2}{1+\lambda}\right] \qquad [28]$$

$$B_2 = C_2 \cdot R^2 - (A_2 + 2R^2)\log_e R + \frac{c^2}{c^2-a^2}\left[R^2 - c^2\left(\log_e R + \frac{5}{4}\right) + \log_e c(2R^2+c^2)\right] - \frac{2\lambda \cdot t^2 c^2}{3(1-\lambda^2)(c^2-a^2)} \qquad [29]$$

$$C_2 = \frac{1}{1-\frac{r^2}{R^2}}\left[2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} - \frac{c^2}{c^2-a^2}(2\log_e c + 1) + \frac{a^2 r^2}{(c^2-a^2)R^2}(2\log_e a + 1) + \frac{3+\lambda}{1+\lambda}\right] \qquad [30]$$

Outer zone

$$A_3 = c^2 + a^2 - \frac{2r^2}{1-\frac{r^2}{R^2}}\cdot\frac{1+\lambda}{1-\lambda}\left[2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} - \frac{2}{c^2-a^2}(c^2 \cdot \log_e c - a^2 \cdot \log_e a) + \frac{2}{1+\lambda}\right] \qquad [31]$$

$$B_3 = C_3 \cdot R^2 - (A_3 + 2R^2)\log_e R \qquad [32]$$

$$C_3 = \frac{1}{1-\frac{r^2}{R^2}}\left[2\log_e R - \frac{1-\lambda}{1+\lambda}\cdot\frac{c^2+a^2}{2R^2} - \frac{2r^2}{(c^2-a^2)R^2}(c^2 \cdot \log_e c - a^2 \log_e a) + \frac{2}{1+\lambda}\right] + 1 \qquad [33]$$

Solid head, load concentrated on circle of radius c.

Inner zone

$$A_1 = 0 \qquad [34]$$

$$B_1 = \frac{3+\lambda}{1+\lambda}\left(R^2 - c^2\right) - 2c^2 \log_e \frac{R}{c} - \frac{2\lambda t^2}{3(1-\lambda^2} \qquad [35]$$

$$C_1 = 2\log_e \frac{R}{c} + \frac{1-\lambda}{1+\lambda}\left(1 - \frac{c^2}{R^2}\right) \qquad [36]$$

Outer zone

$$A_3 = 2c^2 \qquad [37]$$

$$B_3 = \frac{3+\lambda}{1+\lambda}R^2 - 2c^2\left(\log_e R - \frac{1}{2} + \frac{1}{1+\lambda}\right) \qquad [38]$$

$$C_3 = 2\log_e R + 2 + \frac{1-\lambda}{1+\lambda}\left(1 - \frac{c^2}{R^2}\right) \qquad [39]$$

Head with hole, load concentrated on circle of radius c:

Inner zone

$$A_1 = -\frac{2r^2}{1-\frac{r^2}{R^2}}\left[2\frac{1+\lambda}{1-\lambda}\log_e \frac{R}{c} + 1 - \frac{c^2}{R^2}\right] \qquad [40]$$

$$B_1 = C_1 R^2 - A_1 \log_e R - 2(R^2+c^2)\log_e \frac{R}{c} + 2(R^2-c^2) - \frac{2\lambda t^2}{3(1-\lambda^2)} \qquad [41]$$

$$C_1 = \frac{1}{1-\frac{r^2}{R^2}}\left[2\log_e \frac{R}{c} + \frac{1-\lambda}{1+\lambda}\left(1 - \frac{c^2}{R^2}\right)\right] \qquad [42]$$

Outer zone

$$A_3 = 2c^2 - \frac{2r^2}{1-\frac{r^2}{R^2}}\left[2\frac{1+\lambda}{1-\lambda}\log_e \frac{R}{c} + 1 - \frac{c^2}{R^2}\right] \qquad [43]$$

$$B_3 = C_3 R^2 - (A_3 + 2R^2)\log_e R \qquad [44]$$

$$C_3 = \frac{1}{1-\frac{r^2}{R^2}}\left[2\log_e R + 2 + \frac{1-\lambda}{1+\lambda}\left(1 - \frac{c^2}{R^2}\right) - \frac{2r^2}{R^2}(\log_e c + 1)\right] \qquad [45]$$

Inner zone $$Y = \frac{3(1+\lambda)W}{2\pi E t}\left[\log_e R - \frac{1}{c^2-a^2}(c^2 \log_e c - a^2 \log_e a) + \frac{1}{2}\right] \qquad [46]$$

Loaded zone $$Y = \frac{3(1+\lambda)W}{2\pi E t}\left[\log_e \frac{R}{x} - \frac{1}{c^2-a^2}\left(c^2 \log_e \frac{c}{x} - \frac{c^2-x^2}{2}\right)\right] \qquad [47]$$

Outer zone $$Y = \frac{3(1+\lambda)W}{2\pi E t}\log_e \frac{R}{x} \qquad [48]$$

Inasmuch as the distance between the neutral surface and either face remains constant for all values of x and for all conditions of loading (except for the exceedingly small reduction in this distance due to surface application of load, which has nothing to do with detrusion), the values of Y given by these equations apply to the shear deflections of both faces as well as of the neutral surface.

With respect to shear, it is not necessary to distinguish between a solid head and one having a central hole.

To handle the case of a load concentrated on a circle of radius c, let a approach c as a limit in Equation [46]:

Load concentrated on a circle of radius c:

Inner zone $$Y = \frac{3(1+\lambda)W}{2\pi Et}\log_e\frac{R}{c} \quad \ldots\ldots\ldots\ldots \quad [49]$$

Outer zone Use Eq. [48]

The treatment of shearing stresses and deflections is thus completed. The formulas are so simple, that it is not thought necessary to discuss their application to special cases.

Evidently the total or resultant deflection of the head at any point, is equal to the sum of the resultant flexure deflection y and the resultant shearing deflection Y at that point.

ILLUSTRATION

Two fairly typical cases have been analyzed for the purpose of illustrating the application of this article, and the results are shown diagrammatically in Figs. 3 and 4. The two cases are alike, except that the first is that of a solid head, whereas the second is that of a head having a central hole.

Each head is of steel 13 in. thick, and is simply supported on a circle 54 in. in diameter. The gasket is of appreciable width, but for convenience is considered to form a line contact along a circumference 42 in. in diameter. The total gasket load is 491,300 lb. Gas pressure is applied over the entire area of a circle 40 in. in diameter, this being the inside diameter of the gasket; the intensity of this pressure is 2000 lb. per sq. in. In the case of the head with the hole, the gas load acting on the stopper of the hole is transmitted to the head as a shear at the edge of the hole, which is 6 in. in diameter. The steel has a modulus of elasticity of 30,000,000 lb. per sq. in., and Poisson's ratio is taken as $^1/_3$.

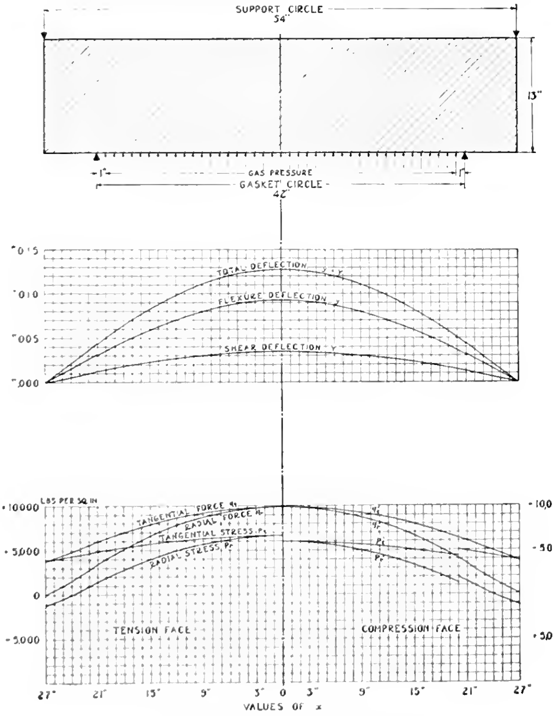


Fig. 3 Analysis of Solid Circular Head

The analysis of the solid head is made in two parts, one for the gas load of 2,513,300 lb., and the other for the gasket load of 491,300 lb. For the head with the hole there are three distinct loads: the main gas load, which is 2,456,700 lb. distributed over the annular space between hole and gasket; the gas load concentrated at the edge of the hole, amounting to the difference between 2,513,300 and 2,456,700 or 56,600 lb.; the gasket load of 491,300 lb.

We therefore take the following as the values for the given constants, which apply to all loads in both cases, i.e., solid head and head with a hole.

$R = 27$ in.	$E = 30{,}000{,}000$ lb. per sq. in.
$t = 13$ in.	$\lambda = {}^1/_3$

The following are the values of the other given constants, which are different for different parts of the analyses:

Solid Head	Head with Hole
Gas load—2 zones, loaded and outer $W = 2{,}513{,}300$ lb. $c = 20$ in. $a = r = 0$	Main gas load—2 zones, loaded and outer $W = 2{,}456{,}700$ lb. $c = 20$ in. $a = r = 3$ in.
	Gas load on stopper—outer zone only $W = 56{,}600$ lb. $c = a = r = 3$ in.
Gasket load—2 zones, inner and outer $W = 491{,}300$ lb. $c = a = 21$ in. $r = 0$	Gasket load—2 zones, inner and outer $W = 491{,}300$ lb. $c = a = 21$ in. $r = 3$ in.

The deflections, forces and stresses are determined separately for the several loads in each case, and the results are added to find the resultant effects. These results are plotted in Figs. 3 and 4. The break in the flexure deflection curve in each case is due to the assumed line application of gasket load, as explained in the analysis, and is numerically equal to 0.000067 in.

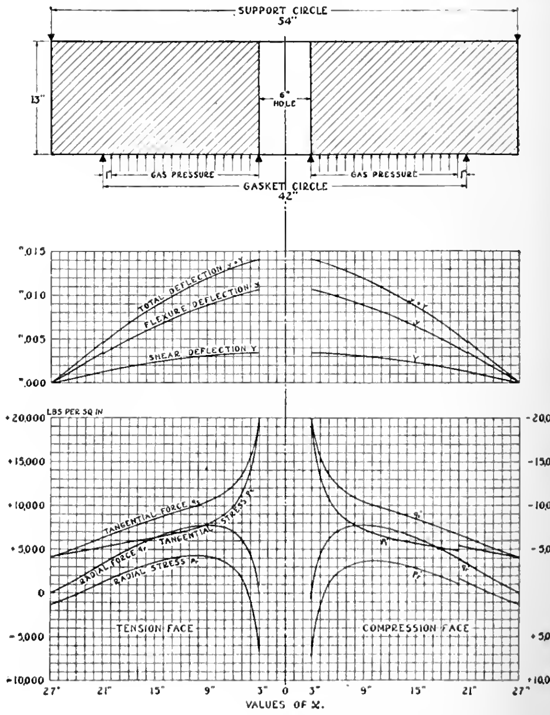


Fig. 4 Analysis of Circular Head Having a Central Hole

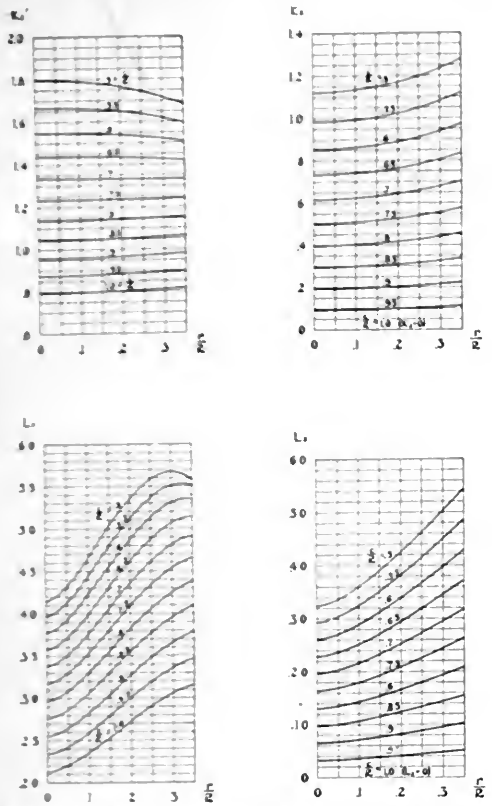
CHARTS

Figs. 5 to 12 facilitate the computation of critical stresses and deflections in cases commonly occurring, subject to the assumption of $^1/_3$ as the value of Poisson's ratio λ.[1]

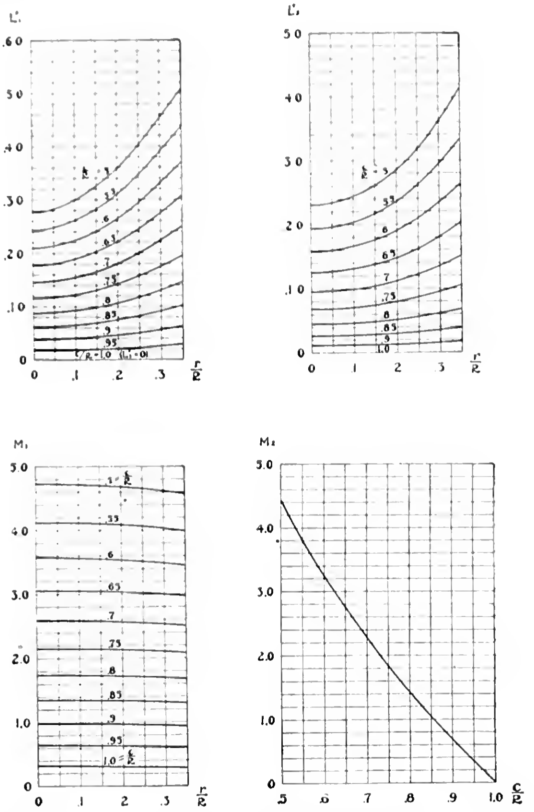
Eight auxiliary quantities are introduced, *viz.* K_1, K_2, L_1, L_2, L'_1, L'_2, M_1, M_2. Each of these except M_2, is a function of r/R and c/R, r/R being zero in the case of a solid head; M_2 is a function of c/R alone. Each of the eight charts yields the value of one of these auxiliaries in any given case.

---

[1] For steel, $^1/_3$ is a convenient approximate value commonly employed; scarcity of experimental information in regard to lateral strainsmakes it useless to seek refinement in regard to the value of λ.



Figs. 5–8 Charts for Facilitating Computation of Critical Stresses and Deflections in Commonly Occurring Cases, Poisson's Ratio Being Taken as 1/3



Figs. 9–12 Charts for Facilitating Computation of Critical Stresses and Deflections in Commonly Occurring Cases, Poisson's Ratio Being Taken as 1/3

TABLE 1 AUXILIARY FORMULAS FOR USE WITH CHARTS, FIGS. 5 TO 12

		Solid Head (put $r/R = 0$)	
	Symbol	Due to load W distributed over area of circle, radius c	Due to load W concentrated on circumference, radius c
Intensity of stress in tension face at center	$p_t = p_r$	$\frac{W \cdot K_1}{3t^2}$	$\frac{W \cdot K_2}{3t^2}$
Intensity of stress in compression face at center	$p'_t = p'_r$	$-\frac{W}{3}\left(\frac{K_1}{t^2} - \frac{1}{\pi c^2}\right)$	$-\frac{W \cdot K_2}{3t^2}$
Center deflection due to flexure	y	$\frac{W}{Et}\left(\frac{R^2L_1}{t^2} - \frac{1}{6\pi}\right)$	$\frac{W}{Et}\left(\frac{R^2L_2}{t^2} - \frac{1}{6\pi}\right)$
Center deflection due to shear	Y	$\frac{WM_1}{E \cdot t}$	$\frac{WM_2}{Et}$
Deflection at radius c due to flexure	y	$\frac{WR^2L'_1}{Et^3}$	$\frac{W}{Et}\left(\frac{R^2L_2}{t^2} - \frac{1}{12\pi}\right)$
Deflection at radius c due to shear	Y	$\frac{WM_2}{Et}$	$\frac{WM_2}{Et}$
		Head with Central Hole of Radius r	
	Symbol	Due to load W distributed over area of circle, radius c	Due to load W concentrated on circumference, radius c
Intensity of tangential stress in tension face at edge of hole	p_t	$\frac{W \cdot K_1}{t^2}$	$\frac{W \cdot K_2}{t^2}$
Intensity of tangential stress in compression face, edge of hole	p'_t	$-W\left(\frac{K_1}{t^2} - \frac{1}{3\pi c^2}\right)$	$-\frac{W \cdot K_2}{t^2}$
Deflection at edge of hole due to flexure	y	$\frac{W}{Et}\left(\frac{R^2L_1}{t^2} - \frac{1 - r^2/c^2}{6\pi}\right)$	$\frac{W}{Et}\left(\frac{R^2L_2}{t^2} - \frac{1}{6\pi}\right)$
Deflection at edge of hole due to shear	Y	$\frac{WM_1}{Et}$	$\frac{W \cdot M_2}{Et}$
Deflection at radius c due to flexure	y	$\frac{WR^2L'_1}{Et^3}$	$\frac{W}{E \cdot 1}\left(\frac{R^2 \cdot L'_2}{t^2} - \frac{1}{12\pi}\right)$
Deflection at radius c due to shear	Y	$\frac{WM_2}{Et}$	$\frac{WM_2}{Et}$

The simple formulas classified in Table 1 give the stresses and the deflections at the center in the case of a solid head, or the tangential stresses and the deflections at the edge of the hole in the case of a centrally bored head, due to any load W uniformly distributed over the entire area of a circle of radius c concentric with the support circle, or due to any load W concentrated along the circumference of such a circle.

The formulas giving the effects of a distributed load, in the case of a head with a central hole, include the effects of that portion of the load which acts on the area of the hole and which is transmitted to the edge of the hole by the stopper which closes the hole; the proper value of use for W is the total pressure within the circle of radius c.

The formulas by means of which the auxiliary quantities were computed, are not reproduced here, being cumbersome; they were reduced directly from formulas derived in the earlier part of this article, with λ put equal to $1/3$. It is to be noted that these auxiliaries do not serve to give stresses and deflections *at all points*, as do the formulas of the analysis; they give only particular stresses and deflections of major importance.

The main practical purpose served by the charts is as follows. In the case of a steel cylinder head of uniform thickness t, simply supported around a circle of radius R, having a central hole of radius r (which is considered zero in case there is actually no such hole), sustaining a gasket load concentrated along a circumference of radius c, and sustaining also a static fluid pressure acting on the entire area enclosed by the gasket circle, *to find the maximum intensities of tensile and compressive stress, the maximum deflections due to flexure and shear, respectively, and the deflections at the gasket circle due to flexure and shear, respectively.*

DISCUSSION OF PAPER ON DEFORMATION OF CYLINDER HEADS

THE attendance at the General Session at which G. D. Fish presented his paper on stresses and deformation in flat circular cylinder heads was limited to a few particularly interested in this subject. The discussion took the form of a round-table talk in which the author answered the questions of this interested audience and explained further details of the problem presented in his paper. A résumé of the important points touched upon and bearing most directly upon the subject of the paper is given below.

W. H. Runkel[1] in opening the discussion asked what factor of safety was used in the flat cylinder heads designed for the nitrate plant. The author replied that a maximum intensity of direct stress of 10,000 lb. per sq. in. was allowed. The material was forged steel, and was expected to be a special alloy. Tests were being made at the Bureau of Standards, at the time the author severed his connection with the Bureau, to determine its strength, at high temperature, and the effect of a hole in it. Many specimens composed of carbon steel, nickel-carbon steel, chrome-vanadium steel, and molybdenum steel were being pulled at high temperatures. The ultimate strength of all the alloys was increased by elevating the temperature to 300 or 400 deg. fahr., but there was a tendency to decline beyond these values, which finally dropped off decidedly at more elevated temperatures.

Conrad C. Jacobson[2] asked if there was not a limit to the efficient thickness of the head, where a very high pressure was developed and there was a tendency toward bending between the bolt circle and the gasket circle. Would it not be a better design, he asked, to use hydraulic clamps directly through the gasket circle, rather than to depend on the bolt circle, and thus do away with this flexure?

The author answered that actual trials with screwed-in heads with the thrust directly against the gasket resulted in serious leakage.

Mr. Jacobson said that this was because no follow-up had been provided, and when the elasticity was gone there was a space between the head and the flange which decreased the initial tension on the gasket. He said that he was talking from experience, in work in which old-fashioned methods were used, but trouble was found in keeping tight joints. No matter how thick the heads were made, there was an initial pressure on the gasket with bolts.

The author said that his method was to calculate the deflation or bulging between the bolt circle and the gasket under a condition of bolt tension, without gas pressure, and also under the condition of bolt and gas pressure. If the overhang on the head beyond the gasket was properly proportioned to the other elements, there was a residual gasket pressure after the gas pressure was applied, and it was found feasible to do with a residual gasket pressure equal to about one-fifth of the total gas pressure. The elasticity of the plate made it possible to retain a residual gasket pressure after the gas pressure was applied.

Mr. Jacobson asked if it was always possible to determine the exact pressure that would be developed by the liquid pressure of the material handled.

The author answered that exact calculations were theoretically but not actually possible. The pressure in the system was maintained by means of a standard type of compressor, and the loss of head through the various members of the circulating system was quite definitely known, so that operating conditions were subject to fairly accurate control, both as to pressure in the apparatus and as to temperature.

In dealing with pressures inside any containers used for other purposes than the ones he was dealing with, he would expect that the calculated pressures would be subject to variations due to impurities of catalytic agents, and that certain mechanical and thermal conditions would affect the chemical equilibrium between the reagents and their product which could not be calculated exactly. Therefore, unless mechanical means were used for maintaining the system at a fixed pressure, a considerable percentage of variation in the pressure might be expected.

In connection with his problem there were incidental temperature differences to deal with, which meant that any construction of head or gasket which did not permit relative expansion laterally between the head and gasket seat would fail.

The bolting of the flanges seemed the most practical method for holding the gas, but even that was not very simple, because wrenches six feet long had to be used to turn up the bolts, and the ends of the wrenches had to be hit with sledges.

Mr. Jacobson, Thomas W. Milnor and the author discussed methods of fastening cylinder heads with clamps.

W. J. Drisko[1] said that he had been working on photoelectricity in connection with a number of problems of engineering interest, and the possibility of studying the distribution of stresses in a disk with a pneumatic pressure applied over the surface had occurred to him. He wondered if any information had been obtained through such means as this on the subject of the paper.

The author knew of no experimental evidence which would help Mr. Drisko. Strains, as put forth in his paper have been completely analyzed. The study of the inside of a thick plate, subject to flexure, showed that the normal elements which were straight before flexure, became curved after flexure, not due to that portion of the deflection which is called flexure but due to detrusion or shear. This was so slight that it would take a photomicrometer to detect it.

Elwyn E. Seelye[2] presented the following written discussion.

The method of analysis used by the author is based upon the elastic theory and is one of the most interesting examples of applied mathematics of which the writer is familiar. Where homogeneous material is in question, if the correct equations are written, very exact results may be looked for.

The writing and solving of these differential equations required considerable knowledge of higher mathematics.

It is interesting to examine the difference in results obtained by analyzing a cylinder head by ordinary statics as compared to the far more correct analysis based on the elastic theory.

In order to make the case as simple as possible, let us take the case of a circular plate uniformly loaded and simply supported around its perimeter, taking the moment about a diametrical section. The moment is readily obtained by determining the location of the center of gravity of the semicircle and the half perimeter, respectively. This gives us a total moment through the diametrical action of $\frac{w\gamma}{3\pi}$, which gives an average unit stress of $\frac{w}{\pi t^2}$, which if assumed to be parabolic in distribution gives a maximum stress at center of $\frac{1.5w}{\pi t^2}$ as compared with $\frac{0.83w}{\pi t^2}$ by the elastic formula.

This contrast in even greater if there is a small hole in the center of the head when the maximum stress is tangential and is three times that of a solid head, whereas the statical solution would increase the stress only directly with the material omitted.

These surprising differences are met with by engineers in floor-construction designs, particularly in the case of flat-slab construction, and affect the mechanical engineer in relation to the strength and economy of his plant-housing structures.

In the course of a paper read before the Institution of Engineers and Shipbuilders in Scotland. Mr. W. Rees Darling described a form of gear for marine propulsion. The place of the teeth on the pinion is taken by a bundle of loose wire rollers, which are free to move and adapt themselves to the form of the teeth on the gear wheel. Pinions of the new type may be moved into gear instantaneously or gradually while revolving at any speed. This is done regularly at present at a speed of 2000 revolutions per minute without shock or danger of any kind. The pinions in use so far have been fitted for the purpose of surmounting difficulties which had previously seemed insuperable, and have proved entirely successful.—*The Engineer*, Jan. 20, 1922.

---

[1] New York City.

[2] Developing Engr., The Celluloid Co., 290 Ferry St., Newark, N. J. Assoc-Mem.Am.Soc.M.E.

[1] Dept. of Physics, Mass. Inst. of Tech., Cambridge, Mass.

[2] Cons. Engr., 101 Park Ave., New York, N. Y.

A Discussion of Draft Tube Designs[1]

With Special Reference to Recent Forms Known as the Hydraucone Regainer and the Spreading Draft Tube

By WEBSTER K. RAMSEY,[2] BOSTON, MASS.

THE purpose of this paper is not to present the hydraulic draft tube from a highly theoretical standpoint, but rather from an angle which will be of interest to the greatest number at the present time. It will be surprising to any one who has studied the subject at all to find what a large number of operating hydraulic engineers have but a limited knowledge of either the importance of the draft tube or the action of the water in the different types.

The primary requisite for an understanding of the draft-tube effect upon the water is a knowledge of the action of the water as it issues from the runner of the turbine. In the explanation which follows, a vertical turbine is considered.

CONDITION OF WATER DISCHARGED FROM TURBINE RUNNER

The condition of the water discharged from a runner depends upon the specific speed of the runner With specific speeds up to 50, which designates a medium-head installation, the water is discharged in such a manner as to cause it to whirl in the same direction as the rotation of the runner, up to best gate. At best gate the water flows practically radially inward. Above best gate the whirl is in the opposite direction to the rotation of the runner. Considering values of specific speed above 50, which designates low-head installations, the velocity of whirl increases in magnitude as the specific speed increases. In this case the water does not change its direction of whirl even after best gate conditions are reached. It is particularly the low-head, high-specific-speed runners having high velocities of whirl which concern the draft-tube requirements, as will be shown later.

The following discussion, in order to cover every condition of whirl, considers a runner which

1 Below best gate gives a velocity of whirl in the same direction as the rotation of the runner; decreasing in magnitude as the gate opens
2 At best gate gives practically radially inward flow with no whirl; and
3 Above best gate gives a velocity of whirl in the opposite direction to the rotation of the runner, increasing in magnitude as the gate opens.

THE DRAFT TUBE

Turning now to the draft tube, it will be found that this device is used to permit the turbine being placed high enough above tailwater level to give accessibility. In providing an air-tight tube to conduct the water from the turbine runner to the tail race, it is hoped that a good part of the head lost because of the position of the turbine will be regained by the vacuum caused by the weight of the solid column of water flowing downward to the tail race. The problem, however, is not so simple. The water drops with a certain initial axial velocity even at best gate; off best gate there is added a velocity component of whirl. Water is discharged from a runner with a very high exit velocity, especially in the case of a low-head, high-specific-speed installation. This velocity represents a certain amount of static head acting on the wheel. If this discharged water is allowed to reach the tail race without giving up most of its velocity, then just so much energy will be lost.

The purpose of the draft tube, then, is to regain the axial component of velocity and the whirl component as well. In any case the regain, which is usually provided for by supplying a tube of increasing cross-sectional area which regains static head (H_s) from velocity head (H_v) in accordance with Bernoulli's theorem, will be practically impossible unless the water can be made to flow in parallel stream lines and without cross-currents or eddies. The nature of the installation in low-head plants has added one more requirement which demands that the discharged water be turned through an angle of 90 degrees in the shortest possible distance measured in the direction of flow. This latter requirement saves the costly excavation otherwise necessary.

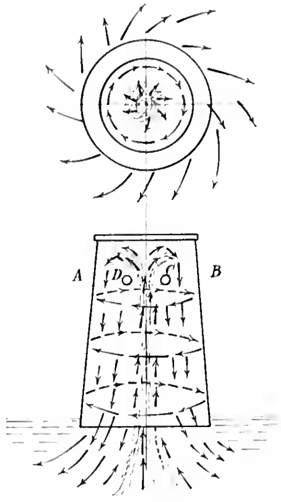


FIG. 1 SHORT, STRAIGHT DRAFT TUBE

THE PLAIN, SHORT STRAIGHT DRAFT TUBE

Consider a short, straight draft tube discharging into a tail race as shown in Fig. 1. When the turbine is operating below best gate, the water is discharged down the draft tube at an angle. Starting at 0.1 gate, and measuring the angle of flow with respect to the vertical axis of the tube, it is found that the angle of whirl near the sides of the tube is greatest at the lower gates, gradually decreasing until vertical (zero angle) at best gate. If the turbine mechanism is so arranged as to allow the gates to be opened much beyond best gate, the angle will be on the other side of the vertical, showing that the angle of whirl has been reversed, and instead of the water whirling in the same direction as the runner, it will whirl down in the opposite direction.

Now, when the water is whirling down a draft tube with great centrifugal force, the action causes water to be drawn up in the central part of the tube. See Fig. 1. This column ascends to a point directly beneath the runner, where it turns over and down and is discharged down the tube again with the water which is being discharged from the turbine.

The presence of this column of upward-flowing water is very undesirable in that it increases friction losses as well as reduces the static head or vacuum which would be formed and maintained directly below the runner.

It is important to note at this point that when the runner is discharging water at best gate, the water is flowing down in practically straight stream lines. Under this condition, there is no centrifugal action to cause the water to be drawn up from the tail race. There is, however, a loss due to sudden expansion at the discharge end of the tube.

It is also to be noted that in a tube of this type there is practically

---

[1] The present paper includes a part of a thesis submitted by Messrs. F. M. Rowell, R. A. Snow, M. H. Winchester and the author to the Massachusetts Institute of Technology in May, 1921, for the degree of Bachelor of Science, Parts I and II of which respectively dealt with an efficiency test of an Allis-Chalmers vertical hydraulic turbine, and a test of a White hydraucone draft tube. The apparent action of the water in the White regainer as tested led the author to investigate the action of the water in the light of the known conditions existing in other tubes.

It is to be noted that the thesis as submitted, which was practically the same as this paper with the exception of the more detailed description of the Moody spreading tube, was given to the Institute previous to the presentation of the paper on the White hydraucone regainer at the A.S.M.E. Spring Meeting in Chicago. The essence of the discussion following the presentation of the White paper as found in the July, 1921, issue of MECHANICAL ENGINEERING was contained in the above thesis as submitted in the middle of May, 1921.

The author wishes to acknowledge suggestions from Mr. W. M. White, received in an interview, regarding the construction of a pitot tube and method of testing the hydraucone regainer; and from Mr. L. F. Moody concerning the Moody spreading draft tube.

[2] Student, 1922, Mass. Inst. Tech.

Presented at the Student Session of the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 8, 1921. Slightly abridged. All papers are subject to revision.

no provision made for straightening out the water flow and thereby utilizing even the short length of tube which has an increasing cross-sectional area. Further, no provision is made for turning the water through 90 degrees, which is one of the chief requirements of a low-head installation.

Flaring Draft Tubes

Until the advent of the radial draft tubes the usual method of discharging water from a low-head turbine was to provide a flaring tube having a short 90-deg. bend as shown in Fig. 2.

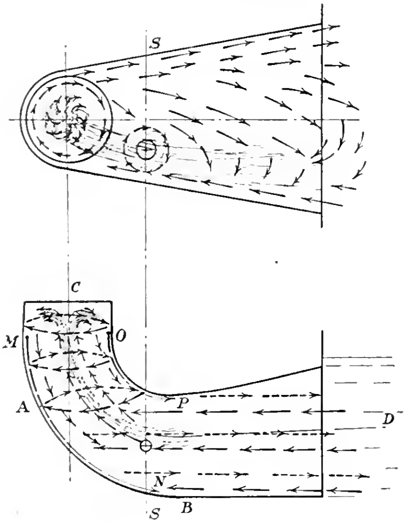


Fig. 2 Flaring Draft Tube with Short Body

If the turbine was operated always at best gate, it is easy to see that the direction of the water would be changed by friction along *AB*. Assuming that a full tube section of water started from *C* to *D*, it is to be noted that this water would pass points *M* and *O* with the same velocity. Assuming the runner discharges water at an equal rate over the entire area at *C*, it can be seen that as the water turns the 90-deg. bend the inner particles flowing along *OP* will not have the same velocity as those flowing along *MN*. Hence an eddy loss—a loss caused by cross-currents set up by the sliding of one layer of water over another—is present in this form of tube, even when operating at best gate. It has been further found that when straight stream-line conditions are obtained, the high-velocity water will flow along the bottom half of the horizontal portion of the tube and discharge below the point *D*. In not a few cases it has been found that when the upper portion of the flare was a little too high, the water actually flowed back into the tube above the line *D*.

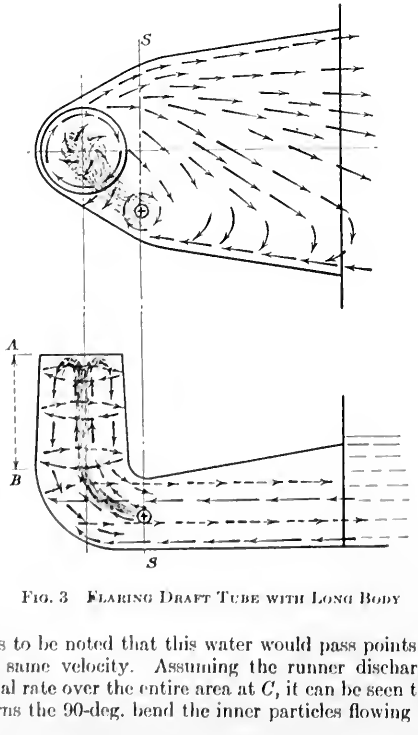


Fig. 3 Flaring Draft Tube with Long Body

Considering actual operation, a turbine is almost always enough off best gate to cause considerable whirling of the water. This whirling body of water possesses properties not unlike those of the rotating wheel of a gyroscope, and like a gyroscope it tends to keep in a plane perpendicular to its initial axis. Hence it will be seen that the water will not continue to rotate in a plane perpendicular to the central axis of the draft tube upon reaching the bend in the tube. This theory is substantiated by noting that the drawing action caused by the commotion of the water at the bend, as shown in Fig. 2, renders a part of the discharge area ineffective. In most cases the water actually flows back into the draft tube and is drawn from the points of most violent eddying (marked "+") up into the vertical portion as shown. In not a few cases the combined effect of the actions stated causes a complete loss of the total draft head available.

The construction of this type is not a factor in its favor. The best of these designs are made in concrete. When made of steel, the tube should bend smoothly at the elbow and not be made up of flat sections of steel plate.

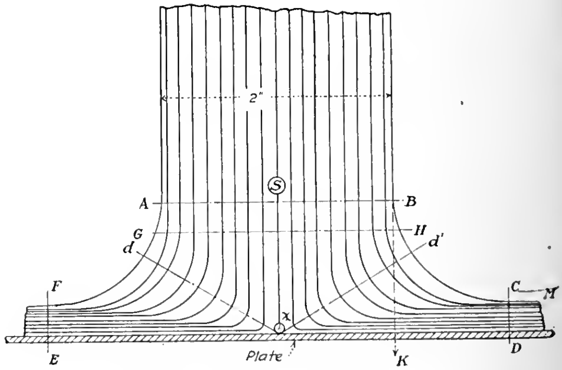


Fig. 4 Hydraucone and Hydraucone Action

Fig. 3 shows a draft tube similar to that of Fig. 2 with the exception of the longer body from *A* to *B*. This longer body has the effect of straightening the flow lines of the water, thus rendering it in a better condition for regaining through the diverging tube. It is evident that this design requires a greater distance from the horizontal center line of the turbine runner to the bottom of the tail race. The beneficial effect of the added length *AB* is actually very small.

The Hydraucone

Mr. W. M. White, manager and chief engineer of the hydraulic department of the Allis-Chalmers Manufacturing Company at Milwaukee, Wis., was the first to patent a means whereby static head could be regained from velocity head, and the direction of water be changed at the same time, in the shortest possible distance measured in the direction of the flow of water. These changes are brought about by what is called by the inventor the "hydraucone action" of the water, together with the regaining qualities of the design which act in accordance with Bernoulli's theorem.

The "hydraucone" is that portion of water bounded by the surfaces *AB* and *CD-EF*, Fig. 4, and its action, in the case of the straight jet normal to the plate, is to turn the water through ninety degrees without losing any velocity, and at the same time preserving parallel stream lines. The velocity head, moving vertically downward, is converted into static head, and this head used to reconvert

the static head into velocity head again, but in a horizontal direction with a very high efficiency.

THE WHITE HYDRAUCONE DRAFT TUBE

Realizing the importance of the hydraucone action of the water under the above conditions, Mr. White conceived the idea of utilizing the action to changing the direction of the water flowing from low-head turbines where expense of excavating for a long, straight draft tube would be prohibitive. The development of the White hydraucone draft tube is herein explained.

Referring to Fig. 4, a jet of water is shown impinging on a flat plate. The flat plate, which is the base of the hydraucone chamber, is made preferably circular and placed concentric with respect to the discharging jet.

Now, if the conoidal surface of the hydraucone, as *ABCF*, were enclosed in a closely fitting chamber, surface friction would result. Hence, a conoidal chamber is so constructed as to be slightly larger than the volume of a free hydraucone. At this point we have an enclosed hydraucone possessing all the characteristics of a free hydraucone. A step further is taken. In order to regain pressure from velocity it is necessary to provide a tube of increasing cross-sectional area. Therefore the conoidal chamber is not only made large enough for a free hydraucone with provision for friction, but also is slightly flared at the lower end, thus combining in one chamber the direction-changing action of the hydraucone with the pressure-regaining action of the section of increasing cross-sectional area.

The complete development of the design is shown in Fig. 5, a study of which will show how the pressure is regained in the following four distinct steps:

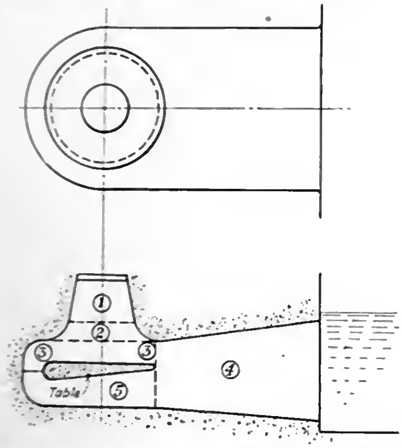


FIG. 5 WHITE HYDRAUCONE REGAINER AS PATENTED

1 First regain due to the diverging draft tube
2 Second regain due to the diverging hydraucone chamber
3 Third regain due to increasing area as water flows radially outward along the plate
4 Fourth regain due to the diverging draft tube which leads to the tail race
5 Collecting-chamber under the hydraucone baseplate. It serves as a place for collecting all the water coming off the plate and directing this water out through the section (4) into the tail race.

TEST ON THE WHITE HYDRAUCONE DRAFT TUBE

The discussion of the hydraucone up to this point has considered that the water issuing from the runner was moving in a radially inward direction and falling thence vertically down the draft tube. In actual practice, as before stated, this is seldom the condition. It is necessary, therefore, that we make a test to ascertain just what happens in a hydraucone-equipped draft tube when the water does not drop vertically downward like a jet, but comes whirling down at a sharp angle.

The draft tube on which this test was run was a part of an Allis-Chalmers 1875-kva. hydroelectric unit at Greggs Falls, N. H. The draft tube is equipped with a White hydraucone tube as shown in Fig. 6.

Ten tests were made in the following manner: The turbine was brought up to speed (257 r.p.m.), and by means of the load-limiting device on the back of the Allis-Chalmers governor, the gate was allowed to open to 0.1 gate. A special long pitot tube was then pushed into the draft tube until the tip was at the extreme opposite zone of the section. Both static-head and velocity-head hoses were connected to the U-tube of mercury. Knowing that the water was whirling down the draft tube at an angle, the exact position of the normal element of water was ascertained by turning the nozzle of the tube until the maximum velocity-head reading was obtained. At this position the velocity head and the angle of the nozzle were read. Holding the tube firmly, the velocity hose was disconnected and the static head read for that position. The tip was then drawn back into the next zone, of which there were ten, and readings taken in a similar manner. Having traversed the draft tube across the diameter at 0.1 gate, the turbine was brought up to 0.2 gate (speed constant throughout) and readings obtained in the same way as at 0.1 gate. In like manner readings were recorded for each tenth gate up to maximum gate opening (1.0).

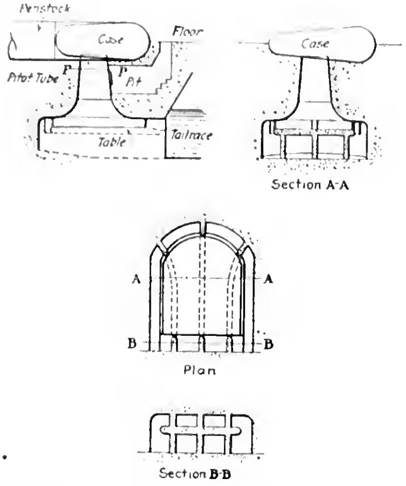


FIG. 6 WHITE HYDRAUCONE REGAINER AS INSTALLED AT GREGGS FALLS, N. H.

An inspection of the curves of Fig. 7 shows that negative velocity-head (H_v) and high static-head (H_s) readings were obtained in the central area of the draft tube at the lower gates, gradually diminishing in magnitude until at 0.9 and 1.0 gates all the velocity-head readings were positive and all the static-head readings were of not unusual magnitude.

The results show further that the angle the nozzle made with the vertical axis of the draft tube was greatest at the lower gates. It was also noticed that at the gates showing negative H_v readings the angle was greatest at the side of the draft tube and gradually decreased until, at the point of negative readings in the central area, the nozzle was vertical.

From the results of the readings taken by the use of a pitot tube traversed across the draft tube as previously explained, the following are noted:

a The velocity and angle of whirl of the water in the draft tube are greatest at low gates, decreasing as the gate is opened
b The negative velocities occur at the low gates when the angle of whirl of the water is greatest
c When negative velocity-head readings are obtained, the pitot-tube nozzle was vertical and in the central area of the draft tube
d The vacuum is greatest at lowest gate, decreasing as the gate is opened.

Recalling the conditions which produce the negative velocity-

head readings in the case of the short, straight draft tube, similar readings on this test appear to indicate that the column of upward-moving water is still present in this type of draft tube.

The construction of the hydraucone-chamber baseplate seems to indicate that it would be impossible for water to be sucked out of the tail race across the top of the plate and thence up the draft tube.

A more logical explanation as to the source of the upward-moving column of water is that water is picked up off the inner surface of the discharged water which is whirling down the draft tube as shown in Fig. 8. It is quite conceivable that the water is whirling around the circumference of the inner surface of the draft tube, leaving plenty of space in which the column of water could rise. At any rate there exists this upward-moving column of water in this design when the turbine is operating at the lower gates.

It is now necessary to consider whether the hydraucone action of the water is still present. In view of the foregoing paragraphs, the writer is inclined to doubt it when the turbine is operating off best gate and the water is whirling down the tube. The water now impinging on the plate is not a straight jet and therefore the action of a straight jet does not hold. With a straight jet, the force which builds up the static head at x, Fig. 4, is the inertia of the water falling vertically downward in a straight line all around that point. The force which prevents particle B, for instance, from continuing in a straight line vertically downward to K is the force which reacts at x and helps maintain the high static head at x.

Now the whirling water has the opposite tendency to the above, namely, a tendency to fly off at a tangent, out through the annular passage through area CD-EF, Fig. 4; or space (3), Fig. 5, and thus create a tendency to produce rather a vacuum at x than a pressure, or at any other point within the draft tube. From this it is evident that the hydraucone is probably not formed at any but the best gate.

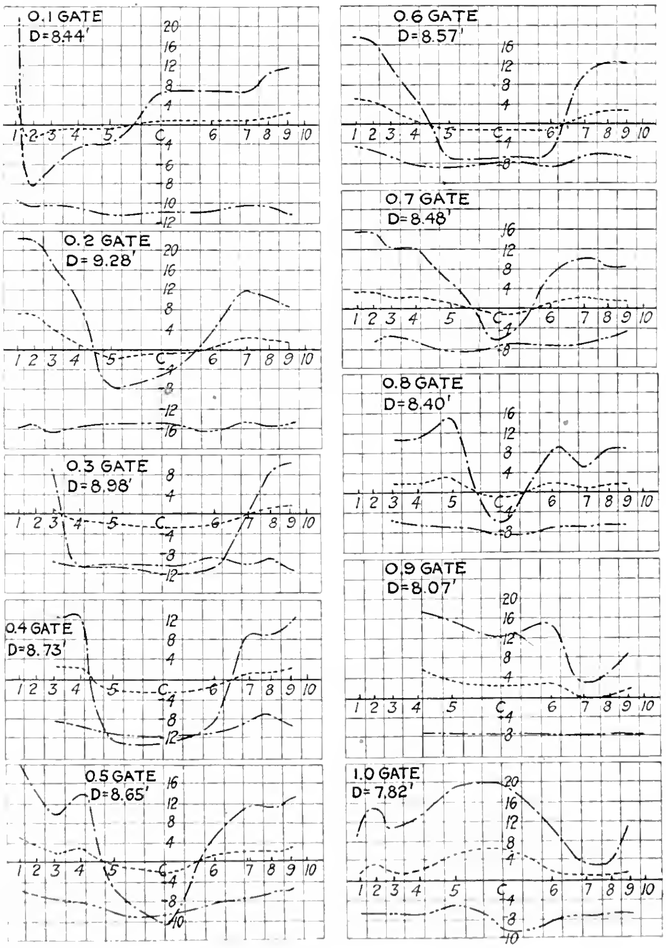


Fig. 7 Variation of Static Head and Velocity Head as Measured Across Draft-Tube Diameter for Different Gate Openings

_ _ _ _ _ _ _ _ Velocity of static head in feet of water
_ . _ . _ . _ . _ Static head in feet of water
_ . . _ . . _ . . Velocity (ft. per sec.) as calculated from velocity-head curve
D = distance from center line of pitot tube to tail-water level.

Notwithstanding the foregoing reasoning which seems to indicate that it would be impossible to maintain a hydraucone under whirling conditions of water, the makers state that they have made exhaustive investigations regarding this phase of the subject and have found that the hydraucone action is present under *any* condition of whirl, but that the pressure at the center of the plate may decrease to some extent, such decrease being dependent upon the velocity of whirl.

If we assume that the hydraucone action is not present at any but the best gate, it is necessary to explain just what are the advantages of this design. As far as the hydraucone is concerned, the writer is inclined to believe that there is very little advantage. There is, however, a gain which more than compensates for the loss of hydraucone effect and which is explained as follows:

In order to regain static head from velocity head efficiently, and regain the energy component of whirl, the filaments of water must be made to straighten out and flow in parallel stream lines. The results of the hydraucone draft-tube test show that the lower the gate opening the worse the eddying and the greater the angle of whirl; hence no material effect from either the hydraucone action or the increasing area can be expected from sections (1) and (2), Fig. 5. Yet it will be noted that at 0.1 gate and 0.2 gate the vacuum was very great. This is explained by recalling that water, like any mass, flies off at a tangent as soon as the restraining force causing it to rotate in a circle is released. Thus, when the whirling water reaches the annular opening (3) it rushes out through the passage with great velocity. The water is then flowing in straight stream lines and is in the proper condition for maximum regain of pressure head by means of the increasing area as the water moves radially outward along the plate, and finally through the diverging tube (4) into the tail race.

The water passing out through the annular space (3) has considerable energy due to the velocity with which it is thrown out. The shape of the annular passage is of increasing cross-sectional area not unlike that of a water ejector in action, and it is because of the suction caused by this ejector action that such high vacuum readings were obtained. That the foregoing action takes place is substantiated by noting that as the gate is opened the speed and angle of the water discharging down the draft tube decrease, as also does the vacuum, until at best gate (0.9) the vacuum is normal and the centrifugal action is replaced by the hydraucone action.

That the resulting loss of the hydraucone action is of less magnitude than the gain due to the ejector effect is proved by tests which show that the draft-tube efficiencies with this type of hydraucone-chamber construction increase as the gate is closed.

While the hydraucone action of the water was the cause for the particular design of Mr. White's, the writer believes that the design has won merit far more because of its ejector action than its hydraucone qualities, in so far as the hydraucone qualities have to do with a regain in the hydraucone chamber, especially under whirling conditions.

An interesting coincidence is to be noted with regard to the surging and other noises within the draft tube at different gates. In

connection with the pitot-tube traverses, the corresponding surging or rattling within the tube was noted for the different gates:

0.1 gate	Light surging as if made by small amount of water
0.2 gate	About same as 0.1 gate
0.3 gate	Surging 64 times per minute. Runner rattles
0.4 gate	Same as 0.3
0.5 gate	Surging partly ceased. Pitot tube vibrates
0.6 gate	Surging 72 times per min. Not so loud. No rattling of pitot tube
0.7 gate	Steady flow
0.8 gate	Steady flow
0.9 gate	Steady flow
Full gate	Steady flow.

It is interesting to note that the upward column of water begins to be very small at 0.7 gate. At this gate the surging ceases and steady flow is maintained.

Suggesting a cause for surging at lower gates, it may be said that the tube is not full of water. Then, if the turbine gates close a slight amount suddenly, the vacuum under the runner may lift the volume of water, which partially fills the tube, up toward the runner. The water, falling back again, may readily set up an oscillating movement which will continue until an equal force in the opposite direction happens to occur by the sudden partial closing of the gates as the surface of the oscillating volume of water is on the down "stroke."

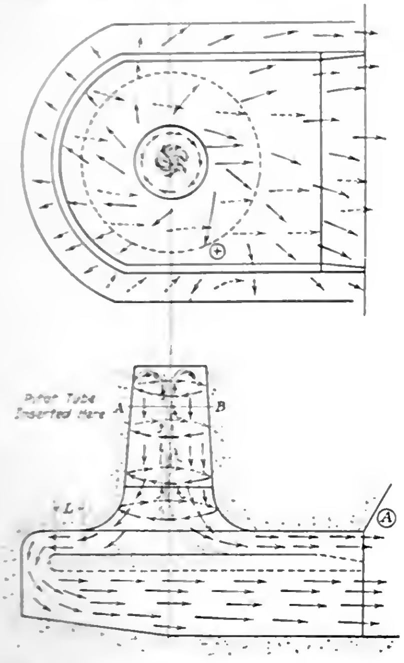


Fig. 8 Action of Water in the Greggs Falls Tube

Whatever the cause, it is certain that such surging is highly undesirable in that it causes an uneven pressure on the runner, thus imposing added duty on the governor and greater strains on the runner and penstock.

White Low-Head Hydraucone Regainer

Fig. 9 shows the White design for low-head installations. The base of the hydraucone chamber in this case is the bottom of the excavation, the collecting chamber being above the table top rather than below. This design may be used for extreme low-head installations. The space marked *s* on this plate corresponds to the space (3) in Fig. 5.

Horizontal turbines have been usually arranged to discharge the water into a sharp 90-deg. elbow placed at the top of a vertical draft tube. From what has been already said concerning the gyroscopic action of the whirling water, it may be readily seen that very poor draft-tube efficiencies are to be had with a sharp bend so close to the runner. The advantages of the hydraucone chamber draft tube on such horizontal turbines are obvious.

The Moody Spreading Draft Tube

Mr. L. F. Moody, consulting engineer of the I. P. Morris department of the Wm. Cramp & Sons Ship and Engine Building Company at Philadelphia, has designed a draft tube which, at first glance, bears a striking resemblance to the low-head design by Mr. White. See Figs. 9 and 10. The two designs appear to be practically identical, with the exception of the concrete cone in the Moody design. There is, however, a radical difference in the principles upon which the tubes are based.

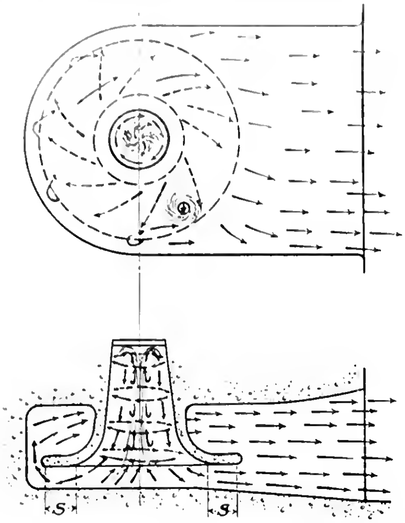


Fig. 9 White Low-Head Hydraucone Regainer

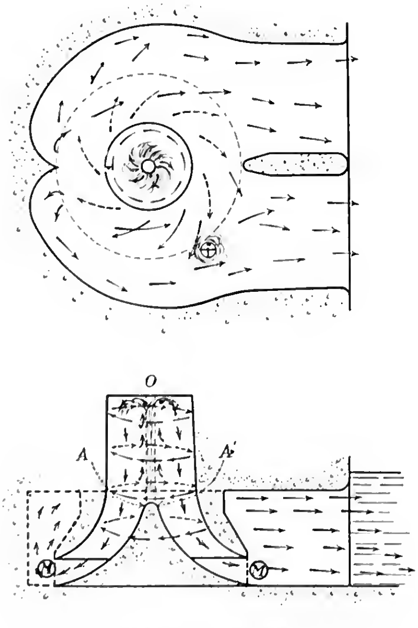


Fig. 10 The Moody Spreading Draft Tube

The Moody spreading draft tube is based on the principle illustrated by the familiar case of a free vortex in an open basin. Fig. 11 is a diagram of a cross-section through a free vortex. The water, as it whirls through the opening *OS*, assumes a definite shape

as shown by the solid lines *ABCDEFGH*. Mr. Moody has shown, with reference to the free flow of water through a space of revolution, that the velocity of whirl varies inversely as the radius and that the corresponding velocity head varies inversely as the square of the radius. If it is assumed, for instance, that the particle x is on the surface at A, it will increase its velocity of whirl as it approaches CD where the radius is smallest. The smaller the radius, the greater the velocity of whirl.

Since the reverse conditions hold—the greater the radius, the less the velocity of whirl—it occurred to Mr. Moody that if the water could be conducted even but a short distance away from the central axis of the draft tube without incurring eddy losses, the velocity of whirl of the water discharging from the runner could be effectively regained into static head. In other words, if the action of the free vortex could be reversed, the regain could be accomplished.

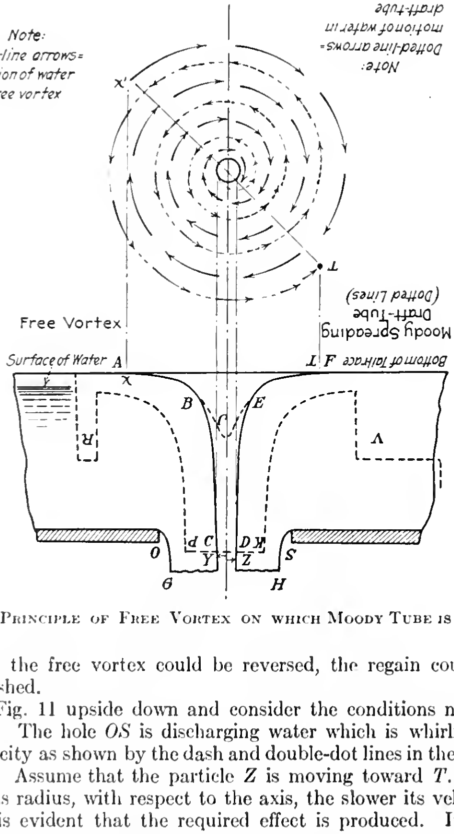


Fig. 11 Principle of Free Vortex on which Moody Tube is Based

Turn Fig. 11 upside down and consider the conditions now as reversed. The hole *OS* is discharging water which is whirling at high velocity as shown by the dash and double-dot lines in the lower drawing. Assume that the particle Z is moving toward T. The greater its radius, with respect to the axis, the slower its velocity. Thus it is evident that the required effect is produced. It now remains to suitably enclose the whirling water and conduct it far enough away from the axis to give the desired reduction in velocity.

The dotted lines in this figure represent an enclosed reversed vortex. The outline is that of the Moody spreading draft tube as installed at Niagara Falls. The concrete cone *TJX* does not fill the entire space which would occur in the case of a free vortex, because such a structure in a tube of this size would be unstable. However, it is recommended that the cone be carried up to the runner in all cases where practicable. The space *RV* is the collecting chamber into which the draft tube discharges.

Now if it is considered that a turbine runner is discharging water with a high velocity of whirl at *KP*, the water will flow spirally around the circumference of the tube, steadily decreasing its velocity as it increases its distance radially from the axis in accordance with the law previously explained. Thus the Moody spreading draft tube, based on the principle of the free vortex, regains static head from velocity of whirl as well as from velocity of discharge.

Conclusions

The extremely low-head installations which are now being considered have made it necessary to investigate thoroughly a method of regaining all the draft head possible. Since a low-head plant requires a runner of high specific speed, and therefore a high exit velocity from the runner, it is evident that the question of converting velocity head of the water revolving at high speed into static head is a question of great importance. Generally, when low-head plants are built, the expense of excavating for a long draft tube would be prohibitive; hence some form of radial draft tube is preferable.

The tests on the radial tubes as against the older designs prove conclusively that the radial type is a long step forward.

The writer suggests that an investigation as to the operation of both designs under service conditions be made before attempting a conclusion as to which of the two radial tubes is the better. It is further suggested that the investigation include some data as to the cost of construction of each form.

DISCUSSION

The discussion of Mr. Ramsey's paper was opened by Lewis F. Moody,[1] who complimented the author on his splendid paper upon which a very large amount of thought and study had been expended.

S. Logan Kerr,[2] showed a large number of slides, principally of spreading draft tubes, and including those at the 30,000-hp. plant at Muscle Shoals, Ala., the 37,000-hp. plant at Niagara Falls, and the 55,000-hp. unit of the Hydroelectric Power Commission. Mr. Ramsey had said that the Moody tube was particularly adaptable to low-head plants, but in one of the highest-head plants, 680 ft., a unit had recently been placed in operation and tested with the spreading tube with absolutely no vibration at any gate. In other words, the whirling component is prevented in the spreading tube, which is equally adaptable to the low-head or high-head plants.

H. Birchard Taylor[3] said that, relative to the subject of spreading tubes when used with high heads, it had been his experience that vibration was due to the condition in the penstock resulting in instantaneous action, and did not properly enter the question of efficiency.

Discussing Mr. Lyon's paper, which was presented after Mr. Ramsey's paper and which follows directly in this issue, R. L. Daugherty[4] said that results of tests he had made at Cornell University some four years previously agreed fairly well with those of Mr. Lyon. He had at that time tried the device of putting in a false floor in the bottom of the tail race so that it could be raised higher and higher and brought close to the mouth of the draft tube. When it was brought within $^5/_{16}$ in. and $1^1/_4$ in. from the end of the tube there was a persistent pressure instead of a suction. When the false floor was a distance from the end of the draft tube equal to a quarter of its diameter, the efficiency was a maximum.

DISCUSSION OF PAPER ON VERTICAL TRIPLE-EXPANSION PUMPING ENGINE

(*Continued from page 161*)

motor-driven centrifugal pumps had been operated in Indianapolis for over two years and that the efficiency, as determined by frequent tests, had not fallen off from the 86 per cent given when first installed.

As to first cost, the geared-turbine-driven centrifugal pump occupied but from $^1/_5$ to $^1/_6$ the cubical space of a triple-expansion engine of the same capacity. This made a very great difference in the cost of labor and material for building and foundations.

As to cost of upkeep, the first large gear-driven pump for water-works service was installed in Pittsburgh some ten years ago. It was still running, and there had never been any change in the gears or repairs made to the turbine.

As to the steady running of gears, none of the water-works gears had given any trouble, and there were something like 50 large units now in operation.

---

[1] Asst. to Vice President, William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.

[2] I. P. Morris Department, William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.

[3] Vice-President, William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.

[4] Prof. Mech. and Hyd. Engr., California Institute of Technology.

Flow in Conical Draft Tubes of Varying Angles

By GEORGE E. LYON,[1] TROY, N. Y.

THE purpose of this investigation was primarily to determine the velocity curves at several cross-sections of straight conical draft tubes. This is of importance as the results will show the flow and its variation along the tube. Incidentally the efficiencies of all but one of the tubes were found.

The function of the draft tube is twofold: first, to produce a suction under the turbine equal to the elevation of the turbine above tail water; second, to regain the kinetic energy of the water as it leaves the turbine. A plain cylindrical tube would meet the first requirement provided its mouth was submerged to exclude the air. It is of far greater importance, however, that the second requirement be fulfilled. The high-speed, high-capacity hydraulic turbine of today, operating under low head discharges water with as much as 25 to 30 per cent of the initial energy of the water in kinetic energy at discharge. Hence it may be seen that without an efficient draft tube the development of much of the potential water power under low head would be seriously handicapped. It is in the design of draft tubes operating under conditions mentioned above that the importance of this investigation may be realized; for, having found the character of flow, a tube may be designed to be more efficient in regaining kinetic energy. Heretofore nothing has been done in the way of finding the character of flow in diverging tubes.

For this thesis experiments were performed on seven draft tubes. All of the tubes were 3 in. in diameter at the throat, five enlarging to 6 in. at the mouth and two to 9 in.

One tube was of concrete, the others being made of heavy galvanized iron. The angle between opposite elements varied from 4 to 12 deg. Velocity traverses were made in each tube at four cross-sections, including the throat and mouth and at three rates of discharge. The efficiencies of all but one of the tubes were found.

This investigation was conducted in the hydraulic laboratory of the Russell Sage Laboratory, Rensselaer Polytechnic Institute Troy, N. Y., during the school year ending June, 1921.

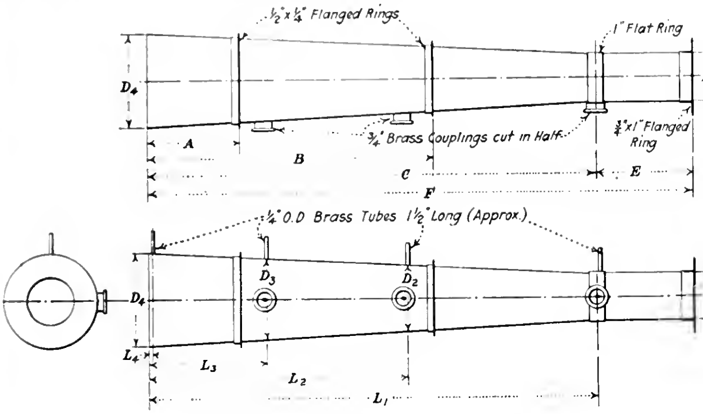
Water for the tests was pumped from a large cistern under the hydraulic laboratory by means of a 6-in. Lawrence double-suction centrifugal pump (1000 gal. per min.) direct-connected to an Allis-Chalmers d.c. motor. The water was pumped into a large tank overhead, from which it discharged through an 18-in. tee into a 5-in. pipe and thence into a 3-in. pipe through a 3-in. gate valve.

After discharging through the draft tube into the concrete-lined flume 30 in. wide by 18 in. deep and containing baffles for smoothing the flow, the water passed over a suppressed weir into the cistern below.

The first draft tube (A) was made of concrete, about one part cement to three parts sand. It was formed by pouring the concrete around a wood core in an 8-in. pipe 4 ft. long. The wood core was represented by a cylinder 3 in. in diameter by 5 in. long on the top of a truncated cone having a diameter of 3 in. at the top and 6 in. at the bottom in a length of 43 in. This gave an angle of 4 deg. between sides. This form of tube was very inconvenient, causing trouble in removing the core, also it was very heavy. The rest of the tubes, six in number, were made of galvanized iron and of the dimensions given in Fig. 1. Brass couplings ($^3/_4$-in.) were soldered to the draft tubes over openings large enough to pass the pitot tube through. These were spaced at equal intervals of cross-sectional area of the draft tubes. The upper section being at the throat and the lower one $^1/_4$ in. above the mouth. At these four sections piezometer connections were made of $^1/_4$ in. brass tubes soldered to the draft tubes and at 90 deg. from the pitot-tube connections. These tubes were connected so that the finish was perfectly flush with the inner surface of the draft tubes.

The Tests

Tests were made at three rates of discharge; 0.985, 0.745, and 0.476 sec-ft. The high rate for draft tube "*E*" was taken at 0.947 sec-ft. instead of 0.985 sec-ft. All tests were duplicated. Readings were taken at eleven (sometimes thirteen) points on each diameter. The points were taken closer together at the sides of the tube, spreading out toward the center. In the traverses taken at the throat sections, the throat pressure and tail-water gages were also read, just before taking the pitot-tube readings.



TUBE	ANGLE BETWEEN SIDES	A	B	C	E	F	D_1	D_2	D_3	D_4	L_1	L_2	L_3	L_4
B	6°	6"	18½"	28.62"	6"	34.62"	2.96"	4.25"	5.20"	5.98"	30.19"	16.77"	7.62"	¼"
C	8°	4½	14½	21.25	13.17	34.62	2.92	4.24	5.22	6.00	21.73	12.56	5.75"	¼
D	10°	3	11¾	17.14	17.48	34.62	2.94	4.24	5.24	5.96	17.33	10.02	4.52	¼
E	12°	2	6½	14.27	20.35	34.62	3.00	4.25	5.22	6.00	14.55	8.36	3.82	¼
F	8°	8	20½	42.90	4.35	47.25	3.00	5.76	7.54	9.04	43.40	23.25	10.45	¼
G	10°	6	16½	34.28	12.97	47.25	2.96	5.74	7.60	9.00	34.75	18.56	8.18	¼

Note: Material No. 26 Gal. Iron

Fig. 1 Dimensions of Draft Tubes Tested

Column 1 of the notes (Table 1) gives the radius from the center of the draft tube to the impact orifice of the pitot tube in inches. All readings between the two L's being taken on the left of the center line and those between the two R's on the right. Column 2 gives the piezometer readings in inches. In the next column are the pitot-tube readings in inches. These were omitted when the mercury manometer was used. Next are the differences in inches marked *y* or *h* for mercury or water, respectively. The next column gives the velocities in feet per second computed from *y* or *h*, and the last column gives the hook-gage readings in feet. The zero of the hook gage was 0.766 ft. and the readings for the rates of discharge were (see above) 1.112 ft., 0.961 ft., and 0.910 ft., respectively. For the high rate of draft tube "E" the reading was 1.000 ft. Whenever readings were taken at other rates of discharge, the velocity tabulated is that found by correcting the calculated velocity in the ratio of the discharge. The variation in discharge, however, was quite small. The notes taken at the throat sections contain two additional columns. One marked "Flume" gives the reading of the tail water in inches and the other marked "Piezometer" gives the throat piezometer reading in inches. The average difference of these two columns gives the negative pressure at the throat due to the regain of kinetic energy.

---

[1] Instructor, Dept. of Mechanics, Rensselaer Poly. Inst.

Abstract of a thesis submitted to the trustees and faculty of Rensselaer Polytechnic Institute in conformity with the requirements for the degree of Doctor of Engineering, June, 1921, and presented at the student Session of the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 8, 1921. All papers are subject to revision.

Computations

Reduction of mercury readings (y) for velocity:

$$v = c\sqrt{2g(13.6-1)y/12} = 1.007\sqrt{2 \times 32.2 \times 12.6\, y/12} = 8.276\sqrt{y}$$

for pitot tube No. 1.

Reduction of water readings (h) for velocity.

$$v = c\sqrt{2gh/12} = 1.007\sqrt{2 \times 32.2\, h/12} = 2.331\sqrt{h} \text{ (tube No. 1)}$$

$$v = c\sqrt{2gh/12} = 1.000\sqrt{2 \times 32.2\, h/12} = 2.316\sqrt{h} \text{ (tube No. 2)}$$

The following will serve to indicate in detail the computations, test D-1 (in Table 1) being selected.

From the piezometer reading of 54.20 in. on the mercury manometer by previous calibration the difference between the piezometer and pitot-tube readings is calculated to be 4.51 in. The zero reading for these two tubes is 51.90 in., but as the bore was not the same, a slight correction was introduced. $v = 8.276\sqrt{y} = 8.276\sqrt{4.51} = 17.58$ ft. per sec.

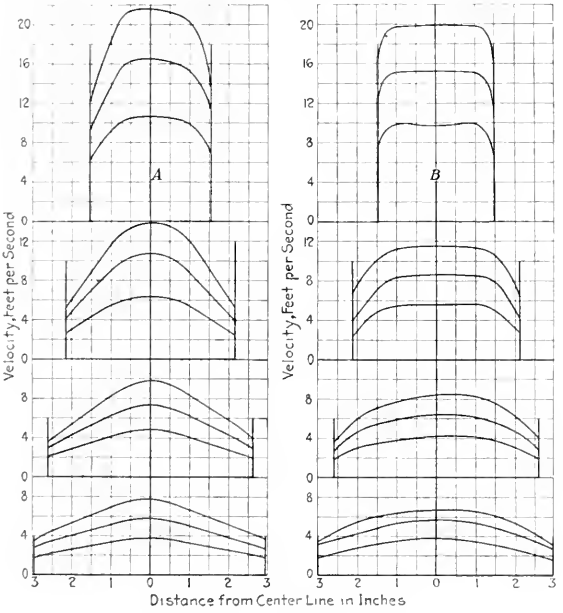


Fig. 2 Velocity Curves of Draft Tubes A and B

After plotting the velocity curves against radius, the moment of this area was found to check the discharge and the per cent error e tabulated in Tables 2 and 3. As will be explained later, the moment of the v-r curve is equal to $Q/2\pi$. $e = 100\,(Q - Q_0)/Q_0$, where Q is the discharge by integrating velocity curve and Q_0 is the discharge by weir which is taken as being correct. For tests D-1 and D-2, $e = 2.2$ per cent.

The average difference of the last two columns of tests D-1 and D-2 gives the negative pressure head in inches at the throat due to regain and is tabulated in Table 2 under "$-p$." In this case $-p = 60.96$ in. From the velocity curve plotted from these tests (Fig. 3) the kinetic-energy curve was constructed by plotting v^3 against r^2. The area under this curve is the kinetic energy possessed by the water at the throat section. In this case K.E./sec. = 394.0 ft. lb.

$$\text{The mean velocity head} = \frac{v^2}{2g} = \frac{\text{K.E.}}{\text{sec.}}\,\frac{1}{wQ_0}\,\frac{1}{(1+e)^3}$$

$$= \frac{394.0}{62.4 \times 0.985}\,\frac{1}{(1.022)^3} = 6.01 \text{ ft.}$$

$$\text{The efficiency of regain} = \frac{60.96}{12 \times 6.01} = 84.5 \text{ per cent.}$$

Values of $\frac{\text{K.E.}}{\text{sec.}}$, $\frac{V^2}{2g}$ and efficiency may be found in Table 2.

Consider test B-12 in which the hook gage regaging was 1.003 ft. instead of 1.002 ft.

TABLE 1 SAMPLE NOTES

Rad. to pitot	Piezometer	Pitot tube	Diff. $=h$	Vel.	Hook gage	Remarks
2.90L	46.50	48.90	2.40	3.58	1.003	Test B-12
2.75	46.10	49.50	3.40	4.25	1.003	
2.50	45.75	50.10	4.35	4.78	1.004	5.98 in. Section
1.75	44.80	51.90	7.10	6.15	1.003	
0.75L	44.20	52.90	8.70	6.76	1.004	Cent. pump
0	43.95	53.35	9.40	7.07	1.003	used.
0.75R	44.15	53.00	8.85	6.86	1.003	
1.75	44.95	51.60	6.65	5.95	1.003	Water gage
2.50	46.10	49.60	3.50	4.32	1.003	used.
2.75	46.45	48.95	2.50	3.65	1.003	
2.90R	46.60	48.75	2.15	3.40	1.002	

Rad. to pitot	Piezometer	Diff. $=y$	Vel.	Hook gage	Flume	Piezometer	Remarks
1.42L	54.20	4.51	17.58	1.002	70.2	6.5	Test D-1
1.32	54.85	5.81	19.95	1.002	70.7	5.9	
1.17	55.20	6.47	21.03	1.002	70.0	6.7	2.94 in. Section
0.92	55.35	6.75	21.50	1.002	68.7	6.2	
0.62L	55.30	6.66	21.35	1.002	68.8	6.1	Cent. pump
0	55.30	6.66	21.35	1.002	72.0?	1.0?	used.
0.62R	55.30	6.66	21.35	1.002	66.0	7.2	
0.92	55.25	6.57	21.20	1.002	66.4	6.5	Hg. gage used.
1.17	55.10	6.29	20.77	1.002	66.7	6.3	
1.32	54.70	5.51	19.42	1.002	66.5	6.6	
1.42R	54.25	4.61	17.77	1.002	66.7	6.3	
1.42L	54.20	4.51	17.58	1.002	67.2	4.8	Test D-2
1.32	54.75	5.61	19.60	1.002	66.2	7.0	
1.17	55.10	6.29	20.77	1.002	66.8	6.0	2.94 in. Section
0.92	55.25	6.57	21.20	1.002	66.7	6.2	
0.62L	55.25	6.57	21.20	1.002	66.2	7.1	Cent. pump
0	55.25	6.57	21.20	1.002	66.4	6.9	used.
0.62R	55.25	6.57	21.20	1.002	66.8	6.2	
0.92	55.25	6.57	21.20	1.002	66.3	7.0	Hg. gage used.
1.17	55.10	6.29	20.77	1.002	66.7	6.5	
1.32	54.70	5.51	19.42	1.002	67.1	6.0	
1.42R	54.10	4.31	17.20	1.002	67.1	6.0	

The difference $h = 2.40$ in.

$$v = 2.316\sqrt{2.40} \times \frac{0.985}{0.990} = 3.58 \text{ ft. per sec.}$$

0.985 = discharge for hook-gage reading of 1.002 ft. (standard)

0.990 = discharge for hook-gage reading of 1.003 ft.

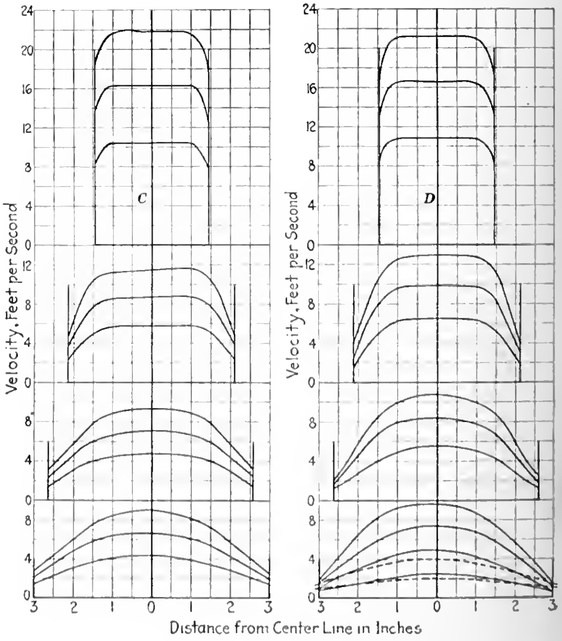


Fig. 3 Velocity Curves of Draft Tubes C and D

At this section the diameter on which the readings were taken did not equal the mean diameter. Hence upon integrating for discharge, the result was modified by multiplying by $\left(\frac{5.98}{6.00}\right)^2$ and the error (e) computed after this correction was made.

The various formulas which are mentioned above are derived as follows:

1 The moment of the area of a v-r curve about the center line is equal to the volume of water per second divided by 2π. Let r = radius in feet corresponding to the velocity in feet per second on

TABLE 2 THROAT SECTIONS

Draft tube	Q sec-ft.	e per cent	−p in	K E.	$V^2/2g$ ft.	Effy per cent
A	0.985	−2.7	—	—	—	—
A	0.745	−1.1	—	—	—	—
A	0.476	−1.3	—	—	—	—
B	0.985	−3.3	62.18	331.5	6.35	81.8
B	0.745	−3.0	33.30	146.7	3.46	85.0
B	0.476	−3.8	14.58	59.8	1.51	80.6
C	0.985	−0.6	88.06	424.5	7.04	80.7
C	0.745	+1.2	39.76	178.3	3.71	89.3
C	0.476	−0.2	15.86	46.2	1.587	84.3
D	0.985	+2.2	60.96	394.0	6.01	84.5
D	0.745	+2.0	38.33	188.8	3.68	87.0
D	0.476	+4.0	16.20	52.2	1.566	86.2
E	0.974	+4.5	37.49	394.0	5.69	78.5
E	0.745	+3.9	32.37	173.2	3.33	81.0
E	0.476	+2.1	13.85	46.4	1.475	78.4
F	0.985	−3.6	68.60	344.0	6.25	91.5
F	0.745	−8.9	38.28	123.7	3.52	90.7
F	0.476	−3.4	13.75	38.4	1.437	91.4
G	0.985	−6.7	58.54	316.5	6.35	77.0
G	0.745	−6.0	32.28	133.0	3.44	78.2
G	0.476	−7.1	13.18	33.6	1.41	77.8

TABLE 3 VALUES OF e FOR SECTIONS BELOW THROAT

Draft tube	1st Sect below throat	2nd Sect. below throat	Sect. at mouth	Q Sec-ft.
A	−7.1	−4.5	+0.5	0.985
A	−3.9	−2.3	+1.9	0.745
A	−2.5	−3.4	+0.8	0.476
B	−1.3	−2.6	−1.7	0.985
B	−4.0	−3.1	+6.6	0.745
B	−2.9	+0.2	+4.4	0.476
C	—	−2.6	+3.7	0.985
C	—	−2.8	+8.7	0.745
C	—	−1.3	+9.4	0.476
D	−1.4	+1.5	+6.6	0.985
D	−2.2	+4.8	+4.8	0.745
D	−1.3	+0.8	+7.7	0.476
E	−0.8	+0.1	+6.7	0.974
E	+0.4	−0.1	+5.4	0.745
E	+1.5	+3.8	+5.7	0.476
F	−2.4	−2.7	+5.6	0.985
F	−2.3	−1.7	+7.2	0.745
F	−2.6	+0.6	—	0.476
G	−3.6	−8.4	+6.8	0.985
G	−1.3	−3.5	+4.0	0.745
G	−1.5	+4.2	—	0.476

the v-r curve. Then Q = discharge in cubic feet per second

$$= \int_0^r v2\pi r dr = 2\pi \int_0^r rv dr.$$

But vdr is d (area) under curve, and $rvdr$ is the moment of this area about the center line. Performing the integration:

$Q = 2\pi \times$ moment of half-area about center line

$= \pi \times$ sum of the moments of the two half-areas about the center line.

2 The efficiency of a draft tube as a regainer of kinetic energy may be determined as follows:

Consider a draft tube as shown in Fig. 4, and that the upper tank

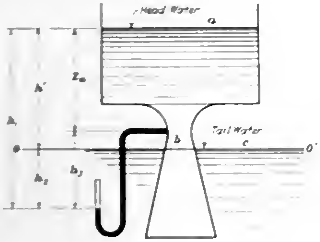


Fig. 4 Arrangement of Draft Tube

is raised or lowered until the head h' is sufficient to overcome the losses at a given rate of flow. Thus h' is the total loss. The velocity head in the upper tank is assumed to equal zero and there is no loss down to the throat of the draft tube. Then

$$p_a + z_a = p_b + \frac{V_b^2}{2g} \text{ or } \frac{V_b^2}{2g} = z_a - p_b + p_a.$$

Now

$$p_b = -h_2 + p_a \text{ and } p_a = 0 \therefore \frac{V_b^2}{2g} = h_1$$

Now h' represents the loss, so that the efficiency of a draft tube as a regainer of kinetic energy

$$= \frac{\frac{V_b^2}{2g} - h'}{\frac{V_b^2}{2g}} = \frac{-h_2}{h_1}$$

Readings are referred to atmospheric pressure as a datum. h_2 is negative as the zero of the gage board is at $O-O'$, the surface of tail water, and hence $\frac{-h_2}{V_b^2/2g}$ is positive.

Where there is a loss between a and b the efficiency can not be found by simply taking the readings h_1 and h_2. In this case the reading h_1 must be replaced by $V_b^2/2g$ determined from the velocity traverse taken at this section. This was the method used in this investigation.

Kinetic energy per second = K.E./sec. = $Wv^2/2g$

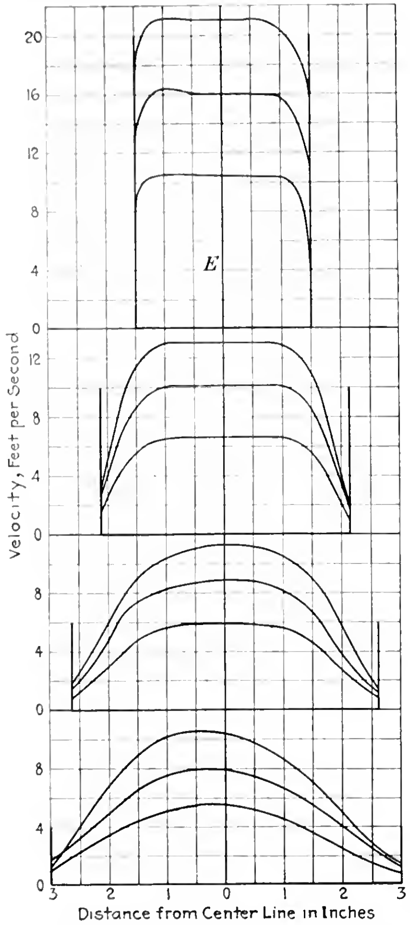


Fig. 5 Velocity Curves of Draft Tube E

$$W = \int_0^r wv2\pi r dr, \text{ where } w = \text{density of water}$$

$$\frac{\text{K.E.}}{\text{sec.}} = \int_0^r \frac{1}{2}\frac{v^2}{g}2w\pi rv dr = \frac{w}{2g}\int_0^r v^3 2r dr = \frac{w\pi}{2g}\int_0^r v^3 d(r^2)$$

Hence the area under the v^3r^2-curve multiplied by $\frac{w\pi}{2g}$ equals the kinetic energy.

To get $V_b^2/2g$, divide by W, since head is the amount of energy per pound of water.

$$\therefore \frac{V_b^2}{2g} = \frac{\text{K.E./sec.}}{W} = \frac{\text{K.E./sec.}}{wQ}$$

Due to the error e found by checking the velocity curves against the weir for discharge, a correction was applied to the velocity head $V_b^2/2g$ just found. This correction is based on the assumption that the velocities found from the pitot-tube traverse must be increased or decreased proportionally so that the discharge found by the "moment" method equals that found by the weir. It will be seen that this is equivalent to changing the constant for the pitot tube.

Let Q_0 = discharge by weir (assumed to be correct)

Q = discharge found by taking the moment of the v-r curve

$Q_0 = kQ$

$$\text{Error} = e = \frac{Q-Q_0}{Q_0} = \frac{1}{k} - 1$$

$$Q = AV \quad Q_0 = AV_0 \quad \therefore \frac{Q}{Q_0}\ \frac{V}{V_0}\ \frac{1}{k}$$

where v = pitot-tube velocity and v_0 = corrected velocity.

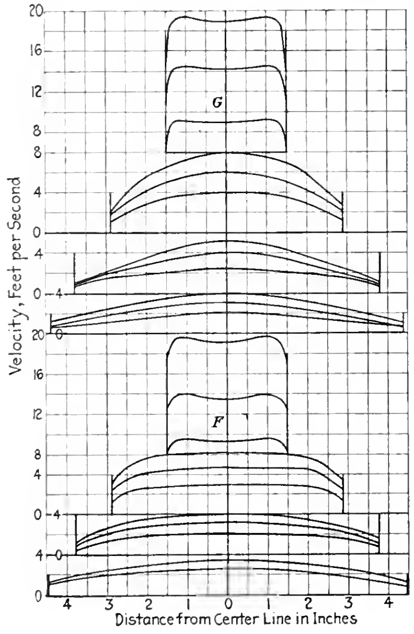


FIG. 6 VELOCITY CURVES OF DRAFT TUBES F AND G

Let K.E. = kinetic energy from v^3r^2-curve.

K.E. = theoretical kinetic energy from $v_0^3r^2$-curve (if such curve were plotted)

$$\text{As before K.E.} = \frac{1}{2}\int_0^r \frac{v^2}{g}\, 2w\pi rv\,dr$$

$$\text{K.E.}_0 = \frac{1}{2}\int_0^r \frac{v_0^2}{g}\, 2w\pi rv_0\,dr = \frac{1}{2}\int_0^r \frac{k^2v^2}{g}\, 2w\pi rkv\,dr$$

$$\therefore \quad \text{K.E.}_0 = k^3\text{K.E.}$$

and

$$\frac{v_0^2}{2g} = \frac{\text{K.E.}_0}{wQ_0} = \frac{k^3\,\text{K.E.}}{wQ_0} = \frac{\text{K.E.}}{wQ_0}\ \frac{1}{(1+e)^3}$$

since

$$k = \frac{1}{(1+e)}$$

Each velocity curve (Figs. 2, 3, 5 and 6) represents the results of two individual traverses or tests. Hence for the 86 curves shown, 172 tests were made. Two additional tests, D-25 and D-26, were made at the mouth of draft tube "D" at a discharge of 0.223 cu. ft. per sec. (hook gage = 1.851 ft.). This is the lowest full-line curve plotted under "D" (Fig. 3). Four more tests, D-27, D-28, D-29 and D-30, were made 6 in. below the mouth of draft tube "D;" the first two at 0.476 sec-ft. and the last two at 0.985 sec-ft. These two curves are shown by the dotted lines (Fig. 3). For the piezometer reading, the flume connection was used. The efficiency curves (Fig. 7) were plotted on a base of average velocity.

The velocity curves for the throat section of draft tube "A" were so distorted it was thought that a sudden enlargement to reduce the velocity would permit the water to be drawn off in a smoother stream-line flow. Accordingly the section of 8-in. pipe with bell mouth at bottom to meet the 3-in. section was introduced. The effect of this was very noticeable, as the curves for the remaining tubes were very nearly symmetrical.

With a couple of exceptions, the curves indicate:

1 That the velocity at the throat (before the water enters the flare) is uniform, falling off at the walls

2 That this uniform velocity breaks down at the sides of the diverging tube first and gradually falls off nearer and nearer the center. The curves for the first section below the throat indicate this

3 That some distance down in the draft tube, the uniform velocity which persisted at the center finally disappears and the velocity curve becomes peaked at the center.

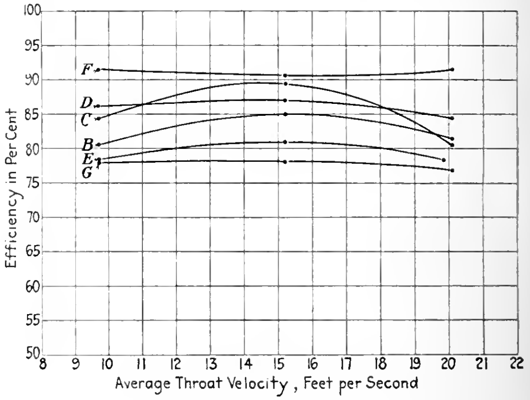


FIG. 7 EFFICIENCY CURVES OF DRAFT TUBES

4 That this peaked curve persists down the rest of the tube, flattening out somewhat toward the mouth, but even there having a center velocity of from twice to five times the wall velocity

5 That this ratio of center velocity to wall velocity increases with the angle of flare

6 That at a distance below the mouth of the draft tube equal to the diameter at this point, the curve remains peaked. This is only based on the four under water traverses below draft tube "D."

"Lateral flow," the motion of the water due to the flare, appears to be greatest near the wall, breaking down the velocity curve very greatly here. Its effect at the center of the tube is more gradual and, at first, uniform.

At the end of the tests the impact orifice in pitot tube No. 1 was plugged and a small hole drilled in the side. A traverse (Table 4) was made, referring the pitot-tube readings to the piezometer at the wall of the tube. It will be seen that the pitot tube records a lower reading than the piezometer. This is not due to whirl as the differences are all negative. The curvature of the pitot tube would not permit its side orifice to record true pressure.

TABLE 4 TRAVERSE DRAFT TUBE "D," 4.24-IN. SECTION

Rad. to pitot	Piezometer	Tube press.	Diff.	Hook gage
2.02L	42.75	42.30	−0.45	0.910
1.92	42.85	42.10	−0.75	0.910
1.72	43.15	41.70	−1.45	0.910
1.42	43.50	41.10	−2.40	0.910
0.82L	43.60	40.90	−2.70	0.910
0	43.65	40.85	−2.80	0.910
0.82R	43.60	41.00	−2.60	0.910
1.42	43.40	41.40	−2.00	0.910
1.72	43.20	41.90	−1.30	0.910
1.92	43.00	42.30	−0.70	0.910
2.02R	42.85	42.60	−0.25	0.910

It would be of interest in the future to conduct tests under very low rates of discharge, also to determine whether or not there is a variation of pressure across a section.

Science in the Textile Industry

THE Textile Division of The American Society of Mechanical Engineers is endeavoring to direct the thought of the textile industry into scientific and engineering channels. In textile manufacturing, as in many other industries, there has heretofore been a great deal of empiricism. This has been notably the case in England where the industry has been built up on a great deal of tradition, and where very little fact has been used in many of the textile-manufacturing processes.

To the end of developing this kind of thought, the Textile Division held an important meeting in New York on the occasion of the Annual Meeting of the Society on Friday, December 9, 1921. The papers presented and the discussion which followed certainly confirmed the viewpoint that research work in the textile industry must be conducted on the basis that the engineering principles of every existing process must be suspected until research work has demonstrated that they are founded on fact.

British cotton manufacturers have just contributed $1,000,000 for the conduct of broad research work in the textile industry. This was brought out at the meeting by Charles T. Main of Boston, Past-President of the Society, who presented a report of the delegates of the Society to the Second World Cotton Conference at Manchester, England, in July, 1921. In the opinion of Mr. Main, this is a lesson for American manufacturers, who naturally pride themselves upon their openmindedness, and who will wish to keep abreast of their brothers across the sea.

The two technical papers presented at the session were Hidden Wastes in Textile Plants, by T. P. Gates, and Economy in Textile Drying, by B. R. Andrews. The first of these papers pointed out a few of the losses found in the average textile plant which have been largely overlooked, and which can be greatly reduced through the application of engineering research. The second enunciated the principles of satisfactory and economical drying, with reduced labor costs and minimum steam consumption. These papers are reprinted below.

Hidden Wastes in Textile Plants

BY THAYER P. GATES,[1] PROVIDENCE, R. I.

THE purpose of this paper is to point out a few of the losses found in the average textile plant which have been very largely overlooked and which can be greatly reduced through the application of engineering research. The types of losses considered are mainly those occurring in the operation of equipment and the utilization of materials. The paper also points out the opportunities in the textile field for men of engineering training.

The essentials in any study on the elimination of waste are:

a to determine the facts of present operation
b to determine what new facts may be found by analysis or research
c to apply these facts to the improvement of operation.

EXAMPLES OF METHODS EMPLOYED IN ELIMINATION OF WASTE IN TEXTILE MILLS

As an example of this method in the study of the operation of equipment, the output from a water mangle as used in cloth-finishing plants may be used. Knowing the present output of the machine, the first step would be to determine the maximum speed at which the machine would operate mechanically, allowing of course a proper factor of safety at the weakest point, and then find whether the goods could be put through the machine at that speed consistent with proper quality.

In such a study it may be found that the cloth will not open to width from the rope form at the required speed because the beaters on the scutcher will not take care of it properly. This involves experimental study by the engineer to determine changes necessary on this scutcher to take the increased output.

Then it may be found that the goods are damaged on the expander. The questions are immediately asked: at what place on the expander? what are the reasons for the damage? and how can the difficulty be eliminated? Another job for the engineer. Further, it may be found that the plaiter will not deliver the goods into the truck at the new speed. The engineer again asks why, and by proceeding to overcome this difficulty by employing the methods of engineering research to solve these problems, one at a time, the maximum capacity of the machine is finally reached. In many instances the output as a result of these studies is more than doubled, and the failure to take advantage of this possible increase constitutes a larger "hidden waste."

In many plants chemical problems may limit the output. As it is usually possible to redesign the mechanical equipment to take care of the maximum output from the chemical standpoint, the first research work should be done in the chemical laboratory. The problem is to determine what are the variables, and then to solve these variables for the best result of each when combined with each other. This involves the determination of a unit which must be applied in measuring and standardizing each variable.

For example, in the determination of luster on a mercerized fabric the standard unit should be saturation, which is measured by shrinkage of the cloth when submerged in caustic. In bleaching, the standard unit is the degree of whiteness combined with the strength and aging qualities of the goods bleached. The chemical research having been completed, the engineer must take these facts and apply them to the study of the equipment to give the maximum output.

The first experience of the author with textile research came when he was engineer of a large finishing plant. One of his problems was to locate a new bleach house to take care of approximately 50 per cent increase in production. A careful study failed to reveal any place where the building could be located and any continuity of the processes be maintained. The present bleach house was then examined to see if the increase could be handled there. The machinery was of modern type, was run at the highest practicable speeds, and could not be rearranged to provide for any additional equipment. An examination of the chemical part of the problem showed, however, that a 50 per cent increase could be taken care of with a slight increase in water and chemicals.

The problem was finally solved over protests that it had never been done before, by running two strands of cloth side by side through the same machinery at the same time instead of one as had been the previous practice. Many experiments were made before this was accomplished successfully, but the new method enabled the plant to secure approximately 50 per cent increase in production with practically the same equipment running at the same speed, with the same amount of labor and with a very slight addition of water and chemicals.

This solution caused a very considerable saving in the cost of production and also pointed the way to further investigations throughout the plant, with the result that many processes were revolutionized and large savings made.

A short time ago a mill treasurer spoke very contemptuously of the possibilities of engineering research in his plant, stating that he knew the business thoroughly, having started in it as a boy. When asked if he was not using individual "dollies" for scouring worsted cloth before dyeing, he replied that he had about twenty-five of them, each one of which required one operative. He was much surprised when informed that all of these dollies could be replaced by one continuous scouring machine, or at most two, re-

---

[1] Cons. Engr. and Textile Specialist.

Presented at the Annual Meeting, New York, December 5 to 9, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly condensed. All papers are subject to revision.

quiring but one operative each and using a smaller amount of soap. Is this not a "hidden waste?"

The increase of output in the operation of tenter frames in another plant may be taken as a further illustration. After careful engineering investigation the dry or hot room was perfected and the frames readjusted to handle the capacity of the dry room. As a result the output was increased over 150 per cent, with a 50 per cent reduction in labor cost. The saving of labor on this job alone within a few weeks more than offset the entire cost of making the study and of changes on the machines.

The foregoing examples have all been taken from dyeing and finishing plants. Turning now to an entirely different line, a knitting mill started about eighteen months ago to study its machines to see if the output could be increased. The net result of much research work on these machines together with a study of the yarn used, was that the output of the entire plant was increased more than 25 per cent with the same equipment. The number of imperfections were reduced very materially, and in spite of the higher wage rate there was a substantial reduction in the labor cost per pound of product.

Various Methods of Cutting Down Waste

Occasionally in the study of equipment it is found that cutting down speed may increase output as well as quality. One illustration of this may be found on pickers in a cotton-spinning mill, where a reduction in the speed of the beaters frequently raises the quality of the product, cuts down waste of materials, and betters the production in the later processes.

Considerable saving can oftentimes be made in the purchasing of materials. This requires research to determine if a cheaper product may not be used to replace a more expensive one with equal or better results. An example of this is found in the studies made to determine if a lower-grade cotton may not be utilized to advantage. The use of this cotton calls for greater care in purchasing and a careful study of the processes of cleaning and mixing to maintain proper strength and uniformity. This, however, has been done by a number of mills without lowering the quality of their product and has resulted in large savings in the finished product.

Another source of loss in many plants is due to the waste of material in process and the reworking of materials which have become damaged. Records should be kept to show the extent of these losses as such records will undoubtedly assist in reducing the waste and act as a stimulant to maintain them at a minimum. In some finishing plants, for example, the amount of rehandled goods due to stains, poor dyeing, poor bleach, etc., oftentimes reaches 15 per cent of the work done, while in other plants it falls below 1 per cent. Frequently the amounts of seconds, remnants and rags reach large figures. In some plants no records are maintained of such losses, so undoubtedly these can be characterized as "hidden wastes."

In addition to the studies in the operation of the machines and in the utilization of materials, it is desirable to standardize thoroughly the labor jobs on these machines. Frequently the engineer can develop labor-saving devices that will reduce the number of operatives required. In other cases standardization may be carried to such an extent that less skill is needed on the part of the operatives and lower-grade labor can be used.

Throughout this paper emphasis has been placed on the savings which may be made by engineering research in the textile field, which has been much neglected up to this time, and it is the belief of the author that in the future great improvements in operation will undoubtedly result by the replacing of tradition with definite knowledge of facts determined by such research.

Economy in Textile Drying

By B. R. ANDREWS,[1] BOSTON, MASS.

THIS paper summarizes some of the means by which those expenses which contribute to the cost of textile drying may be reduced without causing simultaneous increases in damaged goods and without reduction in quality of work produced. There are many such items of expense, but they may be included under the three groups of labor, overhead, and steam.

The relative values of these groups are shown approximately in Fig. 1. The labor item includes only that labor actually applied to manufacture; the overhead item includes the labor for maintenance, as well as interest, depreciation, taxes, and the cost of power. While the relative value of each very naturally varies with the different classes of work, most textile drying is done either on cans or in an air drier, so that a fair average is obtained from a range consisting of starch mangles, drycans and tenters, and it was on such a range that the data for plotting Fig. 1 were obtained. Selection was made, not of an average installation, but of one operating with a comparatively high efficiency, thereby representing a good distribution of these expenses for low cost of drying.

It is natural to attempt drying economies by considering each item separately, yet it is no more possible to do so than in any other manufacturing process, for reduction in labor cost will probably be obtained by increase in investment and consequent overhead expense. If it is obtained by increasing the rate of drying, without much increase in investment, then a sacrifice of steam economy is likely to result. However, if the cost of handling is halved by halving the drying time, with a reasonable increase in overhead and no reduction (or even a 50 per cent increase) in steam consumption per pound of goods produced, an overall economy has resulted. Also, the increase of the rate of drying may make possible the combination into a range with calenders, starch mangles, etc., with a reduction of labor, not to one-half, but perhaps to one-third or one-fourth. Therefore, it is usually safe to assume that what is wanted above all else is to secure the maximum speed at which goods can be handled without damage, and then to maintain this speed at the minimum overhead expense and steam consumption.

While these conclusions are almost obvious, the actual drying process itself is not quite so clear, and a general understanding of it is necessary in order to consider this item of speed intelligently. Textile drying is usually nothing more than the conversion from liquid to gas of the free water, or free solution, carried by the material after leaving the extractor, suction box, or squeeze rolls. The hygroscopic moisture enters only rarely into the problem; that is, the process is really "drying," and not the processing often

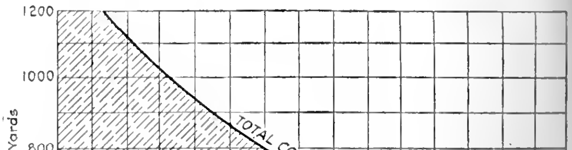


Fig. 1 Cost of Drying after Starching.—5-yd. Goods

---

[1] Treas., Andrews & Goodrich, Inc.

Presented at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

erroneously called "drying," which must be carried on under the most carefully regulated combinations of temperature, humidity and time. Consequently, with drier temperatures not exceeding 220 deg. fahr. and humidities approximating bone-dry atmosphere, we have simply a matching of vapor tension between the water in the material and the air in immediate contact with it. The higher the former, and the lower the latter, the more rapidly the process can be carried on.

There are three good ways of raising the vapor tension of the water in the material: (*a*) by contact with a hot surface; (*b*) by contact with hot air having a high wet-bulb temperature; and (*c*) by radiant heat.

There are two good ways of maintaining a low humidity in the air in immediate contact with the material: (*a*) by a high drier temperature; and (*b*) by rapid air circulation. The second is of the utmost importance because the film of air in immediate contact with the surface in an undisturbed atmosphere becomes very nearly saturated.

In the case of a material brought into contact with the hot surface, moisture may be transferred immediately into water vapor by maintaining the temperature of this surface high enough to keep the water in the material above 212 deg., the vapor then condensing and being reëvaporated by the surrounding atmosphere. It is just this method of drying that is utilized with drycans and drum slashers. It gives the most rapid rate of drying, as well as the greatest economy, particularly where an air current is used to disturb the sluggish film of saturated vapor on the surface of the material, thus giving a direct evaporation in addition. Such air circulation is best obtained by properly designed hoods over the slasher and blast nozzles on drycans.

In case of a material which cannot be brought into contact with the hot surface, but which must be dried quickly, rapid air currents become almost absolutely necessary and radiant heat desirable. However, the use of air currents and radiant heat is usually limited by the nature of the material and its possible arrangement in the drier, so that the most common form of textile drying, next to drycans and slashers, is that in which the material is heated and the latent heat of evaporation entirely supplied by the air in contact with it. For example, skein driers and festoon driers, with which the air is blown over or around the product, stock driers, and the "mast" type of knit-goods driers, with which the air is blown through the stock. However, there are cases in which strong air blasts and radiant heat can both be used, such as with a straight-away tenter frame. Here radiant heat alone, plus the convection, which is a natural result, will give one rate of drying; air blasting alone at a high temperature will give a higher rate; but a combination of the two, the highest rate.

From the foregoing it will be seen that textile drying resolves itself into two general classes: (*a*) with the material in contact with a hot surface; and (*b*) with the material in contact with air only, so that for a study of steam economy it is best that the two classes be considered separately; and the following table, prepared from the averages of many tests run on efficient drycans without air blast, gives the approximate distribution in per cent of the total steam used for the evaporation of one pound of water:

	Per Cent
Loss by radiation	20
Heating wet material	1
Evaporation of water	79
Total	100

or 1225 B.t.u. or $1^1/_4$ lb. steam at 5 lb. gage.

That drying on cans is a very efficient method is apparent and well known. However, actual mill averages often run double this consumption because of time lost between runs and improper proportion of width of goods to the width of cans.

In the second class of driers, possible economy of steam is much greater, for while the steam used per pound of water evaporated in a practical air drier can never be equal to that used in contact driers, the average air drier is more complicated and therefore more difficult to build and operate efficiently. The following table gives the destinations of heat required to evaporate one pound of water as calculated from test data on such a drier of more than average efficiency:

	Per Cent
Loss by radiation	14
Heating wet goods	0.5
Evaporation of water	46.5
Air change	39
Total	100

or 2150 B.t.u. or $2^1/_4$ lb. steam.

No loss has been attributed to leakage, because a properly designed drier can usually be so arranged that even though it may not be made air-tight, and openings must be provided for ingress and egress of the material, all of the leakage can be inward and become the new air required for evaporation without upsetting to any great degree the most efficient route of air travel through the drier.

Inasmuch as neither the heat required for evaporation, nor that necessary to raise the wet material to the temperature at which evaporation takes place, can be reduced to any material extent, steam economy must be effected by a reduction of radiation loss and the heat required to raise the temperature of the new air used to carry off the water vapor. It is sometimes possible to use the heat contained in this exhausted air either for heating or to augment some other drying process where a high percentage of humidity is permissible or desirable.

In the foregoing brief statement of generally well known drying facts, it has been the intention to bring out

1 The desirability of reducing the drying time in any drier at the expense of steam, or even labor, because of the preponderance of the overhead item
2 That this increase in the rate of drying must usually be obtained by increased temperature of the material being dried, and decreased vapor tension of the air actually in contact with it
3 That reduced labor costs, while usually a natural consequence of increased speed from the drier, can often be further reduced by combining the drier with other machinery into a range
4 That steam consumption can be cut only by eliminating leakage, reducing radiation by insulation, and using the minimum amount of new air for removal of water
5 Because cans meet all these conditions, they should be used in preference to all other types of driers wherever the nature of the product will permit.

DISCUSSION AT THE SESSION ON TEXTILE WASTE

AT THE session on Textile Waste, Past-President Charles T. Main, who had been appointed, with Sidney B. Payne, to represent the Society at the Second World Cotton Conference, held in June, 1921, in Manchester, England, submitted his report. Two papers were also read, namely, Hidden Wastes in Textile Plants, by Thayer P. Gates, and Economy in Textile Drying, by B. R. Andrews.

The discussion of the paper by Mr. Gates was opened by Clarence W. Marsh[1] who spoke of the possibilities of textile plants making some of the materials used by them. It is a fact, he said, that any concern using chlorine and caustic soda, especially a textile mill where steam is used for heating and power is therefore comparatively cheap, can make it infinitely cheaper than it can be bought. The reason, he said, is that many of the steps necessary to convert chlorine bleach into the finished product which the textile manufacturer uses represent economic waste. Chlorine and caustic soda can be used as delivered from the mill without conversion. To liquefy chlorine, he said, costs a cent and a half, the container from half a cent to a cent, and shipping a cent and a half. Money must be spent on the control apparatus for the liquid chlorine when an equal amount might purchase apparatus for making chlorine. And finally, the liquid chlorine must be transformed again into a gas.

Francis A. Chiffelle[2] said he wanted to emphasize the need of plant investigation. He asked if there was not a limit to the speed of tenters. A tenter chain, he said, was not built for high speed. Chain manufacturers would hesitate about putting in a chain like a tenter chain on ten-tooth sprockets and yet all tenter chain is run

---

[1] New York, N. Y.

[2] Ch. Engr., Slatersville Finishing Co., Slatersville, R. I. Mem.Am.Soc. M.E.

on ten-tooth sprockets. With expensive chain like tenter chain there is a limit to the speed which should be allowed. Chain manufacturers, he said, figure on about 350 ft. or 116 yards per minute. The author said he had known tenter chains which had been running two years at a speed of 110 yards per minute, and occasionally at a maximum of 140 yards per minute. Mr. Chiffelle thought that this speed was too great for economy, and the author replied that the problem was to determine whether it was cheaper to run fast and have the chain wear out in a few years, or to run slow and have it last twenty.

D. M. Bates[3] spoke of his experience in replacing the iron bearings of chains with maple, and of work done by the late H. L. Gantt in doubling the yardage in textile plant with less wear and tear on the machinery. In regard to textile mills making their own bleach, as had been suggested by Mr. Marsh, he pointed out that this had been considered many times. The convenience of handling the liquid chlorine was appealing, even though the liquid was expensive. There were also difficulties, he said, in making chlorine in the relatively small quantities required by the average cotton bleachery.

H. M. Burke[4] said that as an engineer he realized that more scientific knowledge of the textile industry was needed. It was hard, he said, to convince owners of textile plants that this was so. Much of the knowledge of methods and machinery, however, was merely empirical. There was, he thought, a need for research in this field. It might be necessary to get enough publicity from engineers to sell such ideas to the man handling the money in a textile plant. This could not be done properly unless the processes were studied scientifically.

The author said that it had been his experience that it was easier to convince the man who handles the money than a board of directors. He had found it a good plan to tackle one problem at a time and to get results. Results were always pleasing to the board of directors.

Mr. Burke compared the textile with the shoe industry, in which highly specialized machinery had been introduced as a result of study.

Paul A. Marion[5] opened the discussion of Mr. Andrews' paper on Economy in Textile Drying. The author, he said, had pointed out very clearly that the way to increase economy in textile drying was to increase capacity. Several means of increasing capacity had occurred to him. The most important factor was the operator. Many existing installations would be capable of greater capacity if operators could be induced to obtain it. A second means was to improve the load factor in the case of multiple-width cans; to load these cans to the proper width with the number of strands for which they were designed. Why should finishing plants not be run twenty-four hours a day like paper mills? Another means of increasing capacity, he said, was to put all machinery in first-class condition, and another by removing the moist air from the cloth.

L. B. McMillan[6] discussed some statements by the author which had to do with loss of heat from galvanized iron surfaces. He pointed out that the tests made at the University of Illinois which showed that more heat was lost from such surfaces when covered with asbestos paper and to which the author referred, were correct, but he was afraid that a wrong interpretation might be placed upon the results because of the fact that the radiation from bright polished surfaces of galvanized iron or tin would increase as the surface became dulled by rust.

He also spoke of the insulating value of air spaces, pointing out that in order to be effective these spaces must be extremely small so as to prevent a circulation of air within them.

The author replied that he did not wish anything he had said to be taken as a complaint against asbestos insulation on the surfaces he had referred to. It was interesting to note, however, that these surfaces in connection with driers did stay bright.

J. A. Campbell[7] asked if double ends were still used on driers to take off the large amount of moisture that comes from nozzles on straightaway tenters. The author replied that he had not seen such installations in the last few years.

Charles H. Bigelow[8] asked what differences were found in applying air on the top and on the bottom of goods in straightaway tenters where a source of hot air is used. The author replied that such differences would depend upon the arrangement of the heater. It seems to make no difference if only air is used whether it is blown on the top or the bottom but with heater coils located above the goods there is always a danger of spots from dust and water dropping from above.

W. H. Carrier[9] said he wished to commend the author's consideration of the economic as well as the engineering features of drying. In the interest of accuracy he wished to clear up a possible ambiguity in the sixth paragraph of the author's paper where he states: "There are two ways of maintaining a low vapor pressure in the air in immediate contact with the material." All investigations show, he said, that the air in immediate contact with the material is saturated. The degree of saturation cannot be lowered. The saturated air can be removed, and by raising the temperature the moisture content of the air is raised. Heating has the effect of removing more moisture for the reason that the film of air near the surface of the material can absorb a greater amount of moisture for a given mass. The vapor pressure is increased, not decreased, and this involves a more rapid rate of drying. The object stated by the author is accomplished, but in the opposite way. A higher drier temperature does not decrease the vapor pressure of the air which is fixed by the air supply and depends on the dewpoint. It does raise the wet-bulb temperature and the vapor pressure of the moisture. The vapor pressure of the air in the film in contact with the material depends on the wet bulb-temperature. The rate of evaporation depends on the difference of vapor pressure of the film of air and the vapor pressure of the surrounding air. The vapor pressure of the film is above the vapor pressure of the air, and the higher temperature causes a high vapor-pressure difference. Rapid air circulation does not lower the vapor pressure on the material, except in the case of drycans and paper machines. The ambiguity lies in the fact that the type is not specified. If the author refers to drycans and paper machines, his statement is true and applies, but if air alone is used it does not apply, for in this case the vapor pressure of the air is not lowered, but remains practically constant and depends on the wet-bulb temperature. The effect of high velocity, however, is very important, as the author points out, because at high velocities the film of saturated air in contact with the material is swept away. For example, if the velocity is increased from that of still air to 230 ft. per min., the evaporation is doubled, and if to 280 ft. per minute, it is trebled.

De-Ironing Water

The water from the Metropolitan Water Board's wells at Waltham Abbey and Rammey Marsh having become charged with iron, it was decided to lay down a plant to deal with the trouble. The work is now nearing completion. The plant installed consists of twelve Candy iron-removing filters, each of 8 ft., 3 in. internal diameter and about 7 ft. high. The filtering medium consists of aerating and iron-removing sand and polarite. A small quantity of compressed air will be injected into the unfiltered water for the oxidazation of the iron in solution. The polarite acts as a catalytic agent, transferring the dissolved air to the iron with which it combines to form an insoluable hydrated oxide of iron. By this means it is hoped to reduce any iron which may be contained in the water to be treated to 0.01 part per 100,000. Ten of the filters, which will together be capable of treating two million gallons of the water in twenty-four hours, will usually be in service together, the remaining two acting as spares. For working the filters, a compressor plant, driven by Pelton wheels, has been installed. The whole of the apparatus is enclosed within a brick building, having a reinforced-concrete roof. The subsoil on which the building had to be erected is of a peaty nature, and is charged with water. It was consequently necessary to support the filters and the building on a reinforced-concrete foundation supported on reinforced-concrete piles.

---

[3] Vice-Pres., Day & Zimmermann, Inc., Philadelphia, Pa. Mem.Am. Soc.M.E.

[4] Mech. Engr., Mt. Hope Finishing Co., N. Dighton, Mass. Mem.Am. M.E.

[5] 389 Charles St., Providence, R. I.

[6] Cons. Engr., H. W. Johns-Manville Co., New York, N. Y. Assoc-Mem. Am.Soc.M.E.

[7] Mech. Supt., D. Goff & Sons, Pawtucket, R. I. Mem.Am.Soc.M.E.

[8] Ch. Mech. Engr., Millville Mfg. Co., Millville, N. J. Mem.Am.Soc. M.E.

[9] Pres., Carrier Engrg. Corp., New York, N. Y. Mem.Am.Soc.M.E.

Significance of Standardization to American Industry and the Federal Government

The Advantages of Standardization to All, Including the Government as the Largest Consumer—How the Government Should Coöperate with Industry—What is Being Done by the American Engineering Standards Committee

By A. A. STEVENSON,[1] PHILADELPHIA, PA.

THE significance and importance of standardization to industry and to the Federal Government seem almost axiomatic to those of us who have been actively interested in standardization work for a number of years, and since the present is a particularly opportune time for the launching of extensive coöperation between Government and industry, it seems well to point out the opportunities and means for such coöperation in industrial standardization.

The United States Government is probably the largest purchaser of materials in the world. The War and Navy Departments obviously have special requirements with reference to their military needs, but aside from these the interest of the Government in standardization is the same as that of all other consumers. The Government maintains an unrivaled group of research organizations, the principal object of which is the furthering of the development of our industries. In addition, the efforts of the present administration show a keen appreciation of the importance of standardization and its bearing upon industry as a whole, and constitute a most significant development in the relation of the Government and industry.

Of the many advantages to be derived by both industry and the Government from standardization along national lines, the most important seem to be:

1 Mass production, with its obvious advantage to the producer, means reduction in cost. Competition engendered by such production insures to the consumer, including the Government, the benefit of reduction in price.

2 Elimination of wide varieties and sizes permits producers to concentrate on those retained, and facilitates improvements in method and equipment that will ultimately result in the elimination of waste and the reduction of cost to the consumer, including the Government.

3 Putting all tenders on an easily comparable basis, promotes fairness in competition in both domestic and foreign trade, to the benefit of both producer and consumer.

4 Elimination of indecision in both production and utilization removes a prolific cause of inefficiency and waste.

5 Stabilization of production and employment means for the producer uninterrupted manufacture from stock during periods of depression. This is of vital interest to the Government as being of benefit to the country as a whole.

6 Accumulation of stock means prompt deliveries by the producer, and eliminates the necessity of the Government itself carrying a large inventory of material.

Again, the World War showed us the need of standardization along national lines, and the results obtained were of unlimited service to the country as a whole. Would it not be a calamity not to profit by the lessons taught by these experiences, adapting them to peace-time conditions? The advantages of national standardization are no less real in the midst of the post-war readjustment struggle. The need for unification of standards is, in fact, greater than ever before; for the manufacturer needs it to obtain maximum production, the distributor to minimize stock carried, and the consumer to secure articles at the least possible cost.

STANDARDIZATION AS A FACTOR IN TRADE

In outlining some of the factors tending to emphasize the significance of standardization, the great importance of standardization in helping to retain our foreign trade and meet keen competition from abroad has not been mentioned. In both Great Britain and Germany, national standardization is being carried on intensively. German industries are carrying out a far-reaching program of standardization as a necessary step in building up an unprecedented industrial structure which must rest in large measure on an extensive foreign trade. It is being woven very intimately into the industrial fabric of the country under the guidance of an organization which functions very much like the American Engineering Standards Committee, and in its work 5000 German industrial firms are coöperating.

COÖPERATION BETWEEN GOVERNMENT AND INDUSTRY IS VITAL

For reasons for which neither can be blamed exclusively, there is no doubt that the industries of this country and the Government Departments in many instances have not coöperated in a way to insure best results in standardization along national lines.

In national standardization the coöperation of the Government is necessary to industry and vice-versa. This result can best be realized through representative conferences in which specific projects are initiated, and representative committees by which the work on specific projects is carried out. In the work of such conferences and committees, industry and government should participate actively through accredited representatives of all interested bodies. It has been the experience of the American Engineering Standards Committee that the necessary industry-wide spirit of coöperation is developed and utilized through such representative conferences and committees. No doubt this statement would find confirmation in the experience of the Government Departments which have followed the same comprehensive plan.

To obtain the maximum of benefit from coöperation with industry, the Government should not attempt to set up standards at variance with standards acceptable for use by others for identical purposes. It should consider itself one (although a very large one) of the many consumers, and in its dealings with the manufacturers should coöperate with other consumers in formulating standards acceptable to both producer and consumer.

By means of conferences and committees truly representative of each industry as a whole (including consumers as well as producers), the bureaus can determine what are the needs of industry and learn in just what way their facilities can best be utilized. The bureaus need have no fear that their services will not be appreciated. The fact is that they will be recognized as being indispensable to the industries, and the industries will use their powerful influence to insure for the bureaus adequate equipment and personnel to carry on their work in a proper manner.

BENEFIT OF ONE SET OF STANDARDS FOR ALL

The benefit to be derived from having only one set of standards is so great that the producers should be willing to comply with more severe requirements that are uniform, in preference to less severe requirements different for each consumer or group of consumers. On the other hand, consumers should be willing to accept less severe requirements, thereby obtaining the benefit derived from economy in manufacture, rather than insisting on more severe requirements with accompanying added cost. An ideal specification is one which can readily be met by a producer who is competent and willing. When a specification is so severe that it condemns much good material, it results in economic waste. The creation of uniform national standards means economy for the producer, the consumer, and the country as a whole, and hence activities which will accomplish this desired result should be encouraged by the Government to the maximum extent.

---

[1] Chairman, 1921, American Engineering Standards Committee. Mem. Am.Soc.M.E.

Abstract of paper presented before the Washington, D. C. Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, December 9, 1921.

A recent event of unusual importance was the organization of the Federal Specifications Board, for unifying the specifications for all Government purchases, military as well as non-military. This Board has been charged with the duty of compiling and adopting standard specifications for materials and services, and bringing specifications into harmony with the best commercial practice wherever conditions permit, in order to broaden the field of supply. If common standards are arrived at for the Government and the industries of the country, might it not be advantageous to have a common agency charged with the duty of determining what materials and services do meet properly the standards adopted? It is understood that in at least two of the most important industries of the country plans are now under consideration for the establishment of such a common bureau of inspection. As illustrating the possibilities of such a plan, may be mentioned the great services rendered both the industries and the Government by the adoption of uniform specifications for electric lamps, and the concentration of the inspection of all Government specifications for such lamps.

In discussing the relation of the Federal Government to the movement for industrial standardization along national lines, one naturally thinks first of the Government as a great consumer. But the relation is far broader than that, for in lending its moral and material support to the movement, the Government has an opportunity of the first importance in its labors to "promote the general welfare" of the country as a whole.

Relation of Government Research to Standardization

The relation of the great Federal research bureaus to industrial standardization is no less important than that of the great purchasing bureaus. Research and standardization are very closely related, and in many ways they are supplementary. By showing the need of reliable information as to the facts, in order to determine the best practice, and secure agreements on moot questions, standardization acts as a powerful stimulus to research and development. But what is of even greater importance, standardization is a principal means of getting the results of research and development work into actual use in the industries, so that the industries themselves, and finally the general public, may reap the advantages.

One of the most direct and effective methods of getting the results of the investigational work of the research bureaus introduced into, and of service to the industries, is by coöperation between the research bureaus and the industries, through working standardization committees, which must necessarily be joint committees of the various bodies interested in each specific project. The many advantages of such coöperation, both to the industries and to the bureaus, are obvious.

What is no less important, such coöperation is very effective in helping to extend a knowledge and appreciation of the work of the bureau in the associations speaking for the industry. As illustrating the significance of this, considerably more than a hundred national organizations are now coöperating through accredited representatives in the work of standardizing committees functioning under the auspices and rules of procedure of the American Engineering Standards Committee. In this work the Bureau of Standards, the Bureau of Mines, and the Forest Service are taking a very active part, and in so doing are rendering extremely important services to their respective industries. This coöperative work will be no less valuable to these bureaus than it is to industry.

Clearing House for Standardization Essential

In order that standardization along national lines may be brought about, it is necessary that there be some central body to act as a clearing house in standardization work. It is essential that there be brought together information concerning the organizations by which standards have been formulated and are being promulgated and details relating to such standards as are already in use. From the central body charged with the duty of collecting this information, it should be transmitted promptly wherever needed to insure the elimination of conflicts in the formulation of standards. The success to be expected from a central body organized for the purposes just stated obviously depends upon the authority invested in it, and the recognition received by it from the organizations throughout the country which are engaged in doing standardization work.

The need for closer coöperation in order to prevent duplication and the promulgation of conflicting standards in America crystallized in the appointment of a committee by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, which formulated a plan resulting in the organization of a permanent committee made up of representatives of the five societies mentioned and the three Government Departments of War, Navy and Commerce. The Constitution of this committee, the American Engineering Standards Committee, was broadened later to permit the representation of other bodies, and at the present time it has 50 representatives from 18 bodies or groups of bodies including 7 national engineering societies, 13 national industrial associations, and 5 Government Departments, including the Departments of Agriculture and Interior in addition to the three already mentioned. There are now 37 different national organizations which have accepted sponsorship for a total of 59 projects. In addition there are 108 coöperating organizations other than the sponsor bodies, bringing the total to 145 national organizations who are actively coöperating in the work of the American Engineering Standards Committee and who have appointed accredited representatives to serve on sectional committees.

Objects of American Engineering Standards Committee

The objects of the American Engineering Standards Committee briefly stated are:

"To unify methods of arriving at engineering standards, and to secure coöperation between various interested organizations, in order to prevent duplication of work and promulgation of conflicting standards.

"To receive and pass upon recommendations for standards but not to initiate or develop the details of any particular standard.

"To act as an authoritative channel of coöperation in international engineering standardization.

"To promote in foreign countries the knowledge of recognized American Standards.

"To collect and classify data on standards and standardization bodies in the United States and foreign countries, and to act as a bureau of information regarding standardization."

As a result of the work in which the American Engineering Standards Committee is now actively engaged, existing conflicting standards are being brought into harmony, and there are being created truly representative committees to formulate new standards. The methods employed obviously differ somewhat from methods utilized hitherto, and it must be acknowledged that they are not yet fully understood by many of the organizations in America that should be coöperating in standardization along national lines.

The Rules of Procedure of the American Engineering Standards Committee are at times misunderstood, not by reason of their complexity but because of their extreme simplicity. Only when a standard has been formulated under such auspices that it has the endorsement of substantially the whole of the industry to which it applies is it considered qualified to be designated an "American Standard." The advantage resulting from insuring that all standards to be thus designated have been formulated under the proper auspices and are acceptable to the industry involved are so self-evident that it is sometimes difficult to understand why everyone does not appreciate the industrial significance of the work of the American Engineering Standards Committee. The Committee does not concern itself with the technical details of the standards submitted to it for approval, or formulated by committees organized under its auspices, but limits its investigations to a study of the procedure followed in developing the standard with particular reference to the representative character of the group of persons by which the standard has been formulated and the organizations by which it has been adopted or approved.

The decision of the American Engineering Standards Committee

(Continued on page 203)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Thermodynamic Bases for Determining Efficiency to be Expected from Gas Turbines

By H. SCHMOLKE

TESTS resumed since 1918 with 8000-hp. Holzwarth gas turbines justify the expectation that the difficulties of applying gas turbines for driving turbo-dynamos are not insuperable. The internal-combustion engine may in the not distant future reach a stage of development to a position to compete with the prime movers now employed in electric central stations. In fact, the German State Railroad Administration has already placed orders for several Holzwarth turbines of considerable capacity, and the experience of operating them ought to aid in their further development.

Whether the final aim will ever be attained, depends of course in the first instance on the efficiency to be attained in this type of apparatus. If for one reason or another it is basically impossible to attain a degree of efficiency that will place the gas turbine on a par with other types of heat engines, obviously all the efforts of Holzwarth and other investigators in the field are doomed to failure. Hence it is of the greatest importance to determine in advance the maximum efficiency to be expected from a projected installation, and the following represents a kind of synopsis of investigations published within the last 10 years by prominent experts in thermodynamics. In this connection the gas-entropy chart is of paramount importance. Such a chart may be obtained by plotting curves of equal pressures and equal volumes, with ordinates representing the absolute temperature T and abscissæ the entropy S. The curves themselves may be derived by the following process of calculation.

It is a well-known fact that the heat supplied during the process is equal to

$$dQ = TdS = c_v dT + Apdv$$

when c_v is the specific heat at constant volume, A the heat equivalent, p the specific pressure and v the volume. From this it follows that

$$dS = c_v \frac{dT}{T} + Ap\frac{dv}{T}$$

It is, however, possible to write

$$T = \frac{p_v}{R}$$

in accordance with the equation of state, provided R is a gas constant. If this relation be introduced into the second term of the right-hand side of the equation, we obtain

$$dS = c_v \frac{dT}{T} + AR\frac{dv}{v}$$

and this after integration between the initial values of T_0, v_0 and the final values T, and v gives

$$S - S_0 = c_v \log \frac{T}{T_0} + AR \log \frac{v}{v_0}$$

or, with common logarithms,

$$S - S_0 = 2.303 \left(c_v \log \frac{T}{T_0} + AR \log \frac{v}{v_0}\right)$$

There are, however, the two well-known thermodynamic equations:

$$p_v = RT \text{ and } c_p = c_v + AR$$

from which and the preceding equation, it follows that

$$S - S_0 = 2.303 \left(c_p \log \frac{v}{v_0} + c_v \log \frac{p}{p_0}\right)$$

but at constant pressure $p = p_0$ and $\log \frac{p}{p_0} = 0$.

This gives for the desired curve of pressure the formula

$$S - S_0 = 2.303\ c_p \log \frac{v}{v_0}$$

Since, further, in accordance with the equation of state with pressure p constant, T/T_0 is v/v_0, one easily obtains for the curve the very convenient expression $S - S_0 = 2.303\ c_p \log \frac{T}{T_0}$. If, on the other hand, it is the volume that is constant, that is, $v = v_0$ and $\log \frac{v}{v_0} = 0$, we obtain in a similar manner the expression $S - S_0 = 2.303\ c_v \log \frac{p}{p_0}$, and as at constant volume one may write $p/p_0 = T/T_0$, the above equation may be written as

$$S - S_0 = 2.303\ c_v \log \frac{T}{T_0}$$

Now if the entropy of a gas at 0 deg. and any pressure p_0 as well as volume v_0 be stated as being equal to 0, it becomes possible to plot either the pressure or volume curve on the T-S diagram. In order, however, to plot the curve of pressures for a higher pressure, it is necessary to determine its origin on the ordinates. To do this, it is necessary to compute the temperature in adiabatic pressure from p_0 to np_0, where n may be any number. According to the equation of state

$$\frac{T_2}{T_1} = \frac{p_2 v_2}{p_1 v_1}$$

and further in adiabatic compression

$$p_1 v_1^{\kappa} = p_2 v_2^{\kappa} \text{ or } \frac{p_2}{p_1} = \left(\frac{v_1}{v_2}\right)^{\kappa}$$

By combining this equation with the preceding one, we find

$$\frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{\kappa - 1}$$

and furthermore, since according to the adiabatic equation

$$\frac{v_2}{v_1} = \left(\frac{p_1}{p_2}\right)^{\frac{1}{\kappa}}$$

we find that

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{\kappa - 1}{\kappa}}$$

If we write now $p_1 = p_0$ and $p_2 = np_0$, we arrive at equation

$$\frac{T_n}{T_0} = \left(\frac{np}{p_0}\right)^{\frac{\kappa - 1}{\kappa}} = n^{\frac{\kappa - 1}{\kappa}}$$

This equation determines also the origin of the line of pressures for the compression n times as great. Where the curve of volumes in adiabatic compression begins at the nth part of the original volume, the equation

$$\frac{T_2}{T_1} = \frac{T_n}{T_0} = \left(\frac{v_0}{\frac{1}{n} v_0}\right)^{\kappa - 1} = n_{\kappa}^{-1}$$

holds good. With these two equations available there is nothing further needed in laying out the entropy charts.

Prof. A. Stodola, of Zurich, Switzerland, was probably the first to plot such curves. In the fourth edition of his work on Steam Turbines he published a temperature-entropy diagram for gases, diagrammatically reproduced on the right-hand side of Fig. 1. In developing the arithmetical foundations for the computation of these curves, the specific heat at constant volume c_v of the gases under consideration was referred to the mol, which was indicated by the use of a modified script. It was assumed that $c_v = a + bT$, where $a = 4.67$, and b is a constant depending on the properties of a given gas. It was expected that in this way the variation of heat capacity with temperature would be sufficiently taken care of. Under this assumption it would be found from the above equation

$$dS = c_v \frac{dT}{T} + AR\frac{dv}{v}$$

that

$$d\mathfrak{S} = a\frac{dT}{T} + b\,dT + A\mathfrak{R}\frac{d\mathfrak{B}}{\mathfrak{B}}$$

the bold-face letters indicating that the quantities are computed on the mol basis. From this, by integration between definite limits, it is found that

$$\mathfrak{S} - \mathfrak{S}_0 = a \log \frac{T}{T_0} + b\,(T - T_0) + A\mathfrak{R} \log \frac{\mathfrak{B}}{\mathfrak{B}_0}.$$

The variation of entropy is therefore expressed by a sum of three members which are plotted on the diagram from an inclined ordinate. The inclination of the line parallel to OX to the line parallel to OY varies with the value of b, while the chart to the right of the above-named line remains the same for all gases, due to the fact that all values are calculated on the basis of a mol, and therefore $\mathfrak{R}$ as well as a has the same value for all gases. The suction area located under the line AB is the amount of heat $\mathfrak{W}_v$ which must be supplied to one mol in order to increase at constant volume the temperature from T_0 to T. In order to express this amount of heat in terms of area, the values of $\mathfrak{W}_v$ are plotted as abscissæ to the right of point O on the vertical line, these values being

$$\mathfrak{W}_v = \int_{T_0}^{T} C_v dT = \int_{T_0}^{T} (a + bT)\,dT = (aT + \frac{b}{2}T^2) - (aT_0 + \frac{b}{2}T_0^2)$$
$$= \mathfrak{W}_b - \mathfrak{W}_a.$$

By repeating this process for various temperatures, one obtains the parabolic curve known as the heat curve. To the left of O the magnitudes $A\mathfrak{R}T$ appear as abscissæ.

At constant pressure the number of calories, which on the right-hand side of the diagram in Fig. 1 is represented by the enclosed area under curve AC, is equal to

$$\int_{T_0}^{T} C_p dT = \int_{T_0}^{T} (C_v + A\mathfrak{R})\,dT = \mathfrak{W}_v + A\mathfrak{R}\,(T - T_0) = \mathfrak{W}_c - \mathfrak{W}_{ap}$$

The spaces limited by the vertical lines at O and the line $A\mathfrak{R}T$ are therefore the differences between the amounts of heat at equal pressure $\mathfrak{W}_p$ and at equal volume $\mathfrak{W}_v$, which permits the careful determination of these two magnitudes.

Prof. P. Ostertag, of Winterthur, Switzerland, from whose writings the above scheme has been borrowed, uses the Stodola entropy diagram in a similar manner for the calculation of gas engines of all kinds. With all due respect to his work, however, it should be mentioned that the assumptions lying at the foundation of the above diagram are by no means universally satisfactory. In particular, the assumptions with respect to the specific heats are by no means free from objection. As has already been mentioned, it has been here assumed that $c_v = 4.67 + bT$. Here b for the simple gases H_2, N_2, O_2 and CO is equal to 0.00106, for CO_2 0.00568 and for superheated steam 0.00421; but such a manner of representing the function relation between heat capacity and temperature, while perhaps not objectionable for the first group of gases, is entirely insufficient for H_2O and CO_2. The specific heats of these subtances are very far from following the simple straight-line law, as has long ago been clearly demonstrated with regard to steam by the researches of Jakob, Knoblauch, Winkhaus and others.

It was therefore an important step in advance when, by carefully considering the available experimental data, Prof. W. Schuele, of Goerlitz, developed a diagram in which were shown the heats which must be supplied at constant pressure or volume to 1 cu.m. of air from 0 to 760 mm. in order to produce either a rise or fall of temperature. These heat values are computed in the following manner: If the temperature rises, for example from 0 deg. cent. to t deg. cent., the calories consumed at constant pressure $= \frac{m(c_{pm}) \times t}{22.4}$, where c_{pm} is the average specific heat in the respective region of temperature referred to 1 kg. of subtance and m is the molecular weight. Hence, $m(c_{pm})$ is the average molecular heat, and from this by the law of Avogadro the specific heat per cubic meter of substance may be obtained by dividing the above expression by 22.4. If the rise of temperature occurs at constant volume instead of constant pressure, as above, then the member c_{pm} is replaced by c_{vm}. In the Schuele diagram the heat values at constant pressure obtained in the above manner are shown as ordinates over temperature as abscissæ. Side by side with the curve for air is plotted another curve giving the same kind of values for pure "fire gas," i.e., the products of combustion generated when there is no excess of air. Between the air and gas line there are several broken-line curves representing more or less diluted "fire gas." The heat values at constant volume are

$$\frac{A\mathfrak{R}T}{22.4} = \frac{1.985\,t}{22.4}$$

less than the values at constant pressure. The new diagram replaces to a certain extent the left-hand portion of the entropy diagram of Stodola. Furthermore, it contains material which graphically represents the average molecular heats and the relation $\kappa = \frac{c_p}{c_v}$ for air as well as for the pure and diluted "fire gas." Schuele modified the right-hand part of the Stodola entropy diagram, which was the heat diagram proper, by plotting on the rectangular system of coördinates the p and v curves. While, strictly speaking, this diagram holds only for simple gases, it may be applied also to the products of combustion, provided only that one may assume there is present in them a material excess of air with only a slight content of steam. Thus, for example, there is no difficulty in representing graphically by means of the diagrams the processes that occur in the Holzwarth gas turbine.

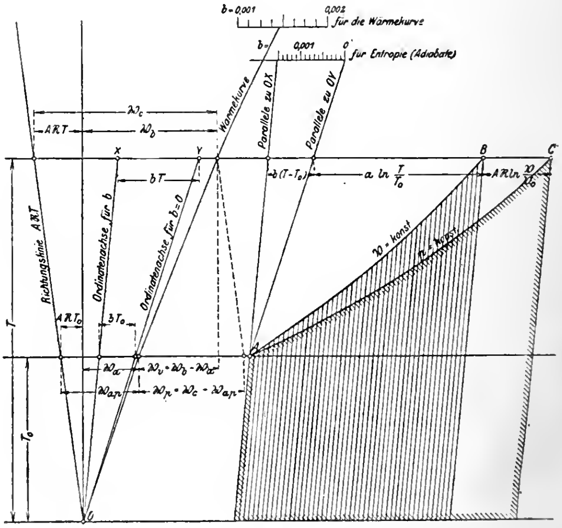
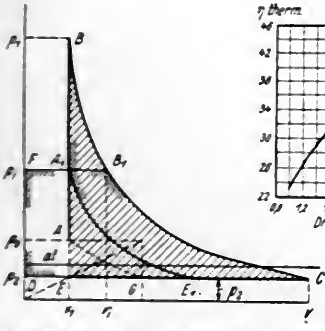


FIG. 1 STODOLA'S GAS ENTROPY DIAGRAM

(*Richtungslinie* = line; *Ordinatenachse fuer* = axis of ordinates for; *Waermekurve* = curve of heats; *Parallele zu* = parallel to; *fuer die Waermekurve* = scale for the curve of heats; *konst.* = constant; • *fuer* = for.)

The curves obtained in this way become quite understandable if one takes into consideration in connection with them the pressure diagram of such a machine as is shown in Fig. 2, which, together with

Fig. 4, is taken from the second volume of Schuele's Thermodynamics which appeared in 1920. In the Holzwarth turbine the precompressed gas-air mixture is ignited in a separate chamber, and as a result of the explosion there occurs an increase of pressure at constant volume (AB). Then a valve opens and provides access to the turbine wheels, which the gas jet reaches after an expansion in a nozzle. If one should assume now that this expansion together with the pressure rise through combustion occur without any exchange of heat taking place, the expansion curve BC is an adiabatic. The gain in work through expansion is represented by the area BCE. Since back of the turbine there is a partial vacuum, C lies below the atmospheric line. There occurs a removal of the exhausted gases by suction which is represented by the line CE. If the exhaust gases have reached a temperature corresponding to the point G the air must first be brought down to a pressure of 1 atmos., and then the new gas-air mixture must be brought to the pressure GA which exists at the beginning of the explosion. The work of compression required for the above processes is represented by the area $AGDp_0$. It is now easy to understand the entropy diagram of Fig. 4. The explosion occurs at the point A'. The increase of pressure resulting therefrom is represented by the line of equal volumes $A'B'$. The area $A'B'B''A''$ corresponds to the total heat supplied as a result of the ignition of the mixture. The temperature of the point B' is found by reading from the heat-capacity-temperature diagram the amount of heating produced by the supply of heat generated by the explosion. The adiabatic of expansion is $B'C'$. The curve joining it indicates the partial pressure of the gas. The total gain in work is $B'C'E'$. The point E' is found in the same way as in the p-v diagram of Fig. 2—namely, by prolonging the iso-volume line $A'B'$ past A' until the intersection of the curve of pressures C'. When G' is reached compression begins and the work employed therefore is represented by the area under $G'A'$. It is delivered by a steam turbine driven by heat derived from the exhaust gases of the gas turbine. If the contents of the combustion chamber of the gas turbine were subjected to no precompression before explosion, they would have had, instead of the p curve through C', the line $C_1'A'$. The area $A'B'C_1'$, which now represents the gain of work, has decreased in size quite considerably, while the total heat supply has not changed. Therefore there has occurred a reduction in efficiency. If the back pressure has become smaller than in the previously considered case, it will be seen that the curve closing the circular process has moved further down. The area representing the work gained increases thereby, and so does the effective result. A drawing to scale would indicate that, with a back pressure of 0.9 atmos., a compression pressure of 3.15 atmos., and an explosion pressure of 19.8 atmos., there is obtained (assuming no other losses) a thermal efficiency, η, of 50 per cent. Even taking into consideration the fact that the waste heat does not provide sufficient power to take care of the gas compression, it would still appear that it is possible to convert into useful work from 40 to 45 per cent of the heat content of the materials of combustion. Such a result is no doubt very promising, as in reciprocating engines the ideal process leads to similar results only under the assumption of compressions in the ration of at least one to ten, and Holzwarth points to such conclusions of theoretical investigation with great gratification in his article of Feb. 28, 1920 in the *Zeitschrift des Vereines deutscher Ingenieure.* In this article he also uses the Schuele diagrams, but in the form employed they hold good only for air and very dilute gases, a defect which has since been corrected and does not appear in the diagrams of Fig. 4.



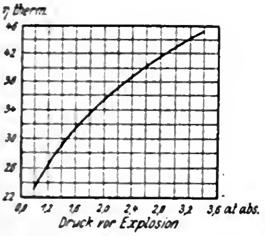


Fig. 2 The Process Occurring in the Holzwarth Turbine Shown in the p-v Diagram

Fig. 3 Efficiency of the Holzwarth Turbine Expressed as a Function of Precompression

(*Therm.* = thermal efficiency; *at. abs* = atomospheres absolute; *Druck vor Explosion* = pressure previous to explosion.)

It is to Schuele that credit should be given for this last step in advance in the theory of gas turbines. His diagram is of such great advantage in considering this new type of prime mover that it deserves a more complete description. Above all, it is remarkable for the great wealth of conclusions that may be drawn from it, notwithstanding its simplicity of appearance.

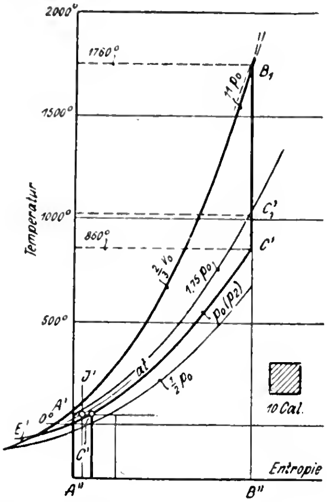


Fig. 4 Process of Holzwarth Turbine Plotted on a Heat Diagram

Schuele uses the following reasoning: From the expression already cited above, $dQ = c_v dT + Apdv$, it follows for any process occurring at constant temperature that $dQ = Apdv$, since dT is equal to zero. Furthermore, we have for cases of isothermal expansion and compression the equation

$$dS_T = \frac{dQ}{T} = \frac{Apdv}{T}$$

This, by reason of the equation of state, may be written as

$$dS_T = \frac{ARdv}{v}$$

from which we obtain by integration

$$S_T - S_{0T} = AR \log \frac{v}{v_0}$$

Furthermore, by differentiating the equation of state

$$pdv + vdp = RdT$$

and for constant temperature $pdv = -vdp$, and by introducing this last relation we obtain

$$dS_T = -AR\frac{dp}{p} \text{ or } S_T - S_{0T} = -AR \log \frac{p}{p_0}$$

From this it appears that the entropies at different pressures but the same degree of heat differ from each other by quite an appreciable amount, which moreover is independent of the temperature. At the same time all the curves of pressure are congruous and one may be derived from the other by displacing it by the amount given by the last equation. The consideration of the expression

$$S_T - S_{0T} = AR \log \frac{v}{v_0}$$

leads to the conclusion that all curves of volume are likewise con-

gruous, and each one may be derived from the other by a proper process of displacement. It is therefore sufficient to plot on the heat diagram only one pressure and one volume curve for a given substance, and indicate on the axis of abscissæ a scale from which for a smooth course of p_0/p and v/v_0 one may read the amount to which the given curve should be shifted for the given substance. It is, however, necessary to remember that different scales apply to different gases, but even this difficulty can be taken care of by carrying out calculations for the different gases in terms of mols. Should this be done and the molecular weight of the gas be denoted by m, the following equations hold good for the curves of pressure and volume:

$$m\,(S_T - S_{0T})_p = -\,LRm \log \frac{p}{p_0};\; m(S_T - S_{0T})_v = ARm \log \frac{v}{v_0}$$

However, according to Avogadro the product mAR for all gases is equal to 1.985 kg-cal. From this we find that

$$m\,(S_T - S_{0T})_p = 1.985 \log \frac{p}{p_0}, \text{ and } m\,(S_T - S_{0T})_v = 1.985 \log \frac{v}{v_0}$$

and from this it follows directly that if all calculations are made in terms of mols, the same scale applies to all gases. The same situation holds good if we consider the gas in terms of cubic meters at 0 deg. cent. and 760 mm. of mercury pressure. The weight of such a gas is $\frac{m}{22.4}$ kg. and the variation of entropy at the same pressure between the limits T and 273 deg. cent. is

$$\frac{m}{22.4} S_p = \frac{1}{22.4} \int_{273}^{T} \frac{mc_p}{T}\, dT = \Sigma_p$$

For equal volumes the analogous equation

$$\frac{m}{22.4} S_v = \frac{1}{22.4} \int_{273}^{T} \frac{mc_v}{T}\, dT = \Sigma_v$$

is found.

The displacements are therefore as follows, as a glance at the equations expressed in terms of mols would indicate:

$$\frac{m(S_T - S_{0T})_p}{22.4} = -\frac{1.985}{22.4} \times 2.306 \log \frac{p}{p_0} = -0.20405 \log \frac{p}{p_0}$$

$$\frac{m(S_T - S_{0T})_v}{22.4} = 0.20405 \log \frac{v}{v_0}$$

From this it would appear that the same scale holds good for all gases dealt with in terms of cubic meters.

For numerical calculations, however, it is necessary to make assumptions as to the specific heat c_p, c_v, the functional relation of which is given in accordance with generally known thermodynamic laws by the equation $mc_p - mc_v = mAR = 1.985$ kg-cal. For air and diatomic gases such as O_2, N_2, H_2, CO, the heat capacity referred to one mol is at constant pressure $mc_p = 6.57 + 0.00106\,T$. For one cubic meter we therefore get

$$\frac{mc_p}{22.4} = \mathfrak{C}_p = 0.2933 + \frac{0.4732}{10000}\,T$$

and since $\mathfrak{C}_p - \mathfrak{C}_v = \frac{1.985}{22.4} = 0.0886$, it follows that

$$\mathfrak{C}_v = 0.2017 + \frac{0.4732}{10000}\,T$$

From this it follows that

$$\Sigma_p = \int_{273}^{T} \frac{0.2933}{T}\, dT + \frac{0.4732}{10000} \int_{273}^{T} dT = 0.6754 \log \frac{T}{273} + \frac{0.4732t}{10000}$$

where $t = T - 273$. In a similar manner it is found that

$$\Sigma_v = 0.4713 \log \frac{T}{273} + \frac{0.4732t}{10000}$$

For all the substances above referred to it is sufficient to plot on the diagram one pressure and volume curve. Likewise, for all the pure gases of combustion generated by combustion with only the theoretically necessary amount of air present, the general equations

$$\Sigma_v = 0.7055 \log \frac{T}{273} + \frac{0.7143t}{10000}, \text{ and } \Sigma_0 = 0.5015 \log \frac{T}{273} + \frac{0.7143t}{10000}$$

hold with sufficient precision. In order, however, to determine the curves which would cover the case of diluted gases of combustion, one has to plot the Σ_p lines for air and the pure gases of combustion. Then the sections of abscissæ located between the two curves are divided in the ratio $\frac{v_e}{v}$, where v_e is the volume of the excess of air and v the total volume of the products of combustion. The points determined in this manner belong to the desired curves. The same process gives the v-curves for the diluted gases of combustion.

Schuele used an interesting graphic process described in the original article for determining the values of Σ_p and Σ_v for carbon dioxide and water vapor. (*Zeitschrift fur Dampfkessel und Maschinenbetrieb*, vol. 44, no. 44, Nov. 4, 1921, pp. 351–354, 4 figs., *tA*)

Short Abstracts of the Month

AERONAUTICS

TWO HUNDRED AND TWELVE MILES PER HOUR. In tests in December, 1921, at Martlesham, England, J. H. James is said to have established a record of 212 m.p.h., flying over the flying kilometer in a Mars-I machine made by the Gloucestershire Aircraft Co. However, the record has not yet been homologated by the Royal Aero Club. The machine is a biplane driven by a Lion engine. (*Flight*, vol. 13, no. 51/678, Dec. 22, 1921, p. 838, 1 fig., *g*)

WORK AT MCCOOK FIELD IN 1921, Maj. T. H. Bane, Mem.Am. Soc.M.E. Brief account of some of the outstanding features of the work of the Engineering Division, Army Air Service.

Among other things is mentioned the 1000-hp. engine now under construction. The engine is said to be of the barrel type and very compact.

Also a duralumin aeroplane has been built and passed its sand test, except for minor defects which it is believed will be corrected. This is the first attempt in this country to build a complete duralumin aeroplane. (*Aviation*, vol. 12, no. 2, Jan. 9, 1922, pp. 41–42, *g*)

FUNCTIONING OF SUPERCHARGER IN ALTITUDE FLIGHT, Lt. John A. MacReady. Excerpts from the report of the author on his flight at McCook Field, Sept. 20, 1921, which established a record for altitude. The flight was made on a supercharged LePere P-53 plane.

A peculiar and unusual condition arose during the flight. At the lower altitudes, instead of putting on the supercharger with altitude, it was necessary to gradually take off a little supercharger as altitude was gained. This is explained by the increase of speed of the propeller with altitude, resulting in increased supercharging capacity, which, if not taken off, would cause preignition. There did not appear to be an increase in propeller speed after 35,000 ft. was reached, and from this point on it was necessary to give additional supercharger to keep the supercharger altimeter dial indicating sea-level conditions.

On the ground the speed of the propeller was 1100 r.p.m., but gradually increased to 1680 at 35,000 ft. where it remained until an indicated ceiling of 41,200 ft. was reached. It was expected that the climb would be continued into some region of pressure above the point of 100 per cent supercharger efficiency, but this assumption proved incorrect. Sea-level conditions were reached at 40,100 ft., but from then on only slight altitude was gained, the supercharger dial registering a tremendous falling off. With 400 ft. more altitude, supercharging conditions within the engine went from sea level to approximately 6000 ft. above sea level, and this elevation became the absolute ceiling of the aeroplane. (*Aviation*, vol. 12, no. 2, Jan. 9, 1922, p. 51, *dA*)

AIR MACHINERY (See also Pumps)

Air Compressors for Marine Diesel Engines

Design of Air Compressors for Marine Diesel Engines, David Bruce. It being impossible to give any definite method of calculating, the first-stage cylinder volume in a marine Diesel engine is made a percentage of the total volume of the working cylinder. The percentage varies from 8 to 10 per cent. Practically all marine-Diesel-engine compressors are of the 3-stage type, though 2-stage machines are also employed as auxiliaries.

The article gives the figures for 2- and 3-stage machines, including the actual terminal figures in each stage, as resolved for final delivery pressures of 1015 and 1215 lb. per sq. in. abs., and also for initial pressures of 12 and 14.7 lb. absolute.

Methods of combining the various stages are described briefly and illustrated with diagrams. The valves used for the suction and discharge are of the automatic type and must be large enough to allow of a maximum air speed of 120 to 130 ft. per sec. through them. To keep within the speed limit in a large cylinder requires such a large valve capacity that in the larger stages two or three similar valves are fitted. In some of the pressure stages in which the diameter of the cylinder is very small, it is sometimes advisable to use small thimble and pocket valves. The article shows the inlet and outlet valves as adopted on small high-pressure stages (Fig. 1), the inlet being a mushroom and the outlet a thimble valve.

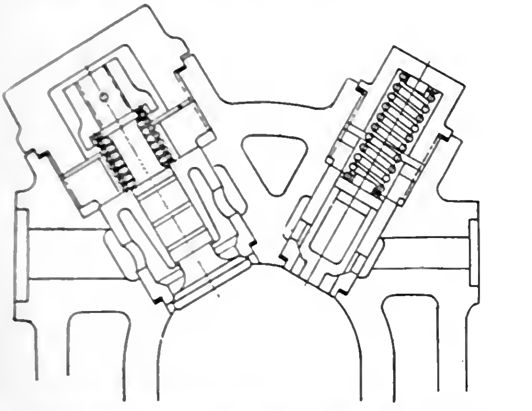


Fig. 1 Arrangement of Valves in Small Compressor Cylinders

The various types of air intercoolers are described briefly and illustrated.

Discussing clearance volumes, the article states that these must be kept as low as can be arranged in accordance with working conditions, although the practice of omitting certain valves, such as the 2-stage delivery valves in small marine compressors, and allowing the next stage suction valves only to provide the separation between the two stages, is undesirable as it leads to a big drop in efficiency of the compressor. (*Motorship*, vol. 7, no. 1, pp. 22–24, 11 figs., *d*)

Handling Material by Compressed Air, F. A. McLean. Description of various types of air hoists, of particular interest on account of the inclusion of several tables of figures giving the cost of hauling and lifting with this type of hoist. (*Canadian Machinery and Manufacturing News*, vol. 26, no. 25, Dec. 22, 1921, pp. 19–23, 10 figs., *gp*)

COMBUSTION ENGINEERING (See Aeronautics)

CORROSION

Corrosion of a Producer-Gas Cooling System, Lloyd E. Jackson. Data of an investigation conducted for the Providence Gas Company, Providence, R. I., at the Mellon Institute, Pittsburgh, Pa.

The incentive for this investigation was that at the manufacturing plant of the Providence Gas Company, after six months' operation with coke some producers developed leaks in the producer-gas cooling-water system.

There were good reasons to believe that the corrosion was not due to electrolysis caused by stray electric currents. Acids which might also lead to corrosion were found in numerous samples. The most economical way to treat acid is to neutralize it with lime, but before commencing to give this treatment to water some carefully cleaned test pieces of iron 5 in. by 2 in. by $^1/_8$ in. were suspended in the cooling system at the same points from which water samples were collected. The test pieces were allowed to remain several days and then were removed, dried and weighed. This test was made to obtain data with which to compare future data to be obtained from tests made following successful steps in treating.

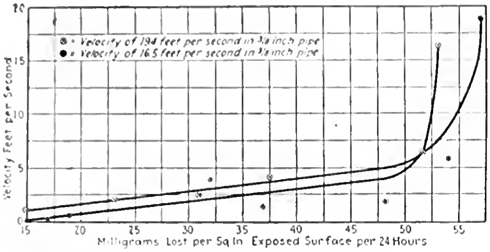


Fig. 2 Erosive Action of Cooling Water Containing Suspended Coke Dust

Apparatus for treating the water with lime was next installed, the water being at first treated with sufficient lime to make it alkaline to methyl-orange indicator. Tests with suspended iron test pieces showed that the corrosion of iron in water so treated was about half as great as in untreated water. However, methyl orange indicates only free mineral acid, and an attempt was made next to treat the water with sufficient lime to maintain it alkaline to phenolphthalein, which latter shows also acidity caused by dissolved carbon dioxide. This did not prove practical because such amounts of carbon dioxide are present in the producing gas with which the cooling water comes in direct contact; that reasonably large amounts of lime would be required to maintain the water alkaline to phenolphthalein.

Numerous analyses of samples were made also for dissolved oxygen, and they showed that the city water used for making up evaporation losses was highly saturated with dissolved oxygen. Further, as the water gives up its dissolved oxygen in the gas-cooling system, it is continually receiving a fresh charge when sprayed into the cooling pond. Dissolved oxygen, however, is an active corrosion agent, both in neutral and acid solutions and is particularly active in the presence of free mineral acids. To free the cooling water of dissolved oxygen, it was proposed to pass it through filters containing steel turnings instead of coke. Tests with suspended iron pieces showed that such an arrangement cut down corrosion in half. Tests were further made to determine the erosive action of the suspended coke dust in the cooling water. The results are presented in a table in the original article and plotted against water velocity in Fig. 2. From this test it appears that erosion due to suspended coke dust and ashes plays a very important part of the deterioration of the cooling system. In fact, in tests with 6-in. service pipe and a velocity of flow of water of approximately 12 ft. per sec. under average operating conditions, erosion tests showed this pipe to be wearing away at the rate of 55 mg. per sq. in. per 24 hr. The following recommendations were suggested as possible remedies for preventing deterioration of producer-gas cooling system:

(1) Cool and clean the producer gas with fresh water, and permit the water to waste to the bay after going through the cooling system. (2) Treat, cool and recirculate fresh water. The treatment recommended consists of filtration to remove suspended coke dust, neutralization of free mineral acid with lime, and removal of dissolved oxygen with steel turnings. (3) Cool and clean the gas with an excess of bay water and let it waste back to the bay.

In commenting upon these recommendations the author calls attention to the fact that first cold deactivated bay water had no

appreciable corrosive action on iron, but in the presence of hot producer gas, iron in deactivated bay water corrodes about three-fifths as rapidly as in the presence of raw bay water, and that the corrosive action of either kind of water increases rapidly as the temperature rises.

When 60 deg. fahr. or cooler water is available, the producer gas can be cooled sufficiently by pumping the cold water over the condenser and pumping warm water from the decanter over the dust catchers and collecting main. To determine whether warm bay water causes greater corrosion under these conditions, weighed pieces of iron were suspended on the bottom of a dust catcher and permitted to remain there for 14 days; then they were removed and reweighed. Water entered the dust catcher at a temperature of 100 to 110 deg. fahr. and left at a temperature of 110 to 120 deg. fahr. The tests show that practically the same amount of corrosion takes place in the dust catcher as when cold water which has not been deactivated is pumped. This recirculation, whether with bay water or fresh water, should not be practiced, because the water when tested contained excessive amounts of suspended coke dust. Under these conditions it is to be expected that pipes and pumps carrying the water from the decanter to the dust catchers will erode rapidly. Bearing out this contention, several leaks developed while test 6 was in progress.

Tests made to compare bay water with unfiltered recirculated fresh water have shown that the advantage lies with bay water. (*Chemical and Metallurgical Engineering*, vol. 26, no. 2, Jan. 11, 1922, pp. 60–64, 5 figs., *eA*)

COST ESTIMATING (See Foundry)

ENGINEERING MATERIALS (See also Railroad Engineering

Bentonite, Raymond B. Ladoo. The name "bentonite" has been applied to a series of claylike materials which occur in Wyoming, California and South Dakota in fairly large deposits, as well as in several other states.

It is coming into use for certain purposes in several industries, including its employment as a water softener. No detailed data as to this latter use are given. (*Chemical Age*, vol. 29, no. 12, Dec., 1921, pp. 493–494, *g*)

Metallurgy of Gray Cast Iron

The Problem of Gray-Iron Castings, H. J. Young. The author recommends the necessity of closer control of iron castings, beginning with the ore used for the pig iron. With the aid of tables he shows how such control is possible—in fact, he claims that purchasing an iron today upon its published composition is buying "a pig in a poke." Pig iron of standard ultimate composition would solve nearly all the difficulties of the jobbing foundry and most of those doing more important work.

Regarding the use of an electric or other furnace in conjunction with the cupola (duplexing), he says, first, that what we know about cupola practice is insufficient to enable us to predict that it cannot by itself give what we require. Next comes the question of cost, especially where competition with foreign markets (the abstract is from a British paper) has to be considered. Finally, it should not be assumed without question that the more carbon, phosphorus and sulphur abstracted from the iron, the better will be the metal for the purposes of making castings.

The author considers gray cast iron as a very high-carbon steel, cut up by and surrounding innumerable plates of graphite—in other words, a matrix of steel containing many spaces filled with graphite. This is why cast iron can be machined, the non-homogeneous material collapsing under the stresses produced by the edge of the cutting tool. For the same reason cast iron has little or no elongation.

The truth of these generalizations is well illustrated in the case of a large propeller casting, blades and boss complete, and weighing, say, 11 or more tons. Here the great mass of the boss causes extremely slow cooling of the adjacent parts, the effect getting less and less along the blades away from the boss and also as the cross-section of the blades themselves gets less. In practice, the molten metal flowing to the tips of the blades is almost chilled, and therefore the tips are very hard and brittle and contain but little free carbon. A short distance from the tip this cooling is less severe and more carbon is released, with the consequence that the metal is gray but rather hard. Half way up the blade the section is greater, and the heat given off by the cooling of the boss delays the cooling, hence the metal will be very normal and perfectly gray and machinable. At the root of the blade, where it joins the boss, the cooling will be extremely slow, taking some hours probably, and therefore the iron has time to free itself almost entirely from combined carbon, and when cold is found to be full of large graphite.

Thus does a propeller casting demonstrate the fact that the quantity and size of the graphite is greatly ruled by the rate of cooling of the metal from hot solid to cold solid. It shows how impossible it is to expect a test bar to represent anything but that part of the casting from which it is cut.

The author cites other examples to show that there is a material difference between metal cast in thicknesses of 4.5 in. and of 1 in. This difference would also appear in test bars cut from such castings. (Paper read before the Inst. of Mining Engrs., Dec. 13, 1921, abstracted through *Foundry Trade Journal*, vol. 24, no. 279, Dec. 22, 1921, pp. 497–501, 10 figs., *ep*. To be continued.)

FOUNDRY (See also Engineering Materials)

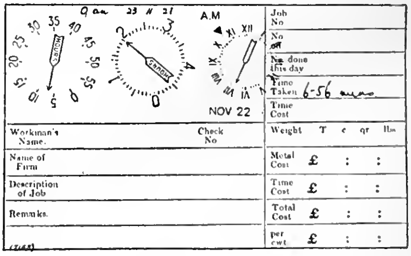
Foundry Costing

Foundry Costs and Establishment Charges, Daniel Adamson, Mem.Am.Soc.M.E. Discussion of the method of determining costs and establishment charges, with particular reference to British conditions. The indirect charges are divided as between the molten metal and the labor expended on the mold, and are a matter to be estimated for each particular establishment. They should be ascertained at regular intervals, say, every four weeks, and can then be allocated somewhat as follows:

Unallocated labor: 25 per cent of this item to be charged to "metal" and 75 per cent to workmanship account.

Power: 50 per cent to metal and 50 per cent to workmanship.

Light: 20 per cent to metal and 80 per cent to workmanship.



Job No

No off

No done this day

Time Taken 6-56

Time Cost

Workman's Name. Check No

Weight T c qr lbs

Name of Firm

Metal Cost £ : :

Description of Job

Time Cost £ : :

Remarks.

Total Cost £ : :

per cwt £ : :

Fig. 3 Job Record For Foundry

Foremen's wages: 20 per cent to metal and 80 per cent to workmanship.

Clerical charges: 25 per cent to metal and 75 per cent to workmanship.

Maintenance of buildings, machinery and plant, mill stores and sundries: 25 per cent to metal and 75 per cent to workmanship.

Depreciation and obsolescence: 25 per cent to metal and 75 per cent to workmanship.

Bank charges: 50 per cent to metal and 50 per cent to workmanship.

Taxes, rates, and insurances: 15 per cent to metal and 85 per cent to workmanship.

Indirect charges can then be converted into percentages of the totals expended during the period for materials and direct labor, respectively. For ascertaining the cost of a particular casting made during that period the percentages would be added to the net cost of material and labor, respectively, and a further sum cover contingencies and profits.

The net cost of materials would include the value of everything charged into the cupola such as pig iron, scrap, coke, limestone. The net cost of workmanship should include as much time as can be booked directly to the job, particularly molders' and coremakers',

also molding-machine time and, in some foundries, dressers' time also. To make the suggestion clearer, an example is worked out, using imaginary figures for purposes of illustration only.

In arriving at the cost of skilled labor booked directly to the job, and upon which the calculations of cost are to be based, attention should be given to the accuracy of the records made, and the most reliable method appears to be that in which job tickets are issued by the foreman to the workman, who in turn stamps these in a time clock at the beginning and end of his time on the order. A typical example of a suitable ticket is given in the article (Fig. 3).

By using the clock in this manner remarkable discrepancies in previous records were discovered, and the conclusion reached that the usual methods of booking time, whether dependent upon the observation of the foreman, or a clerk, or upon the memory or imagination of the workman, are quite illusory and so unreliable as to be almost useless. While the job-ticket system is of great value in other departments of engineering, it is particularly advantageous in a foundry, where it acts also as a check upon the quantity of bad castings made.

The remainder of the article is of interest primarily to British foundrymen. (*Engineering*, vol. 112, no. 2922, Dec. 30, 1921, pp. 894–895, 1 fig., *p*)

Giant Cupola and Molding Big Turbine Runners, E. C. Kreutzberg. The I. P. Morris Foundries of the Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa., have specialized in the production of castings for water turbines. Runners have already been cast weighing 93,000 lb. finished, and still larger castings of the same character to weigh as high as 160,000 lb. are expected shortly. Such huge castings require corresponding foundry equipment, particularly as turbine runners must be very carefully balanced when in use and therefore must be cast with weight uniformly distributed.

Unless the entire casting is made of material at about the same temperature, there is danger of internal stresses being set up. With the ordinary foundry equipment, however, this can hardly be avoided, as hitherto there were no single cupolas capable of giving enough metal for such large castings.

To meet this condition a special cupola was installed capable of delivering 14,000 lb. of molten metal every 15 minutes. The cupola has a shell diameter of 108 in. with a diameter of 84 in. inside for the lining, which is at least 3 ft. greater than the lining diameter of the average cupola. It is claimed that there is only one other cupola of the same size and type in use.

For casting turbine runners an unusual mold is required. Aside from the bottom plate and cover plate, the mold is made up entirely of cores. These are 16 in number and their sides correspond to the 16 veins in the casting. The job of setting up the mold is not an easy one. The cores cannot vary $^1/_{16}$ in. from the correct dimensions, and must then be set with absolute precision. Each core is set to overlap the next, and after they have been assembled sheets are placed around the mold and sand rammed between the sheets and the cores. The total weight of the mold with the casting is 135 tons. The construction of the 93,000-lb. turbine runner mold required 28 days. (*Foundry*, vol. 50, no. 1, Jan. 1, 1922, pp. 6–8, 3 figs., *d*)

FUELS AND FIRING (See also Internal-Combustion Engineering)

The Turbo Pulverizer. Description of a machine representing the self-contained unit for powdered-fuel firing, used in several important plants in England and on the continent of Europe.

The unit provides a pulverizing mill and fan combined. It comprises a rotor revolving on a horizontal axis in a steel casing. This casing is divided into compartments—the one nearest to the delivery containing a blowing and exhausting fan, while the other contains paddles fitted with loaded blades which, acting by impact, crush and pulverize the coal in stages. The coal is fed into the machine by an adjustable revolving table, the feed regulating the amount of coal burned in the furnace. The air is admitted at two points.

At the works of Edgar Allen & Co., Ltd., of Sheffield, England, the turbo pulverizer operates in connection with a first-heating furnace in the forge, and according to the article reviewed the consumption of fuel was cut nearly in four. No banking through the night is now used, and on restarting in the morning the heat can be brought up in two hours, or from stone cold in three hours.

Advantages of this type of equipment are quoted as low initial price and the fact that fine slack coal can be used with fairly high ash and moisture content too high to be employed for other purposes. (*The Iron and Coal Trades Review*, vol. 103, no. 2807, Dec. 16, 1921, pp. 887, 1 fig., *d*)

HYDRAULICS

The Variation of Energy About a Point in a Rotating-Type Hydraulic Machine, M. Eydoux. In a previous investigation published in the *Comptes Rendus de l'Academie des Sciences*, Oct. 24, 1921, the author has shown that when there occurs a variation of energy along a liquid passage in motion, as happens in turbines and centrifugal pumps, there must of necessity be present a gyratory vector. Working along the same lines, but considering the case of a rotating-type hydraulic machine, the author determines a vector expression for the variation of energy along a line of stream of the liquid.

The author establishes the proper equations for this in terms of the various velocities of flow, and finds from these equations that the components of absolute velocity and the turbulence velocity located in the meridian plane are the only magnitudes determining the variation of energy. As water is a viscous liquid and all turbulent motion which does not turn the machinery is simply a loss of energy, it is obvious that it is desirable to avoid all flow which might give rise to turbulence in an axis normal to the meridian plane.

This treatment of the question makes it possible to express as a function of T (velocity of turbulent flow) the components at one point of the reaction due to the wheel blades expressed in terms of unity of masses, and in this way to find in expressions of usual notation the results previously obtained by Bauersfeld and Lorenz. From these it appears that the reaction of the blades is normal to the relative velocity. If we consider, however, a meridian plane and a section of the blade in this plane, we will find that the work of reaction along that line is zero. Hence the meridianal component of reaction is normal to the section of the blade, which holds good also for the reaction, which being perpendicular to the two curves in the blade is therefore normal to the blade itself. Further discussion of the same subject indicates that the turbulent motion being perpendicular to that of reaction is tangent to the blade.

The article is of a mathematical character not conveniently suitable for abstracting. (*Revue Générale de l'Electricité*, vol. 10, no. 25, Dec. 24, 1921, pp. 907–908, *m*)

INTERNAL-COMBUSTION ENGINEERING (See also Air Machinery, Aeronautics, Railroad Engineering)

Novel Control of Velocity of Combustion in Automobile Engines—Carburetor with Thermal Regulation

A Chemically Controlled Automobile, Geo. Granger Brown. The author discusses briefly the known conditions covering thermal efficiency, and proceeds to the consideration of the reaction velocity, stating that essentially the factors determining the speed of combustion are concentration, temperature and agitation or turbulence. To these he adds catalysis.

For the influence of concentration he derives an equation from which it would appear that so long as the composition of the atmosphere remains constant, its oxygen content has no influence on the gasoline content giving maximum velocity of reaction as far as the law of mass action is concerned.

With the temperature factor the situation is different. The rate of chemical action increases very rapidly with the rise of temperature, and the maximum temperature with such fuels as are used in automobiles is produced by the mixture containing fuel vapor and oxygen in combining proportions. This factor of maximum temperature acts, therefore, in opposition to mass action and tends to decrease the excess of gasoline in the mixture of maximum-reaction velocity demanded by mass action, to an extent depending upon the cooling effect or the specific heat of excess gasoline. But the

mixture of maximum reaction velocity of any combustible gas and air has always an excess of the combustible constituent over the combining proportion due to the influence of mass action (Fig. 4). Fig. 5 shows the more intense and more rapid combustion of a mixture of 12 parts of air (curve *B*) over that of a lean mixture of 16 parts of air (curve *A*) as occurs in an engine cylinder, all other conditions being constant.

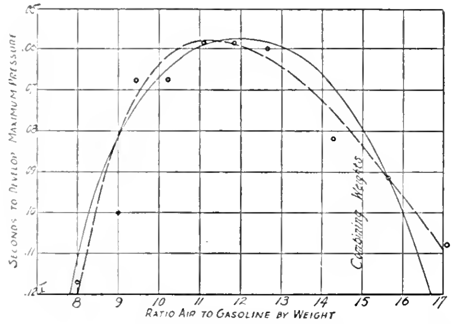


Fig. 4 Velocity of Combustion of Gasoline-Air Mixtures

Furthermore, increase in the temperature broadens the limits of explosive mixtures and renders explosive mixtures otherwise non-explosive.

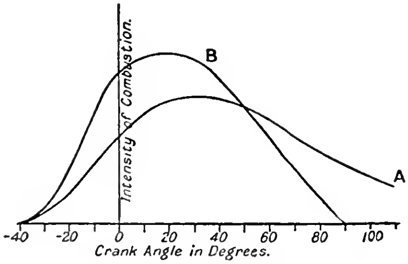


Fig. 5 Intensity and Velocity of Combustion of 12 : 1 and 16 : 1 Air-Gasoline Mixtures

Fig. 6 shows the results of presence or lack of agitation obtained on an indicator card after two idle compression strokes in which the turbulence was allowed to die down. The curve *AB* corresponds to normal firing and the expansion line *A′B′* corresponds to the second case in which all conditions except decreased turbulence were the same.

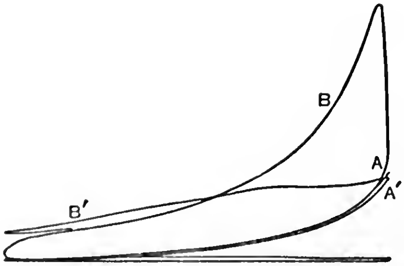


Fig. 6 Indicator Diagram of Turbulent and Quiet Mixtures

Pressure has been found to have practically no influence upon speed of reaction, so long as temperature remains constant. However, increased compression in an engine means increased temperature, since the absolute temperature varies as the absolute pressure in adiabatic processes.

In addition to the complete combustion of gasoline, partial combustion to aldehyde, carbon monoxide, and possibly hydrogen, also takes place, along with some decomposition of the hydrocarbon fuel.

The stability of the hydrocarbons is greatest with the lowest paraffin—methane. Ethane is less stable and can be very rapidly decomposed at 1100 deg. cent. It has been estimated that at 1500 deg. cent., 0.036 sec. is the time required for complete decomposition of the hydrocarbons. At this temperature, which is attained in the gasoline engine, the time of decomposition is of the same order as that of the ignition period.

These two reactions are taking place simultaneously in the cylinder as the mixture is exploded, combustion producing heat and work, and decomposition of the gasoline generally absorbing heat and depositing carbon residue. As decomposition of the fuel takes place much more rapidly at higher temperatures, the lower temperature developed by the combustion of lean mixtures is of advantage in decreasing and eliminating fuel knock and also deposition of carbon in the cylinders. Sir Dugald Clerk has accomplished the same result by introducing cold exhaust gas into the cylinder charge. This method is more effective in reducing the temperature, but probably not so efficient, owing to the higher specific heat and radiation loss of carbon dioxide over air. Also, it introduces complications in the design and operation of the engine.

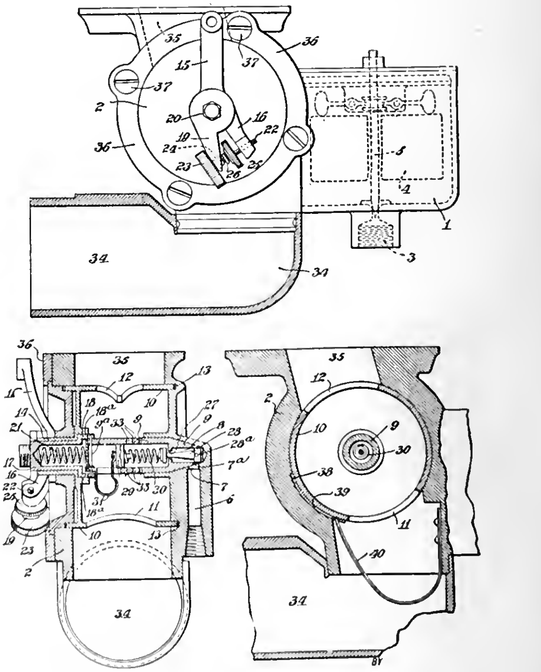


Fig. 7 Construction of Carburetor Giving Automatic Control

The author carried out a series of tests to determine the action of a gasoline engine subjected to various conditions of temperature and concentration of mixture.

The most interesting parts of these tests are those made with the carburetor shown in Fig. 7. The gasoline enters the float chamber 1 at 3 and passes through duct 6 up to the gasoline valve made by part 7 in the casing and part 7*a* in the stem valve 9, which is in the axis of the drum throttle 10 containing the air inlet 11 and the mixture outlet 12. The gasoline valve can be adjusted in relation to the throttle by the thumb screw 23 and locked in place by the nut 20, so that when the throttle lever 15 is moved the gasoline valve moves in unison with the throttle. The mixture outlet and air inlet are so calibrated that the suction in the mixing chamber is constant so long as the engine is running under "normal load." If the engine is running under any load greater than "normal" for that particular throttle position, the suction in the manifold and the mixing chamber will be less.

This variation in the manifold suction is utilized to vary the

mixture proportions in the following manner: Within the valve stem 9 is an opening, 27, in which the governor 28 is free to reciprocate endwise of the valve stem 9. This governor 28 has a taper shank which restricts the effective area of the opening 27 by an amount corresponding to the section of the taper shank of the governor which happens to be within the opening.

The stronger the suction in the mixing chamber, the stronger will be the flow of fuel and the greater will be the restriction of the opening 27, as the pressure of fuel flow upon the head of the governor compresses the spring 30, making the larger part of the taper effective and to that extent closing the fuel opening 27.

The position of the governor is also controlled by the position of the sliding block 29. The position of this block 29 is determined by the bimetal thermal regulator 31, which is fastened to the valve stem at one end and at its other end rests in a socket in block 29. Upon an increase in temperature the thermal regulator 31 curls up in a direction to move block 29 to the left and permit the governor 28 to move a like distance toward the left, thereby restricting the opening 27 an amount proportional to the movement of the thermal regulator. Upon a decrease in temperature the thermal regulator uncurls, causing the governor 28 to move a like distance toward the right, and exposing a greater effective area of the opening 27.

It has been found possible to calibrate this governor and thermal regulator to obtain automatically any desired change in mixture proportion upon change in engine load or change in temperature. It is possible to compensate simply for the decreased density of air and decreased viscosity of fuel with increasing temperature, or further to restrict the flow of gasoline so as to obtain always the leanest possible or most efficient mixture. Likewise the change in mixture proportion with changing engine load may be simply sufficient to compensate for decreased turbulence to prevent missing and backfiring; or may be sufficient to change from the most economical or efficient mixture under normal conditions to the most powerful mixture when the engine is heavily loaded.

This carburetor is supposed to deliver a definite mixture of gasoline and air for each condition of temperature and load. (Paper before the Division of Industrial and Engineering Chemistry, American Chemical Society, September, 1921, abstracted through *The Journal of Industrial and Engineering Chemistry*, vol. 14, no. 1, Jan., 1922, pp. 6–12, 20 figs., *ted*)

MACHINE PARTS

Belting Argument Decided by Cornell Tests. Late in the summer of 1921 tests of the capacity of the grain and flesh sides of leather were begun by the Leather Belting Exchange in its research laboratory at Cornell University. These tests were carried on under the direction of R. F. Jones, director of the laboratory, and covered a period of two months of continuous work.

For the experiments five 4-in. single belts 30 ft. long were used. They came from various manufacturers and weighed from 16 to 18 oz. per sq. ft. Every effort was made throughout the tests to standardize conditions and reduce the probable errors to a minimum. All five belts were run long enough before the experiment to be thoroughly "run in," and when the records were taken had reached a condition of constant capacity.

The method of procedure was to take horsepower readings from the belts, first when running on the grain side and then when running on the flesh side, the power being gradually increased until about 4 per cent slip was reached.

In considering the results it must be remembered that a leather belt is at its lowest point of capacity when new, due partly to the elasticity of the leather and partly to the character of its surface. The newness of the surface makes it necessary to "run in" the belt when testing it; that is to say, the belt must be run for a sufficient time to permit it to reach its maximum capacity for power transmission. As an example, one belt under test at the Cornell Laboratory transmitted 12 hp. at a slip of 1.2 per cent when first put on the pulley. After five hours' running it reached 19 hp. with the same percentage of slip and the same tension. At the end of 13 hours it transmitted 24 hp., and 31 hp. after 20 hours, with a slip of 1.6 per cent. According to horsepower tables the scheduled transmission should have been 26 horsepower.

Space prevents a review of the results of the individual tests, but they indicate clearly the superiority of the grain side. Under reasonable shop tension the flesh side will average only 50 to 60 per cent as much horsepower as the grain side. At higher tensions, however, the flesh side will average from 50 to 100 per cent as much power as the grain side, depending on the belt, the tension and the conditions of service. (*Power*, vol. 55, no. 2, Jan. 10, 1922, p. 66, *d*)

MACHINE SHOP (See Management)

MACHINE TOOLS

Attachment for Cutting Spur Gears on the Shaper. Description of a device placed on the market by a British firm (the illustration in the original article is not suitable for reproduction). The attachment operates on the generating principle, so that single-point tools cut from the bar and ground to a straight-sided rack form are employed. Gears of module, circular or diametral pitch, can be readily cut, the tools being ground to graduated gages. The attachment is intended primarily for use with single-point tools, but rack-form cutters with multiple teeth can be used also. Stepped cluster gears, such as are commonly used in motor-car gear boxes, can be readily handled on this attachment, though frequently impossible of access with milling cutters.

The attachment is said to be readily applicable to standard-type shapers. The only permanent alteration to the shaping machine is the cutting of a spline in the cross-feed screw to receive a pinion $2^1/_4$ in. in diameter. The existing feed motion is utilized, the cross-feed screw being geared up through change wheels and a chain and sprocket transmission to a 60-tooth $^3/_8$-in. pitch steel-worm dividing gear. The combined sliding on the cross-slide and turning on the worm wheel produces a rolling motion. The dividing is effected by hand, through a dividing plate and plunger mechanism. (*Engineering Production*, vol. 3, no. 64, Dec. 22, 1921, pp. 587, 1 fig., *d*)

MANAGEMENT

Conditions Governing Fatigue of Workers—Wattmeter Method of Measuring Human Effort in Polishing Work

Motion Study in Metal Polishing. Data of an investigation, by means of a wattmeter, of the process of roughing, carried out under the auspices of the Industrial Fatigue Research Board in England. The instrument used is a recording wattmeter giving a continuous graphical record of the amount of electrical energy expended by the motor in use.

In the roughing process (removing imperfections and scratches from the surface and edges of the metal by means of a wooden wheel covered with a leather tire and rotating at a high speed), the thrusting of the article against the buffing wheel results in a frictional retardation of the wheel, and the amount of energy expended by the motor to overcome this friction is accurately marked upon the chart.

From the nature of the process this friction cannot be caused passively. The operator cannot just lean the article being roughed, a table spoon in this case, against the wheel, and therefore must exert effort, and the amount of friction produced is directly dependent upon the effort. Hence the height of the individual strokes above the zero line (energy expended by the motor in revolving the buffing wheel idle) made by the pen of the wattmeter on the chart can be assumed to correspond to the amount of effort put forth by the operator (rougher).

Since the wattmeter records every stroke of the rougher against the wheel and also every pause between the strokes, a graph such as Fig. 8 is automatically obtained, giving the complete time study of the operation under investigation.

Each operator in turn was set to work at the spindle driven by the motor to which the wattmeter had been attached and was observed at her work for two days, during which time she was kept supplied with spoons. In analyzing the records, detailed examination was confined to the roughing of the backs of the bowls. This particular portion of the spoon was selected, first because the surface is large and therefore likely to give evidence of any fatigue that may exist; second, because long heavy strokes are generally applied, and third,

because the work is not complicated by any difficult corners or pattern.

The following method was adopted in examining these charts. The total time taken to rough four bowls, and the average time per bowl was ascertained from the wattmeter records. The number of strokes per spoon was counted and each stroke measured, and in this way the average length of each stroke in centimeters on each record was obtained. Finally, the time taken on each four bowls was divided by the total number of strokes, thus giving the average duration of each stroke.

The results obtained from two of the operators are given in a table in the original article. From this it would appear that one of the operators exerted a far greater pressure than any of the others. As the work of a second operator was, however, of excellent quantity, it would appear that the additional pressure exerted by the first was simply unnecessarily fatiguing her, and at the same time wearing out the roughing wheel.

The examination of these tables shows further that in all instances the time taken to perform a unit of work increased toward the end of the day. The number of strokes made by each worker was about the same, but the height of each stroke, which is a comparative measure of the pressure exerted, showed a marked tendency to increase during the afternoon. The duration of the stroke also increases during the day, especially in the late afternoon; this would indicate that the operators growing tired were inclined to give more vigorous strokes and take longer over each individual stroke.

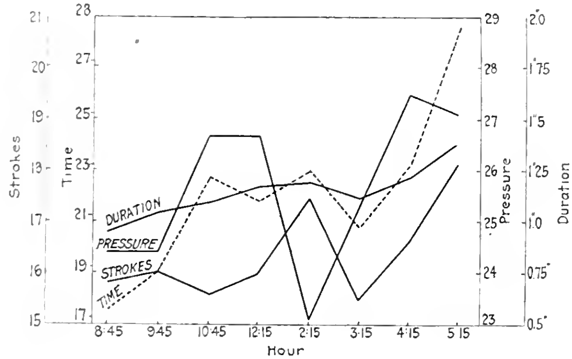


Fig. 8 Duration, Pressure and Strokes in Roughing Four Table Spoons Compared with Time Required

Two factors are present which together determine the duration of the stroke, namely, the length of time that the pressure of the spoon against the wheel is sustained, and the length of the pause between successive applications of this pressure. An examination of the charts shows quite clearly that both these factors were in operation, and that toward the end of the day's work both operators made more sustained strokes, and also paused for a longer time between each stroke.

Another method of measuring the wattmeter records was used, in which the areas enclosed by the recording pen of the meter were measured by a planimeter. These measurements give the energy expended by the motor in order to overcome the frictional retardation caused by the worker pressing the spoon against the revolving wheel, and so give an approximate measure of the human effort exerted.

The records obtained by the first method lead to some interesting conclusions. Fewness of strokes corresponds very closely with high output, or, in other words, implies increased duration and good pressure if good output is to be maintained.

The accounts of earlier experiments carried out in time and motion study have described the large part played by rhythm in the easy performance of most industrial operations, and probably rhythm is the determining factor in this case too. In the earlier part of the day, when the worker is fresh, the work is done rhythmically and the results are satisfactory. The nearest approach that can be made to instill rhythm is by modifying the number of strokes. It will be seen that the number of strokes per spoon varies little in the morning, and that greater variations are introduced in the afternoon. When fatigue increases, the natural rhythm of the body seems to break down and conscious effort is invoked in order to do this work.

The records of the present tests would indicate, however, that as the worker becomes fatigued, the coördination between the factors represented by the curve of rhythm becomes more and more disturbed. Fatigue has the effect not only of slowing the reaction times, but also of causing a certain lack of motor control, resulting in increased pressure and increased number of strokes. The tired worker is not only working slower than when she is fresh, but is also expending her energy extravagantly. From this it would seem that in order to increase the efficiency of certain industrial operations, attention must be paid not to speed nor even to the elimination of unnecessary movements as an end in itself. The first thing to do is to devise a rhythmic method of doing the work, which may be done by means of limiting the number of strokes. Then proper instructions must be given to the method.

The present experiments have shown that other factors besides the lack of rhythm make for fatigue, such as putting too much effort into the work. (*Engineering and Industrial Management*, vol. 6, (New Series), no. 26, Dec. 29, 1921, pp. 738–742, 3 figs., *ep*)

MEASURING APPARATUS

Pressure-Corrected Recording Steam Meter

The Kent-Hodgson Steam Meters, J. L. Hodgson. Description of steam meters developed by the writer together with a British concern.

Fig. 9 shows in a diagrammatic form the essential parts of the pressure-corrected steam meter. An orifice, *O*, is placed in the steam main and creates a difference of pressure $(p_1 - p_2)$ which is transmitted through the pressure pipes, *PU* and *PD*, to the two sides of the battery of diaphragms, *DP*, in the recorder. These diaphragms are held apart by a spring, *S*, so that any increase in the difference of pressure causes them to come together. Their motion is transmitted through the gland *G* to the slotted arm *B*, which is pivoted at *C*. In this way *B* is given an angular motion, which is proportional to the difference of pressure existing across the orifice. The pressure of the steam is transmitted through the pipe *PU* to the tempered steel diaphragms *P*, which expand with increase of pressure and give the pointer *Q* a motion proportional to the pressure. This motion causes the connecting rod *H*, which carries the roller *R*, to descend an equivalent amount. The motion transmitted through the connecting rod *H* to the pen arm *A* is thus proportional to the product of the angular motion of the arm *B* [which depends upon $(p_1 - p_2)$] and of the linear movement downward of the roller *R* [which depends upon the absolute pressure of the steam p_1].

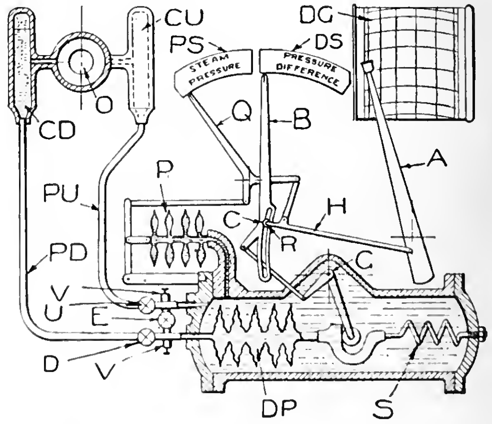


Fig. 9 Diagram of Essential Parts of Kent-Hodgson Steam Meter

If the superheat of the steam be assumed constant, the formula

$$Q = K\sqrt{(p_1 - p_2)\,p_1} \text{ pounds per hour}$$

(where K is the constant depending upon the size of the orifice and the size of the main, and upon the superheat or wetness of the steam) represents approximately the steam flow through an orifice, so that if the diagram DG is divided on a square-root basis it will show

$$\sqrt{(p_1 - p_2)\,p_1}$$

or by suitably numbering the lines on the diagram it will show

$$K\sqrt{(p_1 - p_2)\,p_1}$$

i.e., Q.

Actually, the law of steam flow through an orifice is slightly more complicated than that represented by the above formula. The meter is made to operate according to the true and more complex formula by correctly adjusting the initial angles of the various cranks.

Scales PS and DS, showing the steam pressure and the pressure difference across the orifice, are provided, which enable the adjustments of the meter to be checked at any time.

The error introduced by not correcting automatically for the superheat or wetness of the steam is small. A variation of 20 deg. fahr. in the superheat or 2 per cent in the wetness, corresponds to an error of about 1 per cent. Usually the superheat and the wetness are fairly constant, so that their variations can be allowed for by means of a table of corrective factors without introducing any material error.

It will be noticed, on reference to Fig. 9, that the meter body is full of water, and that two cooling chambers, CU and CD are provided. The function of these cooling chambers is to condense the steam which passes through the pressure noles on the upstream and downstream sides of the orifice. So long as the water level in these cooling chambers is *above* the horizontal center line on which the pressure holes are drilled, the true difference of pressure will be transmitted to the recorder. The portions of the cooling chambers below the level of the pressure holes provide reservoirs of water which prevent steam reaching the recorder when any air that may have separated in the pressure pipes is being blown away through the air vents V.

Valves U and D enable the meter to be shut off from the main, and the valve E enables the meter to be "equalized" (and the zero of the differential pressure pointer checked).

If the meters are overloaded, the corrugations of each pair of the diaphragms DP fit into one another, so that no damage is done. The meters are fitted with other protective devices (not shown in the diagram) which prevent them from being damaged if wrongly connected up, or if one pressure is turned on before the other. These protective devices have proved to be a most important feature of the meters.

The recorder referred to above and the orifice tipping are shown in considerable detail. This latter consists of an orifice plate fastened into a steel ring provided with a head through which the pressure holes are drilled, but no pressure holes have to be drilled in the pipe line. The coefficient of discharge of every orifice is determined by calibration with water. This has been found to be fully sufficient for most practical purposes, although where high precision is necessary, means illustrated and described in the original article must be used. The meter is not suitable for measuring pulsating flow unless the pulsations are reduced to a negligible amount at the point where the orifices are inserted.

The original article describes also a counter attachment which may be fitted to these meters. It is not described here as it does not differ materially from the fairly well-known integrating mechanism used in Kent water meters. (*South African Engineering*, vol. 32, no. 12, Dec. 31, 1921, pp. 243–245, 5 figs., *d*)

MOTOR-CAR ENGINEERING

Rickenbacker-Six Automobile, J. Edward Schipper. The new car incorporates some departures from usual engineering practice. For example, it has flywheels at the front and rear of the engine, which is claimed to minimize vibration. The cylinder block and the upper part of the crankcase are cast together, and the block casting is so designed that the chain case and the flywheel housing are bolted on, thus simplifying casting and machining processes.

The usual practice in finishing the connecting rods is to check the alignment of the rod on a gage, and if it is not true to bend the rod so that it will check properly on the gage. On the new car a small end of the connecting rod is ground to assure alignment, as was done by some of the manufacturers of aeroplane engines during the war. This alignment is important in eliminating side friction of the piston, insuring an easier- and smoother-running engine.

The clutch has a Raybestos facing, running in a bath of oil. It is claimed that the combination of this facing and the oil bath eliminates any possibility of burning and at the same time insures a smooth action. (*Automotive Industries*, vol. 45, no. 26, Dec. 29, 1921, pp. 1258–1261, 7 figs., *d*)

POWER GENERATION

Internal-Terrestrial Heat as an Important Source of Energy. Whether the theory of a molten central portion of the terrestrial globe is correct or not, there is no doubt that the temperature of the interior increases with the distance from the surface of the earth.

The observed increase amounts to about 3 deg. cent. for every 100 m. of depth, but there are reasons to believe that as the depth increases beyond a certain point the rate of increase in temperature becomes even greater than that. In any event, there is no question but what the temperature at some attainable distance from the surface is quite considerable, and the question is whether it might not be possible to utilize this heat commercially. The well-known scientist, de Moupertius, was the first who called attention to this possibility. In fact, partly on account of this and partly for solving many geological problems, he suggested to the Prussian Academy of Sciences in the middle of the 18th century that a shaft be dug to the center of the earth, a proposition which was vigorously ridiculed by his colleague in the membership of the Academy, the famous Voltaire.

The main obstacle in the way of commercial utilization of the internal heat of the earth is the thickness of the superficial layer over and above the sixth strata where sufficiently high temperatures obtain under the influence of the magma.

As a rule the surface layer is supposed to extend from 15 to 25 km. (10 to 16 miles). However, it is of uneven thickness and in some places, as, for example, near the hot springs in the Yellowstone Park and New Zealand, must be quite thin, possibly only a few hundred feet thick. In fact, in such places saturated steam comes naturally from the ground with temperatures of the range of 300 deg. cent. (572 deg. fahr.).

Of late Sir Charles Parsons has shown an interest in this problem. The question appears to be within technical possibility, but of quite uncertain economic practicability, at least under the conditions of today. (*Rauch und Staub*, vol. 12, no. 3, Dec., 1921, pp. 16–18, *g*)

POWER PLANTS (See Measuring Apparatus)

POWER-PLANT ENGINEERING (See Corrosion)

PRODUCER GAS AND GAS PRODUCERS (See Corrosion)

PUMPS

Operation in Parallel of Centrifugal Pumps and Fans

Operating Pumps or Fans in Parallel, J. C. Hobbs. Discussion of problems encountered in parallel operation of centrifugal pumps. Almost any properly designed fan or pump will perform satisfactorily if operated alone, but when two pumps discharge into the same distribution system operating in parallel certain requirements must be satisfied or trouble will occur. The situation is somewhat similar to the operation of electrical generators in parallel, and in order that fans or pumps operate properly they must have proper operating characteristics and the method of regulation must be correct. By characteristics is here meant the interrelations

between pressure produced, output, horsepower and speed, which may be expressed in the form of curves.

Figs. 10 and 11 show respectively the pressure characteristics that are favorable and unfavorable to operation in parallel. In Fig. 11 the characteristic curve, instead of being flat, has a hump, showing that there are two outputs having exactly the same pressure and speed. If two pumps with such characteristics are operated in parallel and discharge against the same pressure, one of them might be on the upward part of the curve and the other on the downward part, thus causing an unequal distribution of the load.

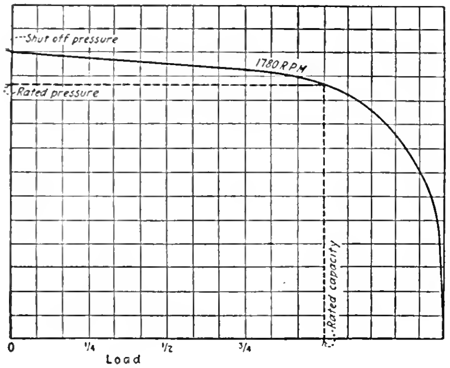


Fig. 10 Typical Pressure Characteristic of Fan or Pump Giving Satisfactory Operation in Parallel

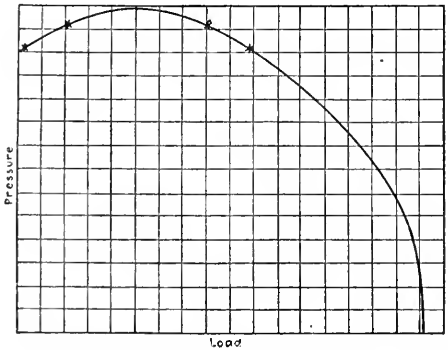


Fig. 11 Effect of Hump in Pressure Curve of Fan or Pump

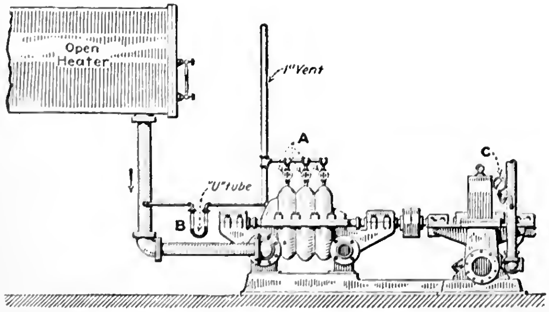


Fig. 12 Connections to Prevent Pumps from Becoming Steam- or Air-Bound

This condition is not so serious in cases in which steam-turbine drives are used, but with motor drives in which the speed is practically constant unsatisfactory performances will occur.

With a steam-turbine drive there is the possibility of one of the pumps being "backed off the line." When this occurs, there is danger of the pump becoming air-bound, and the rotor, in rubbing against the dry seal rings, will likely cause damage. Instances have occurred in which parts of the bronze impellers and seal rings have melted, owing to the large input of power from the turbine shaft being converted into heat through friction.

It is not desirable to try to regulate the pressure between excessively narrow limits, because hunting action of the governor and pressure-control valve may occur. The desirable form of characteristic is one in which the discharge pressure drops slowly from zero load up to a point beyond the full capacity rating, and then drops off suddenly.

The possibility of damage to a pump on account of becoming steam- or air-bound has been reduced, if not eliminated, by provisions indicated in Fig. 12. This shows a scheme of piping which can be used in connection with open heaters to prevent the first stage from becoming steambound. The arrangement should be installed on each pump operated in parallel, whether it has the proper characteristics or not, because a small amount of trouble with the pressure governor is liable to divide the load unequally at any time, and one of the pumps may cease to discharge water when the total load becomes light.

A metering arrangement on the discharge of the pump is desirable, such, for example, as the U-tube in Fig. 12, which is installed in such a way to use the friction head through the suction piping for approximately indicating the flow. Such a meter does not measure the exact quantities flowing, but shows relatively the load on the different pumps.

The original article discusses in some detail the effect of using different shapes of impeller blades. (*Power*, vol. 55, no. 2, Jan. 10, 1922, pp. 58-60, 6 figs., *p*)

The "Hydrohoist" Endless-Rope Pump. Description of a novel variation of the endless-rope pump made by a British concern. In this pump an endless flexible wire rope is used having threaded on it a series of small pressed-steel cups, both the rope and the cups being galvanized. Each bucket or cup is made in the press and is fitted in the center with a pressed thimble which acts as a spacing piece and through which the flexible rope is threaded. The standard size of the cups is $1^1/_2$ in. in diameter and the rope works over pulleys 14 in. in diameter.

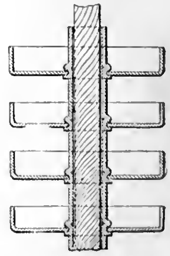


Fig. 13 "Hydrohoist" Endless-Rope Pump

The manufacturers state that with an immersion of 3 ft. and rope speed of 600 ft. per min. the delivery is 3500 gal. per hr. This is due to the fact that not only are the buckets completely filled with water, but in addition a large quantity of it is carried upon the outside. The pump can be worked by hand on lifts as high as 150 ft. (*Engineering*, vol. 112, no. 2918, Dec. 2, 1921, p. 759, 1 fig., *d*)

RAILROAD ENGINEERING

Wheels for Railway Rolling Stock. Description of a new process for producing disk-center wheels developed in England in 1921 and carried on at Coventry by Powell, Brett, Ltd. The process consists in turning out wheel centers in the shape of drop forgings by means of special hammers.

The wheel centers are produced direct from an ingot by a special process, and the cast condition of the steel under powerful drop hammers is broken down into a proper forged state. The final operation of stamping ceases practically at the critical period of temperature of the steel, and the center leaves the dies with the material in what is said to be an ideal state, uniform in shape, perfectly balanced, and possessing a ductility and tensile strength leaving nothing to be desired for this class of steel.

No more information is given as to the process of manufacture, but some data of tests are published. It is said, however, that the production of wheel centers by this method involves the employment of a very powerful drop hammer of special design. The tup

and dies used in the final operation are shown in one of the illustrations. (*The Railway Gazette*, vol. 35, no. 27, Dec. 30, 1921, pp. 1000–1002, 6 figs., *d*)

Gasoline-Driven Rail Car. Description of a car manufactured by the J. G. Brill Co., on a chassis made by the International Motor Co., and in design following essentially the Mack automobile truck. The car has seating capacity for 31 passengers, operating speeds up to 30 m.p.h., and weighs about 11,000 lb.

The Gilmore & Pittsburgh R. R. has recently placed one of these cars in service, but having space for the accommodation of baggage and seating 17 passengers. The railroad runs from Armstead, Mont., to places in Idaho through a mining country with severe grades as high as 6 per cent. The snows in that section of the country are so severe that at times it is impossible to operate steam trains for a week or ten days at a time, but except in the worst snow the car has been able to operate successfully.

Another instance of the operation of a gasoline rail car having proved an effective means of stimulating passenger traffic and curtailing operating costs, is provided in the case of the Narragansett Pier Railroad Co., in Rhode Island. This railroad is eight miles long and had the competition not only of automobiles but until recently of an electric line (abandoned in Nov., 1920).

The comparison of operating costs of light steam trains and gasoline rail cars in local passenger service shows that the cost per mile on a steam train is \$0.95, as compared with \$0.14 to \$1.21 for the gasoline car. In one instance the cost was \$1.56 for the steam train and \$0.25 to \$0.38 for the gasoline car.

The company has also designed a larger car, to seat 35 passengers in addition to the baggage space.

Comparisons of cost per seat per mile between the steam train and gasoline car show a striking difference in favor of the latter, often exceeding 50 per cent. (*Railway Review*, vol. 69, no. 26, Dec. 24, 1921, pp. 860–863, 4 figs., *dcp*)

Sandberg Sorbitic Steel

Sandberg Sorbitic Steel for Tires. References have occurred in the engineering press to Sandberg sorbitic steel, and tests are being carried on in this country on rails made of this material. On account of this, the information contained in the present abstract may be of interest. As known from the general metallurgy of steel, the microstructure and physical properties of steel depend on its rate of cooling. Slow cooling produces pearlitic condition, with softness and ductility. Sudden cooling from a temperature above the upper critical point produces martensitic conditions, and makes the steel intensely hard and correspondingly brittle. Sorbite is softer and tougher than martensite and harder than pearlite, and is obtained by a slower rate of cooling than that used to produce martensite but not slow enough to create the pearlitic condition.

The method used in the Sandberg process consists of heating the steel to a temperature above the critical point, and then cooling it so slowly that the martensitic condition is not retained and yet the cooling is sufficiently rapid to offset the pearlitic stage being reached. The cooling is done by blowing air or steam on the heated steel. In making tires for railroad wheels they are cooled by being placed one at a time on a revolving table. Moist air is then drawn through branch pipes and nozzles on to the tread of the tire.

The results given in Fig. 14 refer to a test of railroad-wheel tires, all from the same cast of steel. The third line refers to tires cooled in the atmosphere but not reheated. The railroad tires were 2 ft. $9^{1}/_{2}$ in. internal diameter and of a section $5^{5}/_{8}$ in. wide and $3^{3}/_{8}$ in. deep in the middle of the tread.

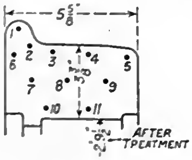
The original article contains microphotographs showing very clearly the difference in structure between the treated and untreated steel. The steel in these tires contained 0.73 carbon, 0.313 silicon and 0.74 manganese. The process is said to have been successfully applied also to steels of lower carbon content. (*The Railway Gazette*, vol. 35, no. 27, Dec. 30, 1921, pp. 991–993, and 999, 6 figs., *cd*)

SANDBERG SORBITIC STEEL. RAILWAY TYRES 2' $9\frac{1}{2}$ INTERNAL DIAMETER. $5\frac{5}{8}$" x $3\frac{3}{8}$" SECTION.

ANALYSIS { CARBON ·73, SILICON ·313, MANGANESE ·74, SULPHUR ·033, PHOSPHOROUS ·038

ALL TYRES MADE BY THE UNITED STEEL COMPANY.

TYRE Nº	CAST Nº	TREATMENT	DROP TESTS									TENSILE TEST			
			10'	15'	20'	25'	30'	30'	30'	30'		BREAKING STRESS TONS □"	YIELD POINT TONS □"	ELONGATION %	REDUCTION %
1	6861	FULL SANDBERG	$\frac{5}{8}$"	1"	$1\frac{7}{16}$"	$1\frac{13}{16}$"	$2\frac{1}{4}$"	$2\frac{5}{8}$"	$3\frac{1}{16}$"	$3\frac{3}{8}$"	NOT BROKEN	76·4	58·0	14·0	15·8
2	6861	COOLED IN ATMOSPHERE. REHEATED TO 850°	$\frac{3}{8}$"	1"	$1\frac{11}{16}$"	$2\frac{5}{8}$"	$3\frac{9}{16}$"	$4\frac{15}{16}$"	$5\frac{1}{16}$"	BROKE AT BOTTOM.		58·21	—	13·0	18·3
3	6861	COOLED IN ATMOSPHERE	$\frac{3}{8}$"	$\frac{15}{16}$"	$1\frac{5}{8}$"	$2\frac{5}{16}$"	BROKE AT BOTTOM.					57·32	—	10·8	10·08



BRINELL NUMBERS. 3,000 KGS. ON 10 M/M BALL FOR 15 SECS.

Nº	1	2	3	4	5	6	7	8	9	10	11
1.	331	311	321	321	331	302	302	302	302	255	269
2.	248	248	241	241	241	248	241	241	241	235	230
3.	269	262	262	262	269	262	262	255	255	255	248

Fig. 14 Chart Showing Results of Tests on Sorbitic and Non-Sorbitic Steel Railway-Wheel Tires

SPECIAL MACHINERY (See Fuels and Firing)

SPECIAL PROCESSES (See also Railroad Engineering)

Gear Manufacture by Upsetting. At the new shop of the Amforge Company recently completed at Chicago a method was developed for the production of gear parts which it is claimed gives a stronger product than hammer forging.

In making these gears round bar steel of forging quality is used after close inspection for seamy stock. The bar is always forged horizontally and forced into the dies by the headers in two or three operations. In the finished pinion the grain of the steel is such that teeth will be cut against it. As a further advantage for the upsetting method of gear manufacture, it is claimed that it does not tend to crystallize the steel as drop forging is apt to do at times.

It may be mentioned in this connection that the process of upset forging is practically in its infancy, the plant of the Amforge Company being the only one in the world devoted exclusively to the manufacture of upset forgings. This new method has been developed only within the last few years, but this development has been so rapid that it is estimated that 250 upset-forging machines are now operating on commercial forgings. (*The Iron Age*, vol. 109, no. 6, Feb. 9, 1922, pp. 401–404, 5 figs., *d*)

STEAM ENGINEERING (See Measuring Apparatus)

TESTING AND MEASUREMENTS (See also Measuring Apparatus)

Measurement of Pulsating Flow by Nozzles

The Use of Nozzles in Measuring Pulsating Flow. When nozzles are used for measuring pulsating flow, errors result unless the flow curve is known as a function of time. In the testing or regular supervision of the air delivery of reciprocating compressors, it is quite possible to install a large tank between the compressor

and the delivery line. This tank may well act as an aftercooler for removing the moisture from the air. If this tank be about three or four times the volume of the high-pressure cylinder, the flow fluctuations are greatly reduced. If in addition a throttling flange be applied at the end of the tank, i.e., at the place where the tank joins the delivery pipe—then the flow in the delivery pipe will be rendered quite even, and a nozzle or a similar instrument can be used with great accuracy. The larger the tank and the smaller the throttling flange, the more uniform is the flow. The flange need not be so small as to produce any noticeable pressure drop.

The same method can also be used in the application of steam meters to measure the flow of steam for reciprocating engines. Every engine should be equipped with a large receiver separator, and can in addition be equipped with a throttle flange at the place where the steam main joins the receiver separator. The flow is made even enough to apply a steam meter and to accept its readings without any correction.

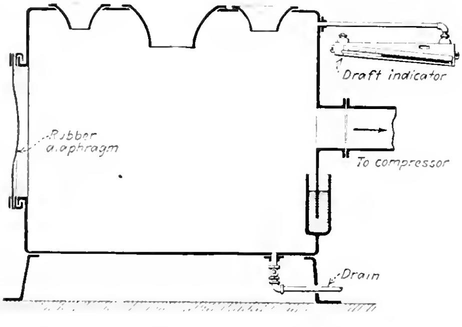


Fig. 15 Use of Nozzle on Inlet Side of Compressor

It has also been suggested that the flow in lines carrying variable-velocity fluids can be made even for a distance by placing a fan in the line at either side of the nozzle or of the measuring instrument. The theory is that the fans have inertia and resist pulsating flow, thereby reducing the violence of the pulsations.

For the ordinary run of shop compressors, it is usually preferable to test the compressor while in operation. This can be done by using nozzles on the inlet side, provided, of course, that the piston-rod packings are tight. In this case it is quite easy to obtain uniform flow by attaching to the compressor inlet a sheet-iron box which carries the nozzle or nozzles, and which in addition is equipped with a rubber diaphragm as shown in Fig. 15. The volume of the box acts as an equalizer, and the rubber diaphragm which flops in and out helps materially to maintain an almost constant flow through the nozzles. A box of this kind is a very valuable adjunct to mechanical laboratories and especially to shops in which air compressors are built or used, because it allows testing of the actual air-compressor delivery with very little trouble. To this end it is advisable to have several nozzles in the box and to plug up those not in use.

It is very desirable to have a safety valve on the box to protect the rubber diaphragm from injury in case some one should close more nozzles than is good for the rubber. Such a safety valve is indicated on the right-hand side of the box in the shape of a U-tube full of water. The section of the U-tube must be large enough to prevent the formation of such a vacuum in the box as might break the rubber diaphragm. The pressure drop of the nozzles can be kept quite small, and can be measured by means of an inclined gage, such as a draft gage. The pressure drop through the nozzles amounts to much less than the variation in barometric pressure, and no fear need exist that the measuring box will interfere in any way with the air delivery of the compressor.

Nozzles have not been used for testing to the extent they deserve, probably because of lack of standard nozzles on the market. However, these are now available. Occasionally it is practically impossible to dampen the vibrations on account of the size of the equipment—for instance, to the air inlet of blast-furnace blowing engines. In that case the flow-velocity curve can be determined occasionally by placing in the nozzle a very light flapper and by recording its motion on the indicator. (*Chemical and Metallurgical Engineering*, vol. 26, no. 1, Jan. 4, 1922, pp. 32–34, 3 figs., *dp*)

TRANSPORTATION (See Railroad Engineering)

VARIA

Chemical Research in Germany. In connection with the story of the development of a process for the manufacture of synthetic gold in Germany, given wide circulation by the public utterances of Prof. Irving Fisher, *The Chemical Age* quotes the information of authorities who have made personal inquiry into the matter that important progress has been made during and since the war in agricultural chemistry in Germany.

It is said that processes have been developed of treating seed both to protect it from pests and disease, and to increase its vigor enormously. The idea, in short, has been by new chemical processes of fertilization to impregnate the seed with energy which has hitherto been applied externally at later stages of growth. How far this is true we are not in a position to say, but it is confidently asserted that as the result of experiments, seed so treated is rendered far more immune from disease and pests, that the plant life is fed with far greater effect and becomes proportionately more vigorous, and that the yield is largely increased. All this, like the story of synthetic gold, has to be proved in practice, but it is enough to convince us that German research chemists, instead of resting content with past achievements, are working for further advances and eagerly searching after new starting points. (*The Chemical Age*, vol. 5, no. 132, Dec. 24, 1921, p. 788, *g*)

Wages in German Machine Industries. Table 1 shows a comparison of hourly wages paid in the machine-building industry in Chemnitz, Germany, previous to the war and since Jan. 1, 1922. In the present agreement on wages of workers in the metal industries a basic hourly rate is fixed, and the worker receives a certain additional rate on account of the high cost of living. In the table these two items are added together. Furthermore, skilled workmen who are always employed at an hourly rate (not on piece work) receive an additional amount which has also been included in the figures given. In figuring present exchange, one mark has been assumed to be equal to 0.6 cent. (*Machinery*, vol. 28, no. 6, Feb., 1922, p. 453, *g*)

TABLE 1 COMPARISON OF WAGES IN MACHINE BUILDING INDUSTRY

Class of Worker	Age	Marks	1922 Dollars, Present Exchange	Marks	1914 Dollars, 1914 Exchange
Toolmakers	over 25	11.20	0.07	0.60	0.15
Patternmakers	21–25	9.85	0.06	0.60	0.15
Molders, (Highly	19–21	8.50	0.05	0.60	0.15
Skilled Operators)	17–19	6.29	0.04	0.60	0.15
Machine Operators	over 25	9.50	0.06	0.50	0.125
	21–25	8.25	0.05	0.50	0.125
	19–21	7.00	0.04	0.50	0.125
	17–19	5.05	0.03	0.50	0.125
Unskilled Labor	over 25	9.30	0.06	0.40	0.10
	21–25	8.15	0.05	0.40	0.10
	19–21	6.80	0.04	0.40	0.10
	17–19	4.75	0.03	0.40	0.10

Overhead Conveyances. A new type of overhead conveying system has been placed on the market and it is claimed that its construction is such as to make it necessary to erect a superstructure from which to suspend the system. The track consists of two parallel rails which is said to minimize the possibility of the trolley jumping the track. The rails are laid on a plate to which the U-bolt hangars are bolted and are thus supported from the bottom instead of the top which is said to eliminate the danger of the rails becoming dislodged and dropping to the floor. To insure further the stability of the track a special rail section is used with the base wider on one side than on the other. By throwing the center of gravity of each rail towards the middle of the track, the possibility of the rails being forced out of position and turning outward is reduced. (*The Iron Age*, vol. 109, no. 6, Feb. 9, 1922, pp. 409–410, 5 figs., *md*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Electrical Instruments A1-22. Capacity Effects in Induction Coils. A coil of wire wound in any of the familiar forms called *inductance coils* behaves in an electric circuit primarily as an inductance. The potentials of the different parts of the coil are, however, different from each other and from the potential of the ground. For this reason the coil also behaves to a certain extent as an electric condenser, or rather a system of condensers. These capacity effects of inductance coils are particularly important at the high frequencies employed in radio communication. The effective capacity of an inductance coil depends in general both on the capacities existing between parts of the coil itself and on the capacities existing between parts of the coil and the ground.

On account of the importance in radio communication of capacity effects in inductance coils, careful studies of these effects, both theoretical and experimental have been made at the Bureau of Standards. An interesting result which has been found is that one effect seems to depend primarily on the capacity of the coil to ground. This effect is observed when two condensers in series are connected across the terminals of the inductance coil, and the common terminal of the two condensers is grounded. If the inductance coil possesses capacity to ground, the familiar criterion for resonance in the system, computed from the known value of the capacities of the two condensers, will not apply.

If both condensers are variable and the system is adjusted for resonance by successively assigning arbitrary values for the setting of one condenser and then tuning with the other condenser, it would be expected from elementary considerations, neglecting the effects of distributed capacity, that the successive resonance values of the capacity of the two condensers in series, determined as the product of their capacities divided by their sum, would be constant. On account of the distributed capacities this simple relation does not hold. It is found, however, that under the conditions above mentioned, with the common terminal grounded, the capacity of the two condensers in series determined as the product of their capacities divided by their sum, is linearly related to the reciprocal of the sum of their capacities. This relation has been verified both mathematically and experimentally.

The results of both the mathematical and experimental investigation of this particular phase of the problem of capacity effects in inductance coils are given in Scientific Paper No. 427, entitled "Some Effects of the Distributed Capacity between Inductance Coils and the Ground," which has just been issued by the Bureau of Standards. Copies may be purchased from the Superintendent of Documents at 5 cents a copy.

Fuels, Gas, Tar and Coke A5-22. Lignite Carbonization. One of the recent reports of the Bureau of Mines is that on Lignite Carbonization and Carbonized Residue Briquets by W. W. Odell, Fuel Engineer. In his introduction the author states that "the development and utilization of low-grade fuels is not new, but on this continent conditions have not heretofore been favorable to such enterprises. The abundance of the available supply of lignite in this country in locations where other fuel is only obtainable by a long freight haul from distant sources, has made the 'lignite problem' a serious one for domestic consumers in such localities as North and South Dakota and Texas."

The plan of the work was to carbonize approximately 1000 tons of raw lignite by continuous operation of the carbonizer, briquetting the residue into a firm, solid fuel, and to obtain meanwhile as much data as possible relating to the following: (1) Quality and quantity of gas obtained, (2) quantity of gas required for carbonizing, (3) behavior of lignite during processing, (4) capacity of carbonizer, (5) quality and quantity of residue obtained under various conditions, (6) analyses of lignite, residue and the briquets made therefrom, (7) binder requisites, (8) character of briquets made, (9) control methods, (10) cost of briquetted residue, (11) quantity of by-products, and (12) design of apparatus suitable for carbonizing lignite. Address Bureau of Mines, Washington, D. C., H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A7-22. Alcohol for Power. The Fuel Research Board of the British Department of Scientific and Industrial Research have prepared for distribution the Second Memorandum on Fuel for Motor Transport. This report gives a brief general survey of the work of the Fuel Research Board with regard to Power Alcohol since July, 1920, the date of the publication by H. M. Stationery Office of the Board's Interim Memorandum on Fuel for Motor Transport."

The subject is dealt with under the following heads: (*a*) Raw Materials, (*b*) Experimental Cultivation of Jerusalem Artichokes and Sugar Mangolds, (*c*) Molasses as a Raw Material, (*d*) Production of Alcohol in the British Dominions and Colonies, (*e*) Synthetic Production, (*f*) Production from Cellulosic Materials, (*g*) Legislation, (*h*) Denaturing, (*i*) Experimental Work on Utilization, (*j*) General Conclusions. Address H. M. Stationery Office, 28 Abingdon Street, London, S. W. 1. Price including postage 7$^1/_2$d.

Gases, General A1-22. Gas Cylinders. The British Department of Scientific and Industrial Research has just issued the first report of its Gas Cylinders Research Committee. This report, which consists of a majority and a minority report, gives the conclusions and recommendations of the Gas Cylinders Research Committee on the types of gas cylinders which should be employed for the storage and transport of compressed gases which are not in the liquid state in the cylinder.

Appendices to the Report include full reports on tests made at the National Physical Laboratory on cylinders of high-carbon steel subjected to varying heat treatments and on very light steel cylinders made for the Royal Air Force during the war, a summary of the evidence given by witnesses before the Committee, a summary of the regulations governing the use and transport of cylinders in Great Britain, France, Germany, and the United States of America, and a note on the deviations of technical gases from Boyle's Law. Address H. M. Stationery Office, 28 Abingdon Street, London, S. W. 1. Price including postage 7s. 9d.

Heat A2-22. Thermal Stresses in Steel Car Wheels. For some time the Bureau of Standards has been accumulating data obtained in thermal tests of car wheels. So far the tests on 16 wheels have been completed and it is possible to summarize the interesting features of this data as follows:

1 None of the steel wheels failed.

2 Because of the movement of the hub with respect to the rim, on account of the heating of the rim, a beam effect is produced in the plate which induces tensional stresses near the hub and stresses in compression near the rim on the face of the plate, while on the back of the plate the stresses are approximately equal in magnitude but reverse in nature.

3 These effects were observed in new wheels, while in the case of old wheels the stresses on the face of the plate were in tension near the hub and at the rim they decrease to practically nothing, this difference from the new wheel probably being due to the quantity of metal worn away.

4 The magnitude of the maximum stresses developed approximated the yield point of the material as determined in tensile tests.

5 After the first "run" on the new wheels, an apparent set was obtained which was not the case in succeeding "runs" nor in "runs" on old wheels. The maximum stresses were in the surface of the plates and beyond the yield point of the material.

Further work on single-plate chilled-iron wheels seems justified in view of the fact that a survey of the stresses on the back of the plate of this type of wheel was not made. From experience with the steel wheels, it is believed that the stresses will be quite different from those on the face. Address Dr. S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Lignite A1-22. Lignite Carbonization. See *Fuels, Gas, Tar and Coke A5-22.*

Petroleum, Asphalt and Wood Products A2-22. Specific Heats and Heats of Vaporization of Motor Fuels. In a paper read before the American Chemical Society Messrs. Robert E. Wilson and D. P. Barnard, 4th, present the results of a series of observations on the total sensible heats of completely vaporized motor fuels. These, combined with critically compiled data from the literature on heats of vaporization of motor fuels, make it possible to draw accurate total-heat curves over the whole range of temperatures up to 500 deg. cent. and derive fairly accurate values for the specific heats of the hydrocarbon vapors. Combinations of these with vapor-pressure data make it possible to determine just how hot the air or the fuel must be preheated in order to completely vaporize the motor fuel in a carburetor. Address Charles L. Parsons, Secretary, American Chemical Society, P. O. Box 1505, Washington, D. C.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Electric Power B1-22. Design of Electrical Machinery and Lines. During the present year Prof. V. Karapetoff is carrying on an investigation on mechanical aids in the design of electrical machinery and lines. He expects also to make a study of fields of force or flow, electric,

magnetic and hydraulic. Address Professor Karapetoff at Cornell University, Ithaca, New York.

Highways B1-22. Traction Dynamometer. See *Transportation B1-22.*

Machine Tools B1-22. Cutting Tests of High-Speed Tool-Steel Bits. See *Steel, Its Treatment and Products B1-22.*

Steel, Its Treatment and Products B1-22. Cutting Tests of High-Speed Tool-Steel Bits. A number of tool bits of standard high-speed tool steel have been heat-treated in various ways by the Bureau of Standards to determine the effect of these treatments on the cutting qualities of the metal. About 55 cutting tests were made, and while no new facts were brought to light, the data obtained were interesting and show that it is possible to obtain valuable results from tests made with such small samples. This work is being continued, and an effort will be made to study the time temperature relations in preheating and hardening on the cutting qualities of high-speed tool steels. Address Dr. S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Transportation B1-22. Traction Dynamometer. Prof. F. L. Fairbanks is now developing and completing at Cornell University a traction dynamometer of considerable interest.

Ventilation B1-22. Infiltration of Air. A study of the infiltration of air into buildings through walls and windows is one of three problems which Prof. H. Diederichs has taken up this year. The other two are (*a*) satisfactory heat treatment of "Kimite" alloy steel and (*b*) the combustion process in a Diesel engine.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

Available Equipment. In a letter just received from Assoc. Prof. William J. Dana of the Mechanical Engineering Department of North Carolina State College of Agriculture and Engineering, it is stated that owing probably to its distance from a large industrial center the facilities of the mechanical laboratory of this college, though well equipped, are not being taken advantage of. They have all the usual small apparatus, such as the Emerson bomb calorimeter, the Saybolt viscosimeter, the Sargent improved gas calorimeter, etc. Their power plant and equipment include six boilers, hand-fired, steam engines, small steam turbines, an 11-hp. Foos engine and other gas and oil engines of various sizes.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Petroleum and Allied Substances. Under the title Recent Articles on Petroleum and Allied Substances, Mr. E. H. Burroughs, Bibliographer of the Bureau of Mines, has compiled a valuable bibliography of interest to all those in any way connected with the petroleum industry. This report is known by Serial No. 2305 and may be obtained by addressing H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, and brief articles of current interest to mechanical engineers.

Advantage of Nitrogen in the Boiler Furnace

To the Editor:

Referring to the short article on the Advantage of Nitrogen in Boiler Furnaces, published on page 802 of the December issue of Mechanical Engineering and credited to *Power,* I would say that the logic of it is all wrong. To carry the author's course of reasoning further, why not run with large quantities of excess air and buy coal with the largest possible amount of ash so as to lower the furnace temperatures to the greatest possible extent?

The use of oxygen or enriched air promises paying results in blast furnaces or open hearths, etc., because the working temperature of the furnace is so high that normally most of the heat generated passes off in the products of combustion, and any method by which the volume of these and their heat control may be materially reduced will have an enormous effect on the efficiency and fuel consumption of these furnaces. Boilers, on the other hand, can utilize heat down to very low temperatures by the use of economizers so that the possible fuel saving is much less, and the cost and complication of the apparatus for supplying oxygen would have to be reduced correspondingly to make it commercially attractive.

From a purely operating point of view, however, the problem of boiler adaptation is simpler than maintaining a roof in an open hearth at any higher than present temperatures, though these can be controlled and practically the same efficiency of the process obtained by arranging the mixture of fuel and oxygen so that this and the combustion are progressive and the heat is absorbed as fast as it is generated, resulting in temperatures not exceeding a safe limit but with all the heat generated at a high enough temperature to be effective.

I have seen a boiler with a little over 10,000 sq. ft. of heating surface evaporate over 150,000 lb. of water per hour for 3 hours on oil fuel, so that no anxiety need be felt regarding the heat absorption of the water-cooled surfaces.

Material arguments controverting those in the article in question appeared over the writer's signature in the issue of *Power* for November 22, 1921.

New Haven, Conn. H. D. Fisher.

Novel Pumping Plant in Operation at Key Biscayne, Florida

To the Editor:

A rather unique pumping plant has been placed in operation at Key Biscayne, Miami, Florida. The accompanying snap shots show the installation of an overshot water wheel to take the flow from an artesian well. This wheel, 12 feet in diameter and turning at 7 r.p.m., is geared to a duplex pump operating at 40 strokes per minute which is used to pump water from the well drainage sump well into an elevated storage tank. This tank supplies water for irrigating a nursery and also for homes on the island.

Overshot Wheel Driving Duplex Pump

The water from the well is very strong in sulphur and comes from a depth of approximately 1,000 feet. Tests give the rate of flow at an elevation of 12.92 feet as 248 gallons per minute which provides 0.82 hp. for operating the wheel. 0.46 hp. is utilized in pumping the water which gives an overall efficiency on the plant of 56.8 per cent.

Welton A. Snow.

Miami, Florida.

Standardization in Japan and Norway

Standardization work in Japan has recently been given a great impetus by the organization of the Japanese Engineering Standards Committee. The main function of this Committee is to serve as a bureau for solving and initiating problems involving engineering standardization. The Committee consists of 70 members presided over by the Minister of the Department of Agriculture and Commerce acting as president, and a vice-president, who is elected or appointed. The details of the work are handled by seven secretaries who are engineers of the government departments of Agriculture and Commerce, Communications, Railways, Military Engineers and Naval Engineers. The work is being pushed with vigor, investigations already being under way on metals, woods, bricks, screws, electric wires and electric motors.

In Norway a national standardization committee has been organized by the Federation of Norwegian Industries. One of the first projects which is being taken up by the new committee, after the necessary work on organizational problems, is the standardization of ship machinery and ship details.

There are now national standardizing bodies in the following fourteen countries: Austria, Belgium, Canada, Czechoslovakia, France, Germany, Great Britain, Holland, Italy, Japan, Norway, Sweden, Switzerland and the United States.

International Cooperation in Standardization

A.E.S.C. Sales Agent for Foreign Standards. The American Engineering Committee has just completed arrangements by which coöperation with the standardizing bodies in other countries will be made more effective. In doing this it has followed out the recommendations of the Unofficial Conference of the Secretaries of the National Standardizing Bodies held in London in April, 1921.

In order that all standards shall be available to the industries of the various countries, it is planned that each national body will sell the approved standards of the other bodies. The American Engineering Standards Committee, 29 West 39th St., New York City, has available now the publications of the standardizing bodies in Austria, Belgium, Canada, France, Germany, Great Britain, Holland, Sweden and Switzerland.

Hereafter the A.E.S.C. will regularly exchange information with the foreign bodies as to the status of work on the various projects being undertaken under its auspices. This information will be limited to the indication of the stage of development of the projects, it being left in each case to the various sectional committees and sponsor bodies to decide to what extent they desire to exchange technical memoranda or drafts of standards. This exchange of information on the general progress of the work will, however, lay the basis for closer international coöperation as the need for this develops in special instances.

A.S.M.E. Transactions Index Contemplated

Pressure has been exerted on the Society to compile and issue a comprehensive index of Transactions to date. Such a book will render available the exceedingly valuable information contained in Transactions, and the Committee on Publication and Papers has the project under advisement, pending an expression of opinion from the Society. The acknowledgment card, which is sent out with volume forty-two of Transactions, will permit a statement of each member's desires in the matter of this index, and if sufficient orders are received the book will be issued some time during the fall. It will be bound in half morocco, uniform with Transactions. Price will depend somewhat on the number of copies ordered, but it is believed that it will not exceed $4.00.

A Correction in Machine-Shop Discussion

Professor John Airey has called our attention to an error in the report of his closure to the discussion on the paper entitled Art of Milling by John Airey and Carl I. Oxford. At the bottom of page 16 of the January issue of Mechanical Engineering mention is made of "machine belt." This should have read "machine ability tests." The shortness of time alloted to the discussion of this paper did not permit a proper closure by Professor Airey. This will be included in Transactions.

STANDARDIZATION, AMERICAN INDUSTRY AND THE FEDERAL GOVERNMENT

(*Continued from page 180*)

not to deal with technical details has proved a source of great strength in its real work of insuring the full coöperation of organizations producing standards not in conflict.

An Example of Functioning of the A.E.S.C.

In determining the desirability of undertaking the development of a proposed standard, it has proved highly satisfactory to initiate the movement by calling a conference of the bodies interested, which the A.E.S.C. does upon request from a responsible organization or organizations.

As an example of such a conference, mention may well be made of the Conference on the Standardization of Railroad Ties held in Washington, D. C., in October, 1921, at the joint request of the Forest Service and the American Railway Engineering Association. Invitations to this Conference were issued to the several national organizations representing not only producers and consumers but also general interests, the last mentioned being the American Society of Civil Engineers, the American Society for Testing Materials, the Department of Commerce, and the Forest Service. The official representatives of the organizations were asked to decide: (1) whether the unification of specifications for railway cross-ties and switch ties should be undertaken; (2) if so, what the scope of the work should be; and (3) how the work should be organized.

After a very full discussion of all phases of the important problem before it, this Conference reached a unanimous agreement on all points under consideration. It recommended that the Forest Service and the A.E.R.A. be designated as joint sponsors for a "Sectional Committee" to unify railway-tie specifications under the Rules of Procedure and auspices of the A.E.S.C., and recommended to the sponsors that certain specified national organizations be invited to be represented officially on the sectional committee. Although it might seem apparent, without discussion, that the unification of railway-tie specifications should be undertaken, the subject was discussed for two hours before the Conference was asked to place itself on record on this matter, which it did by unanimous vote. All of this discussion was beneficial in paving the way for the discussion of the scope of the work and the organization therefor.

A conference called as this conference was called and conducted as this conference was conducted results in a spirit of coöperation that cannot otherwise be brought into existence. The plans laid down for carrying out the work of standardization will insure that the coöperative spirit brought into being by the conference will continue to be the controlling feature of the work of eliminating existing conflicting standards and "Americanizing" the standards that will be formulated hereafter.

Too much emphasis cannot be put upon the advantages of the conference method of initiating work on any particular standard or set of standards, provided the conference is truly representative. When men get together in such a conference, from an interchange of ideas they obtain a comprehensive view of the whole field; harmony emerges from discord and differences disappear in agreement.

Advantages of National Standardization Reiterated

In closing, it cannot be too often repeated that a national standardization program means almost unlimited advantage to the manufacturer in cheapening the processes of production and stabilizing his market; to the distributor in clarifying and simplifying his problems; and to the ultimate consumer by lessening costs and expediting deliveries. The real significance of standardization to industry and the Federal Government—what it may mean and what it can accomplish, will not be fully realized until there is sincere coöperation which is sympathetic, systematic and comprehensive, between industry and the Federal Government, in which coöperation the general consumer has a part.

MECHANICAL
ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie
Ralph E. Flanders John T. Wilkin
O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Engineering Education—the Development of the Resourceful Mind

It may seem presumptuous for me to offer any observations upon the subject of engineering education. I feel prompted, however, to make the attempt, at least, because of the kindly urgent request of the Editor of this magazine and also because the end of education for the engineer is the same as for any other profession. This end in a word is the development of mind and of character. One who has a highly developed mental equipment without character is a menace to the community; one who has character without mind, however high may be his purpose and ambition, proves ineffectual in the contests and conflicts of life. Therefore, I affirm most emphatically that true education has for its object both the trained mind and the thoroughly trustworthy character.

John Grier Hibben

Owing to the limits of the space assigned me I shall confine my observations solely to the training of the mind, not wishing however, to leave the impression that I regard character as in any way of secondary significance.

The discipline of the mind depends more upon the methods of teaching than the subjects taught. In preparing for the career of an engineer, as for any other profession, it is indispensable for future success and conspicuous leadership that the student should be led to a firm grasping of fundamental principles rather than the mere accumulation of facts. The fundamental sciences, mathematics, physics and chemistry, must be mastered by every student of engineering. To acquire a knowledge of these sciences encyclopedic information is not adequate.

Many centuries ago Aristotle remarked that there are two types of mind, the one which acquaints itself with the facts of a subject, and the other which penetrates to the reasons underlying these facts. The latter, he adds, are the philosophic minds. By philosophic mind Aristotle meant what we today would characterize as the scientific mind.

The true engineer must be the scientific engineer, that is, the one acquainted with the great fundamental principles of the underlying sciences of his profession and who early acquires the habit of asking the question Why, and searching for the answer with eagerness of spirit as for a hidden treasure.

Many years ago one of our graduates in engineering started a career in the West of very brilliant promise, brought to an end with only partial achievement by a fatal accident in the prosecution of his duties. Upon one occasion I met him in Princeton and I asked him what in his opinion was the most valuable characteristic of a successful engineer. After a moment's thought he responded, "The most successful engineer is the man who does not lose his head when face to face with an entirely novel situation." This gives the gist of the whole matter. To learn a rule easily applicable to familiar conditions and to apply the same with facility calls for a mind of intelligence, of course, but one acting only on the low level of routine. But to encounter a problem not familiar because disguised by entirely new conditions, to penetrate to the heart of the difficulty, to seize upon the possibility of applying some fundamental principle of mechanics, or of mathematical law, and to devise a method of procedure which will attain the desired result, this requires the talent of the truly scientific mind.

Throughout the whole of the training of the engineer there must be the supreme objective held in view by the teacher and by the student alike, namely, the development of the resourceful mind. That is the reason why I feel that an engineering education should produce first of all the engineer as such, rather than the engineer in any particular phase of his profession, such as that of the civil, the mechanical, the electrical, the chemical or the mining engineer. I imagine that the difficult problems which come to the engineer, however highly specialized his work may be, can never be dealt with satisfactorily by a knowledge only of his specialty. A problem in mechanical engineering may require the mechanical engineer to make his excursion into neighboring fields for the solution of the problem.

No method in education moreover, is satisfactory which appeals solely, or in a large measure, to the memory. The point of attack must always be the reasoning powers of the student, not only that, but there must be in the schedule of his studies and in the method of teaching a constant stimulation also of his powers of imagination. I do not refer to the unlicensed ranging of his fancy in fields foreign to his subject, but I do insist upon the mind being quickened in the solution of any problem by the discernment of all the possibilities of solution which may be dictated by the reason. We often think that the function and scope of the imagination are the natural activities solely of the artistic temperment, but there is a type of imagination which is essentially the function of the reasoning powers of man.

When an unfamiliar situation develops in any engineering enterprise and which stands as a stubborn obstacle in the way of progress it is the mind possessing imaginative skill which immediately brings before its scrutiny the complete array of possibilities of explaining the fundamental reason for the obstacle in question, and that in itself suggesting a proper method of overcoming it.

There is another phase in the career of the engineer which he has in common with all men whose work is to possess some permanent value for his day and generation. He must be able to deal successfully with the human elements in his problem as well as the material.

General Goethals said of his great engineering enterprise in Panama, that the great difficulty of his work was the human problem. There must be, therefore, in the engineering studies not only the laying deep of the foundations of the fundamental principles of the great sciences, but there must be a like fundamental knowledge of human nature in its manifestations, both of the past and of the present.

I appreciate the fact that the secret of dealing wisely with men, gaining their confidence, understanding their weakness and their strength, creating among them a spirit of coöperation and even of willing sacrifice—all these are essential to the success of an engineer and cannot be adequately learned from textbooks or from lectures. It is the result of an experience gradually gained in the school of the world. But humanistic studies do tend, in some slight measure at least, to create the spirit of human understanding and of human sympathy, and that advantage (and I believe it is a real advantage), may be gained from them, and should not be

withheld from the prospective engineer. To learn something of the great masters of the world in philosophy, in art, in literature and in the guiding of national destinies, gives him not only a realizing sense of the secret of human power and attainment but suggests to him also the secret of how to make actual the potential energy that is always to be found in groups of men with whom he will have to deal, whether they be laborers, soldiers, or the directors and stockholders and colleagues in some great engineering enterprise.

The engineer who compels the forces of nature and the powers of man to conspire to do his bidding, who brings to his task, whether great or small, a creative spirit, who regards obstacles as a challenge gladly welcomed, and who has the courage to attempt that which to men of restricted vision seems impossible, such is the one who not only attains success as an engineer but is capable of contributing richly to the advancement of knowledge.

Autogenous Welding and the Unfired Pressure Vessel Code

The scope of the proposed code for the safe construction of unfired pressure vessels is far greater than was at first anticipated by the Boiler Code Committee of the A.S.M.E. which is now formulating this code to supplement its rules for the construction of steam boilers.

The demands from the state and municipal authorities for a code covering unfired pressure vessels have been insistent and the Boiler Code Committee has, as a result, been at work for over two years on this supplementary code. In this endeavor, however, it has been a difficult matter to adequately provide for all types and classes of pressure vessel construction and the fact that autogenous welding has been widely introduced for the construction of the joints of such pressure vessels has materially complicated the situation.

As the most recent development in this work, the Boiler Code Committee held a hearing on Monday, December 5, during the A.S.M.E. Annual Meeting, for those who were interested in the manufacture or use of unfired pressure vessels, to consider and discuss the proposed code for unfired pressure vessels, of which a preliminary draft was issued previous to the meeting. This pamphlet was the result of over two years of investigation and conference with allied organizations, and in it there was presented a constructive suggestion for this long-desired code.

The results of the investigations of the Sub-Committee on Welding were shown in the form of proposed specifications for autogenous welding, forge welding and brazing. While there was an attempt to render the code comprehensive, still every detail of either the construction requirements or the various specifications on which there had been lack of agreement were omitted and fourteen questions were listed for discussion at the end of the report.

This preliminary report had been distributed to nearly 500 individuals and concerns known to be interested in the manufacture or use of unfired pressure vessels considerably in advance of the meeting. The result was a large attendance at the hearing during both forenoon and afternoon sessions.

The preliminary draft of the proposed code was read paragraph by paragraph and discussion invited on each. The responses to the fourteen questions at the end of the report furnished the committee with much constructive data for use in shaping the proposed code into final form.

The committee finds that one of the major problems involved is the question of the use of autogenous welding and every endeavor will now be made to bring out the greatest possible amount of information concerning this form of welding in its relation to pressure vessel construction. To this end the A.S.M.E. Meetings Committee, the American Welding Society and the Boiler Code Committee are planning a special welding session at the coming Spring meeting of the Society to be held in Atlanta, Ga., May 8–11. It is expected that a number of welding experts who have carried on extensive research in this field will report there.

Charles Russ Richards Elected President of Lehigh University

Charles Russ Richards, at present Dean of the College of Engineering of the University of Illinois and Director of the Engineering Experiment Station, was elected President of Lehigh University at a meeting of the Trustees held February 7

Dean Richards was born at Clarks Hill, Ind., on March 23, 1871. He was graduated from Purdue University with the degree of Bachelor of Mechanical Engineering in 1890 and a year later received the degree of Mechanical Engineer at the same Institution. In 1895 he obtained his Master's degree in mechanical engineering from Cornell University and in 1920 the University of Nebraska conferred on him the degree of Doctor of Science.

He was instructor in mechanical engineering at the Colorado Agricultural College during the year 1891–92. From 1892 to 1911 he taught at the University of Nebraska holding successively the positions of Adjunct Professor of Manual Training, Professor of Practical Mechanics, Professor of Mechanical Engineering, Associate Dean of the Industrial College, and Dean of the College of Engineering.

CHARLES RUSS RICHARDS

In 1911 he went to the University of Illinois where he has held in succession the positions of Professor of Mechanical Engineering, Acting Dean of the College of Engineering and Director of the Engineering Experiment Station. In March, 1917, he was appointed to succeed Dean W. F. M. Goss.

At the University of Illinois, under the general direction of Dean Richards, the work in the college shops has been completely reorganized so that they have been converted into laboratories to provide instruction in the principles of industrial management in the art of manufacturing to illustrate the effect of the shop processes on the materials of instruction, and to do experimental and research work in connection with the cutting of metals and in the general field of engineering production. It is felt that the method employed in these laboratories constitute a distinct contribution to the field of engineering education.

Dean Richards has served as consulting engineer in connection with the power-plant and water-works problems and the appraisal of public utilities. He has been interested in engineering research relating to fuels, steam, air, and gas-power engineering.

He was elected to membership in the Society in 1892 and served as manager from 1918 to 1921. He is Chairman of the Power Test Codes Sub-Committee on Fuels. He also belongs to the Western Society of Engineers, Society for the Promotion of Engineering Education, Sigma Xi, Tau Beta Pi, Sigma Chi and Sigma Tau.

Herbert Hoover Emphasizes Duty of Engineers in Reestablishing Economic Balance

In Address at Annual Meeting of the American Engineering Council, Secretary of Commerce Indicates the Responsibilities of the Profession and Suggests Steps Toward Fulfillment

THE first Annual Meeting of the American Engineering Council was held in Washington, D. C., on January 5 and 6. An account of the proceedings of this meeting was included in the January 7 issue of *A.S.M.E. News*. The delegates to the Council gathered with the engineers of Washington at dinner on Thursday evening, January 5 and were addressed by Herbert Hoover, past-president American Engineering Council, Dr. Bedrich Stepanek, Minister from the Czecho-Slovakian Republic and John Temple Graves, journalist. Mr. Hoover's address inspired the subsequent deliberations of the Council by his call to the engineering profession for greater service. We are giving his remarks in full.

Fellow engineers: I did not come prepared with any large and efficient words of wisdom and have been rather fearful that I did not sit down in council with your directors and develop someting.

I am interested in this association not only because I participated—I do not put it higher—in the organization of the Council, but because this body has entered upon a path of public service that is unique in the whole United States. I have perhaps said before in urging some of our brother societies to join with the Council, that the engineer has developed himself all these years to the upbuilding of the material values of the United States He has done that effectively—more effectively than has been accomplished in any other of the great countries of the world. The birth of this society marks the evolution of the engineer into an interest in public affairs. With his intelligence, his experience and training and the unique knowledge that he possesses not only of the material but the intangible values amongst our people, he is now organized so that his united voice may become heard outside of his profession. We have probably 175,000 engineers in our country, representing an intellectual possibility for service possessed by no other group. It is therefore an augury of real social development when the engineers of the United States join together for purposes of public service.

This association has the unique value among the associations that it cannot have any material interest for its purpose. No engineer can receive any material benefit from it. It can advance no economic interest. It cannot therefore be charged with any ulterior motive. It is accepted by the whole American people who have become acquainted with its objectives as being clearly single-minded.

During the last year we considered a number of the problems that confront the American people in the light of what services the engineers could perform in their solution. We resolved early in the progress of the Council to undertake an investigation into the elimination of waste—a problem with which the engineer alone was fitted to deal, a problem that had not come in for solution outside of engineering circles. As a result of the investigation carried on during the past year and of the report made, there has been an enormous expansion of the consideration of these fundamental questions—questions that enter into the whole problem of the standard of living of our people. At the time we undertook that investigation we were still at the height of a boom. The country was going on recklessly spending, with extravagance and over-expansion. Almost every engineer, in consideration of the economic situation of the time and the early meetings of the Council, wondered when it would all come to an end and appreciated the waste that came from the operation of the business cycle, which reaches its peak in booms like that then affecting the country. That investigation resulted in a final report in the midst of the depression that was inevitable. It came just at a time when the country was receptive for ideas that in the long run must mean the correction of these tremendous losses from over-expansion and from depression.

On taking this position that I now hold I had felt that it was the duty of the Government, if it was possible, to carry into effect some of the purposes outlined by the Council. We have in the Department of Commerce, accordingly, established a number of agencies intended to effect the results outlined as possible. And in getting further knowledge and experience with this problem I am indeed impressed with the fact that it is the most fundamental of all of the economic problems with which the American people must deal. It becomes doubly important now because we are faced with certain primary conditions that cannot, in my view, receive any solution except along the lines laid down in that report on the elimination of waste.

If we take the year 1913 as a base year for economic calculation and assume that the price of goods to the producer was 100 and likewise the cost to the consumer was 100, and if we then examine the situation today we will find that in many, in fact the majority of cases, the value of commodities is not far from 100 in their return to the producer and, more particularly, we will find the agricultural products often far below that level. But, on the other hand, to the consumer, the price level is, in the majority of cases, from 150 to 170. We have, therefore, a tremendous distortion. That distortion bears heavily on the producer and the consumer. One or the other of the two must carry the brunt of that load. And if we are to decrease that margin, it can only be through the elimination of waste.

We have to bear in mind that during these last seven years we have probably added eight billions per annum to national, state, and municipal taxation. If, on the basis of the present value of the dollar, we estimate that the national productivity of the country is somewhere near fifty billions, it is possible to calculate at once that taxation alone accounts for at least twenty units out of the sixty or seventy with which we have to deal.

There are other elements that have entered into the problem—increased cost of transportation and a thousand direct or indirect increases in the cost of manufacture or distribution.

And, clearly, unless we can bring the cost of commodities to the consumer more nearly into line with the return to the producer, we shall indeed, to go no further, reduce our agricultural population to the status of the European peasant.

That is a problem of manufacture, transportation, and distribution. The distortion is not due to undue profits at the present time. It is distortion that can be corrected only through the elimination of wastes in our processes of distribution and other phases—transportation, business methods manufacture, and so on. Indeed the question of the elimination of waste entered into two years ago because of those glaring, outstanding instances that challenged every engineer now looms in the mind of every economist as the real hope of reestablishing economic balance in the United States.

We have enlarged our vision as to what constitutes waste. We are suffering today from one of the most fearful wastes that can come to us in that we have from two to three millions of idle men. Lost labor once over the dam is lost for all time. Any inquiry into the causes of our vast unemployment brings us at once to consideration not alone of the world as a whole and of our own economic cycle in relation to it but also to the problem of how to avoid such periods of waste.

Now, the engineers have rightly pointed out that there are times when we make large increases both in the direction of plant and equipment and production of consumable commodities; that if we are to correct and alleviate the intensity of our business cycles, we must find some method by which we can expand our plants and equipment at periods when the demand for consumable goods has relaxed. Nor is that a misconception. For if we were to hold over a part of our seasonal operations on great public utilities and public works through periods of from seven to ten years, a reserve of probably no more than ten per cent stored up for periods of depression in the production of consumable goods would enable us to maintain an even tenor and to secure even production of all commodities. There lies one of the greatest wastes and it is in the anticipation of that waste that lies one of the great economic problems of the country.

There are many ramifications of the waste problem with which you are familiar—many, more familiar than I am. But there is one factor in the saving of waste that I believe the engineers might give further consideration to and perhaps more investigation. And that is the problem of a larger view in electrification.

We are all aware of the results obtained in the investigation of the superpower development of the Atlantic seaboard. Superpower is not impossible in many other sections of the country. We are indeed on the threshold of enlarging the distances of transmission. We have the possibility of reducing waste through a large phase of electrical development made during the past thirty years. The American people have no appreciation of the possible results and the added efficiency, productivity, safety and advance that could be obtained in the enlargement of our entire electrical equipment. And there is nobody that could give this problem such consideration and so illuminate it in the national sense as this Council could do. It indeed requires the services of every branch of engineers that compose the Council. With the possibility ahead of us of the development of some twelve to fifteen millions of horsepower, the consolidation of hundreds, even thousands of minor plants, the enormous savings to be made through the substitution of electrical power for steam—in that there is a probability of the greatest material saving of waste possible in any country in front of the American people.

Now, it is one thing to suggest a problem and another thing to suggest its solution. It is a far more difficult thing to state a problem in a fashion that people will understand and state its solution in a fashion that will carry conviction. But an association of this kind, ramifying as it does into the best intelligence of every single community of the United States, has the opportunity to develop popular conception of its ideas more effectively than any other group in the country.

Still, I am not attempting to outline to you the services that you can undertake, for you have on your docket a long list of matters which must be given study and advancement. Thus I understand that you have had before you some question in the matter of a publication. That subject was up when I participated in your deliberations. We recognize the necessity of cohesion among the engineers. The objectives of the Council can be phrased in the common language of the great visions of engineers in the direction of the services they can perform for their communities. And in the contact of engineers with the public life of the Nation there is no possibility of overlapping in the technical services of our member societies.

I realize that the financing of such a publication as some of our members contemplate is of extreme difficulty. Yet, when we entered upon the publication of the Report on Elimination of Waste, we faced an expenditure of

some forty or fifty thousand dollars, and found that there were enough men ready to aid in carrying the investigation through. I do not therefore assume that the necessary expenditure in this case is insuperable but I do believe that one of the strongest measures that can be taken by the Council in promoting the unity of its own membership and the cohesion that it will create is some form of a service journal. And it is not alone a problem for your directors that the engineers should be reported in the public councils of the Nation but it is a problem of inspiring the same attitude of mind amongst the engineers in every city, town, and village in the United States. There is no State or city or municipal government that does not need the advice of the Engineering Council. There is no problem either in Federal or State or municipal legislation that does not at some point touch upon material construction and therefore come within the purview of the engineer. So that while the Council here in Washington and in those centers where the directors can keep in contact with needs and the problems in hand do a great service, the same opportunity and the same need exist throughout the country. I know of no way of inspiring service except by contact. That service the country needs.

It needs the plans and the intelligence of its engineers—the men who have in the very nature of their work the inspiration and enthusiasm and yet are the greatest realists in the world—and they are the men who should be heard from.

For the services you have done during the past year is small measure of what can and will be accomplished by you, through the Council.

Following Mr. Hoover's remarks, Mr. Calvert Towsley, vice-president of the American Engineering Council, presented him with the following resolutions:

Whereas, our first President, Herbert Hoover, has been appointed Secretary of Commerce in the Cabinet of the President of the United States and

Whereas, in consequence of his acceptance of this high public office, he deemed it necessary to tender his resignation as President of The Federated American Engineering Societies,

Be it therefore resolved by American Engineering Council, that we hereby record our appreciation of the rare judgment and vision with which Mr. Hoover has directed the initial policies of The Federated American Engineering Societies, and the ability and uniform courtesy with which he has presided over the deliberation of the Council and the Executive Board.

Be it further resolved that American Engineering Council acting through its Executive Board express to him the sincere regret with which his resignation has been accepted and its sincere good wishes for a continuation of that distinguished success which has followed him in his past services to this profession, his country and mankind.

In acknowledging the presentation, Mr. Hoover said:

Gentlemen, I very much appreciate this expression but I do feel that because I did not give the services to the American Engineering Council while I was its president that I should have given, the Council was the product of your four vice-presidents.

Any man likes to have such things, to treasure in his household, for they bring back recollections of the sweetest things in life.

And I accept them too, in view of the day when I shall have to return to the profession to earn my daily bread, when I shall need such a certificate of character.

So I shall have them framed, and have them ready for the engineer's office that stares me in the face. Nor would I be sorry to re-enter a profession whose sole passion is to build and to construct, for those indeed are the greatest privileges given to man.

I thank you.

American Welding Society Issues First Number of Proceedings

The first number of the Proceedings of the American Welding Society has just reached us. This publication will deal with the activities of the American Welding Society and its Research Department, which is organized as the American Bureau of Welding. Technical papers, research items and other notes of interest to those engaged in the art of welding will appear as well as news of the American Welding Society and its sections.

The American Welding Society is to be congratulated upon its enterprise in developing this medium of communication with its membership. Its form is readable, attractive and dignified.

Announcement of the DeLameter-Ericsson Tablet Committee

At the Commemoration meeting, December 3, 1919, fourteen organizations participated. Afterward it was decided to turn the money that was left over into a fund which would be increased sufficiently to erect bronze tablets on the sites of four buildings with which the lives and work of the two men who were being memorialized were identified. Seven more organizations then joined the movement and it was decided to assess each the sum of $250 and thus raise a fund of $5000 which amount was deemed necessary for the plan proposed. Some of these organizations have over-subscribed their quota, others have not met theirs There is about $1000 still to be raised.

The following members of the A.S.M.E. subscribed the amounts specified:

H. R. Towne	$50.00
H. F. J. Porter	11.00
J. W. Lieb	10.00
G. M. Newcomer	10.00
S. Bevin	5.00
V. D. Bevin	5.00
A. Falkenau	5.00
D. S. Jacobus	5.00
D. J. Lewis, Jr	5.00
Alex Schein	3.00
A. Hollender	1.00

The Committee would welcome further subscriptions. Checks should be drawn to the DeLamater-Ericsson Tablet Committee and forwarded to the headquarters, 29 West 39th Street, New York, N. Y.

Any money remaining after the unveiling exercises on March 9 will be devoted to securing a permanent repository for Capt. Ericsson's models, medals and other memorabilia which are now widely scattered.

Engineering Study of the Pittsburgh District

The Carnegie Institute of Technology has undertaken an investigation of the Pittsburgh district to be carried out on an unusually broad and comprehensive scale. An area covered by a circle of 30 miles radius with the City of Pittsburgh as a center, is to be considered, and the investigation is to embrace power generation, finances, natural resources, transportation facilities, land and labor markets—all from an economic rather than a sociological point of view. It will differ in this way from the majority of previous similar investigations.

Since the fields covered are so diverse that no one individual could undertake such a study, the Carnegie Institute of Technology has alloted the power problem to its engineering departments, its economic department is working on the finances, the geological department on natural resources, etc., while the whole is under the general supervision of the commercial-engineering department.

The real value of such a study comes not so much from the individual reports, as from comparisons that it is possible to draw and the weighing of one report in terms of the others. For example: at the present time there are no means of telling whether the power, finances and transportation facilities in this district are properly balanced. The report as a whole will disclose such conditions, where they would not have been evident from the individual studies. It should also bring to light certain things regarding labor in its relation to investment and industry.

The Pittsburgh district particularly lends itself to such a survey, both because the industrial density is greater than in any district of equal area in the United States, and especially, for general power study, because certain large divisions of power having complete available records, can be separated with considerable accuracy.

In this connection it is surprising what interest has been manifested in this report. The two large electric power companies have worked together to get the data desired, and the steel and other manufacturers are giving figures that would otherwise be almost impossible to obtain. Data is being collected, not only for the present time, but extending back for a considerable period of years, so that the general industrial trend and growth and the effect of the war can be seen.

Some of the individual reports have progressed more than others, and may be published singly from time to time. One or two are nearing completion, but it will be some time before the complete report can be finished.

The Carnegie Institute of Technology states that they will welcome assistance and information that might help towards a more perfect execution of their important task.

The purpose of the investigation is heartily endorsed by Secretary of Commerce Hoover.

Engineering and Industrial Standardization

New Standardization Projects under the A.E.S.C.

Bolt, Nut and Rivet Proportions. During the past fifteen years or so a considerable number of standards for the external dimensions of bolts, nuts and rivets have been formulated by the societies and associations whose members are vitally interested. These standards are now to be reviewed by a Sectional Committee organized under the Rules of the A.E.S.C.

This Sectional Committee is being sponsored by the Society of Automotive Engineers and The American Society of Mechanical Engineers and the individuals and firms most directly connected with the activities of the former Nut, Bolt and Rivet Institute are lending every possible aid in the organization of the Committee. It is the desire of the Sponsors that every organization, which is in any way interested in this project, be represented on the Sectional Committee.

The board representation which this Committee will have, therefore, will insure the general acceptance of the standards which it will propose to the A.E.S.C. as American Standards. The results of its work, however, will have an international as well as a national significance, for the Swiss through their Commission de Normalisation du VSM of Switzerland have already inquired concerning the American Standard external dimensions of nuts and bolt heads of various kinds.

Safety Code for Compressed Air Machinery. The American Society of Safety Engineers and The American Society of Mechanical Engineers have been designated as sponsors for a Safety Code for Compressed Air Machinery by the American Engineering Standards Committee. The code will include rules for the construction and use of compressors, tanks, pipe lines, and the utilization apparatus where compressed air is the active agent. In accordance with the usual procedure, the code will be formulated by a Sectional Committee composed of representatives designated by the various bodies interested. This Sectional Committee is now being organized by the Sponsors who cordially invite suggestions for the personnel.

Census of Engineers and Others Engaged in Promoting Industrial Safety. All branches of the engineering profession will watch with close interest the results of the safety census now being taken by the National Safety Council. Many engineers are devoting their efforts entirely to safety engineering and practically all engineers have more or less to do with safety principles in their work and are interested in the subject. This census is intended to include, however, all persons engaged in safety and industrial health, and it is believed that this is the first time that any attempt has been made to list all the persons engaged in these activities professionally.

The information which the Council seeks includes (*a*) name and full address of the worker, (*b*) company or organization for which engaged, (*c*) nature of the company's business, (*d*) nature and extent of the present safety activity and (*e*) previous experience. By sending these data promptly to the National Safety Council, 168 N. Michigan Avenue, Chicago, those engaged in this line of work will help to make this census taking a success which will thereby assist the whole safety movement.

Standard Methods for Wood Testing. The American Society for Testing Materials and the United States Forest Service have been designated by the American Engineering Standards Committee as joint sponsors for the development of uniform standard methods of testing wood. This action was taken as the result of a canvass made of the principal national bodies concerned with the proposed project, from which it was apparent that there is a real demand for the work, and that the joint sponsorship here indicated would be acceptable to the industry.

Standardization of Railroad Ties. The American Railway Engineering Association and the U. S. Forest Service have been designated by the A.E.S.C. as joint sponsors for the unification of specifications for wood cross-ties and switch ties for all classes of use including mining ties. The work is to include the grouping of ties with regard to preservative treatment, but not methods of treatment; and inspection rules. This action is in accordance with the recommendations of a conference on railroad ties, to which the following organizations had designated representatives:

American Electric Railway Association
American Railway Engineering Association
American Society of Civil Engineers
American Society for Testing Materials
National Association of Railroad Tie Producers
National Hardwood Lumber Association
National Lumber Manufacturers Association
U. S. Department of Commerce
U. S. Forest Service.

For carrying out the work there will be organized by the sponsors a sectional committee having accredited representatives of the above organizations and of the American Mining Congress, and the American Wood Preservers Association.

A.E.S.C. Calls Conference on Overhead Wire Crossing Specifications

At the request of the American Electric Railway Association, a conference is being called by the American Engineering Standards Committee to decide whether there shall be uniform specifications for the crossing of overhead wires, and to dispose, if possible, of certain differences of opinion in regard to those parts of the National Electrical Safety Code which deal with overhead lines. It will be remembered that the Code has been submitted to the American Engineering Standards Committee for approval. Invitations have been issued to all interested bodies to attend the conference, which will be held March 2 in New York.

The following has been planned for the agenda of the conference:

1 Shall there be a set of national specifications for crossings between overhead electric wire lines and railways, and between different wire lines?
2 If so, what should be its relation on Part 2 of the National Electrical Safety Code, "Rules for the installation and maintenance of overhead and underground electrical supply and signal lines."
3 Can disposition be made of the differences of opinion on Part 2 of the National Electrical Safety Code by
    a Approving the present edition,
    b revising the present edition through a sectional committee of the American Engineering Standards Committee?
4 What procedure shall be recommended for carrying out the conclusions reached by the conference?

The American Electric Railway Association has summarized its reason for calling the conference as follows:

> For many years various associations and interests, either individually or jointly, have developed and in many instances adopted, specifications intended to govern the construction of electric light, power, trolley, signal and communication lines across steam and electric railways.
>
> Recently the National Bureau of Standards has promulgated the National Electrical Safety Code, Part 2 of which applies to the general construction of overhead lines, including requirements at railroad crossings. The differences between the several specifications and codes has led to confusion.
>
> Realizing the desirability of having a standard that would be generally acceptable, the American Electric Railway Association has requested the American Engineering Standards Committee, by conference of the bodies interested, to determine the desirability of developing an American Standard Specification which will include the requirements at railroad crossings.

Insulated Wire and Cable

In the past many engineering societies and commercial organizations have issued standard specifications for insulated wires and cables which have come into very general use. Indeed, at the present time there are something like fifteen such specifications in wide use in the United States.

All these specifications, however, are made to apply to specific industrial uses and little has been done to coördinate them. It has therefore become a matter of concern to both manufacturers

and users of wire to bring about some coördination, with the idea of establishing a definite set of American Standards.

The first step toward this was taken last winter when the following ten engineering societies and other public organizations agreed to act as Sponsors, under the auspices of the American Engineering Standards Committee, for a comprehensive standardization of electric wires and cables for other than telephone and telegraph use:

American Electric Railway Association
American Institute of Electrical Engineers
American Railway Engineering Association
American Society for Testing Materials
Associated Manufacturers of Electrical Supplies
Association of Edison Illuminating Companies
Association of Railway Electrical Engineers
National Board of Fire Underwriters
National Electric Light Association
National Fire Protection Association.

These organizations enlisted the coöperation of several others, and created a comprehensive group of committees to handle the work. The other coöperating organizations are:

Associate Bell Telephone Companies
Electric Power Club
Society of Automotive Engineers
U. S. Department of Commerce
U. S. Department of Navy
U. S. Department of War.

The first meeting of the Sectional Committee was held at the headquarters of The American Society of Mechanical Engineers on Friday, December 6, 1921. At this meeting, a formal plan of organization, and procedure was adopted, officers elected, and the work definitely launched.

There are twelve technical committees to which specific phases of the work have been assigned. Like the Sectional Committee itself, they are organized under the representational plan; that is, they are made up of representatives designated by the various organizations concerned in the particular subject with which each committee deals. These committees with their chairmen are as follows:

Definitions	W. A. Del Mar
Copper Conductors	J. A. Capp
Stranding	H. A. Morss
Rubber Insulation	F. M. Farmer
Impregnated Paper Insulation	D. W. Roper
Varnished Cloth Insulation	L. L. Elden
Magnet Wire	R. W. Longley
Fibrous Coverings	C. B. Martin
Metallic Coverings	W. I. Middleton
Standard Make-Ups	C. A. Greenidge
Export	W. S. Clark
Weatherproof, Heat-Resisting and Similar Materials.	(to be appointed later)

The officers of the Sectional Committee and other members of the Executive Committee are:

Chairman, W. A. Del Mar, Chief Engineer, Habirshaw Electric Cable Co.
Vice-Chairman, E. B. Meyer, Asst. Chief Engineer, Public Service Electric Co., of New Jersey
Secretary, F. J. White, Electrical Engineer, Okonite Company, 501 Fifth Avenue, New York
F. M. Farmer, Chief Engineer, Electrical Testing Laboratories
Dean Harvey, Engineer in Charge of Material Section, Westinghouse Elec. & Mfg. Co.
E. B. Katte, Chief Engineer, Electric Traction, New York Central Railroad Co.
Dana Pierce, National Board of Fire Underwriters.

The task before this Sectional Committee is one of the largest yet undertaken under the auspices of the American Engineering Standards Committee. The total number of engineers participating in the work is over one hundred and thirty, and the list includes most of the men who have achieved distinction in the field of wire and cable engineering.

Five Standards Approved as American Standards

A.S.T.M. Specifications. The American Engineering Standards Committee has approved as Tentative American Standard the specifications of the American Society for Testing Materials for—

Cold-Drawn Bessemer Steel Automatic Screw Stock (A32-14)
Cold-Drawn Open-Hearth Steel Automatic Screw Stock (A54-15)
Methods of Chemical Analysis of Manganese Bronze (B27-19)
Methods of Chemical Analysis of Gun Metal (B28-19)

These specifications may be found in the 1921 volume of A.S.T.M. Standards. Copies may also be obtained from the American Engineering Standards Committee, 29 West 39th St., New York City. Price 25 cents each.

Factory Lighting Code. The Code of Lighting for factory mills and other work places, based upon earlier codes issued by the Illuminating Engineering Society and recently revised by a sectional committee under the sponsorship of this society, has been officially approved as American Standard by the American Engineering Standards Committee.

The code is very brief, consisting of a few rules covering the minimum requirements, from the point of view of safety, for the illumination of traverse spaces during the time of use, methods for the avoidance of glare, and for exit and emergency lighting. Supplementary to the code are numerous suggestions relative to illumination values considered desirable for different classes of work and an outline of the advantages of good lighting.

State lighting laws based upon the I.E.S. code have already been put into effect in Pennsylvania, New Jersey, New York, Wisconsin, Oregon, California and Ohio. The adoption of the code is now under consideration in several other states. Copies of this code may be secured from the American Engineering Standards Committee, 29 West 39th Street, New York City. Price 25 cents each.

All the standards which have so far been approved by the A.E.S.C. are now available bound in a loose-leaf expanding binder appropriately stamped. We are told that recently the Chief of Ordnance of the War Department ordered four of these complete sets for the convenient use of his Department.

American Railway Association and Steel Manufacturers Join the A.E.S.C.

Beginning with 1922, the American Railway Association (Engineering Division) and the Association of American Steel Manufactures became member bodies of the American Engineering Standards Committee.

The Association of American Steel Manufacturers is an organization of forty iron and steel manufacturing companies. Its activities are limited to the standardization of rolling-mill practices, and to the standardization and inspection of iron and steel products. The association was organized in 1895. Its official representative on the American Engineering Standards Committee has not yet been designated.

The American Railway Association, which speaks for practically all the steam railways of the country, has four great technical branches, each having its own secretary, the Engineering and the Mechanical Divisions, and the Signal and the Telephone and Telegraph Sections. The Engineering Division, which is intimately connected with the American Railway Engineering Association, the two organizations having the same officers, covers broadly the civil-engineering activities of the railways. The standardization work in which the two associations are engaged, and which they have accomplished, is very extensive, both in scope and in amount. Mr. E. A. Frink, of the Seaboard Air Line Railway, who is chairman of the standardization committees of the two associations, is the representative of the American Railway Association (Engineering Division) upon the American Engineering Standards Committee.

These two new member bodies bring the total number of national organization represented upon the American Engineering Standards Committee up to twenty-eight, and of representatives to fifty-two.

NEWS OF OTHER SOCIETIES

American Society of Heating and Ventilating Engineers

Many important scientific as well as practical contributions to our knowledge of heating and ventilation were presented at the Twenty-eighth Annual Meeting of the American Society of Heating and Ventilating Engineers held at the Pennsylvania Hotel, New York, January 24 to 26, 1922. The attendance at this meeting was over four hundred. There were five professional sessions, the usual business meeting and a conference of chapter representatives with the National Committee on Chapters. Important committees reporting were those on Code of Ethics, on Legislation and on Revision of the Constitution.

The technical papers were published in the January issue of the Journal of the Heating and Ventilating Society. They included: Improvements in the Process for Cleaning and Drying Air Mechanically by William J. Baldwin; Standardized Method of Measuring Fan Delivery by E. N. Fales; Current Research in Heating and Ventilating by F. Paul Anderson; A Study in Heat Transmission with Special Reference to Building Materials by F. C. Houghton; Temperature, Humidity and Air Motion Effects in Ventilation, by O. W. Armspach and Margaret Ingels; The Control of Blower Motors by Henry G. Issertell; The Under-Feed Stoker by Frank A. DeBoos; and Heat Transfer for Conduction and Convection by W. K. Lewis, W. H. McAdams and T. F. Frost.

The officers elected for the new year were J. R. McCool, President, H. P. Gant, First Vice-President, Samuel E. Dibble, Second Vice-President, Homer Addams, Treasurer, and C. W. Obert, Secretary.

The usual entertainment features included the annual dinner-dance at the Hotel Pennsylvania, a reception-dance and functions for the ladies.

American Society of Civil Engineers

The sixty-ninth annual meeting of the American Society of Civil Engineers, held in the Engineering Societies Building, New York, January 18–20, 1922, was devoted to the subject of Transportation, one technical session being on Water Transportation, one on Railroad Transportation, and three on Highway Transportation. A large proportion of the speakers, many of whom were experts in financial and economic subjects, dealt with the economic side. At the evening session of January 19, Mr. Frank A. Vanderlip, former President of the National City Bank, delivered an address on World Activities and their Effect upon the Engineer. These features emphasized the financial aspect of the meeting, which is quite important at this time to civil engineers, since millions of dollars of contracts for civil-engineering work are being held in abeyance pending the world-wide adjustment of the financial situation.

A feature of interest at the meeting was the conferring of Honorary Memberships on five distinguished engineers, M. Charles Prosper Eugene Schneider, of Paris; Dr. Luigi Luiggi, of Rome; and Messrs. Samuel Rea, Ambrose Swasey and Howard A. Carson. M. Schneider was the recipient of the John Fritz Medal presented to him in Paris last year by the Delegation of American Engineers to Europe, and both he and Mr. Swasey are Honorary Members of The American Society of Mechanical Engineers.

Mr. John R. Freeman, Past President, Am.Soc.M.E., was elected President of the Society for the coming year.

Excursions of the meeting included visits to the Stock Exchange, the foundations of the new Federal Reserve Building, the Plant of the McGraw-Hill Publishing Company, and the Hell Gate Power Station of the United Electric Light & Power Co.

Among the speakers at the technical sessions were: Dr. Emory R. Johnson, Dean, Wharton School of Finance and Economy, University of Pennsylvania; R. H M. Robinson, President, United American Lines; Winthrop L. Marvin, Vice-President and General Manager, American Steamship Owners' Association; Samuel O. Dunn, Editor, *Railway Age;* Howard Elliott, Chairman, Northern Pacific Railway Company; William N. Doak, Vice-President, Brotherhood of Railroad Trainmen; Col. F. A. Molitor, Chairman, Board of Economics and Engineering, National Association of Owners of Railroad Securities, together with a number of Commissioners of State Highway Departments of the Eastern States and officials of various financial institutions, as well as several representatives of motor vehicle associations.

Society of Automotive Engineers

The nineteenth annual meeting of the Society of Automotive Engineers was held in New York City, January 10-13, during Automobile Show week. The outstanding feature was emphasis on research in current engineering and this was evident not only in the session devoted to that field, but in the discussions on many of the other subjects.

At the meeting of the Committee on Standards which was the first event following registration, there was a tendency toward revising old standards rather than adopting new ones. An evening session on airplane engines was devoted to the consideration of a paper on Air-Cooled Engines by Charles L. Lawrence, in which he laid particular stress on the relation of cylinder construction to satisfactory cooling.

The Annual Business Meeting on Wednesday morning opened by President David Beecroft with an account of the accomplishments of the Society during this period of Service. The balance of the session was devoted to a review of the general activities of the Society.

Among other items of interest, vice-president H. M. Crane read a report in which he pointed out the commercial achievements in aviation during 1921 and regretted the general handicap of inadequate terminal facilities which must be removed before commercial aviation can be a reality on a large scale. Vice-President Harry L. Horning gave a paper on the desirability of international affiliation of engineers in view of the general economic problems which the world is facing.

The retiring President, in his valedictory, emphasized the opportunities and responsibilities of the engineering profession in the present day. He stressed the need for professional solidarity in meeting the technical phases of the economic problems of reconstruction. The meeting was adjourned after a few remarks by the incoming President, B. B. Bachman of Philadelphia.

In the afternoon three simultaneous sessions were held, covering Body Engineering, Motor Truck Transportation and Lubrication. In the latter Winslow H. Herschel, Associate Physicist of the Bureau of Standards, presented a paper on Viscosity and Friction, one on Fluid Friction and Transmission Efficiency was read by Neal MacCord, and Robert Wilson and W. P. Barnard, 4th, gave The Mechanism of Lubrication.

Technically, at least, the high point of the meeting was reached on Thursday when at a research session the whole morning was given up to Harry Ricardo, the distinguished British engineer whose research work on the factors affecting combustion has attracted so much attention. His paper dealt with the effect of latent heat of vaporization, mean volatility, temperature, pressure, dilution, mixture strength, stratification and other factors upon combustion, and especially the detonation of various fuels for gas engines.

Simultaneous sessions were again held in the afternoon. At one on Fuel and Engines, O. C. Berry and C. S. Kegerreis presented Manifold Vaporization and Exhaust Gas Temperatures; Methods of Measuring Detonations in Engines by Thomas Midgley, Jr., and T. A. Boyd was read; and a paper on Spectroscopic Investigation of Internal Combustion by Thomas Midgley, Jr., and W. K. Gilkey. The other sessions covered Materials and included a paper by C. N. Dawe, on Chrome-Molybdenum-Steel Applications from the Consumer's Viewpoint. G. R. Norton presented Continuous Die Rolling; J. H. Nelson read his paper on Drop-Forging Practice and Enrique Touceda gave Pertinent Facts Concerning Malleable-Iron Castings.

At a Passenger Car Session Friday morning papers by J. Edward Shipper on Passenger Car Brakes; S. von Ammon on Developing a Method for Testing Brake-Lining; and Augustus Trowbridge on Photographic Recording of Engine Data were read.

The meeting was considered the most successful of its kind ever held by the Society and more than seven hundred were in attendance at the technical sessions. The social events included a dinder and carnival at the Hotel Astor.

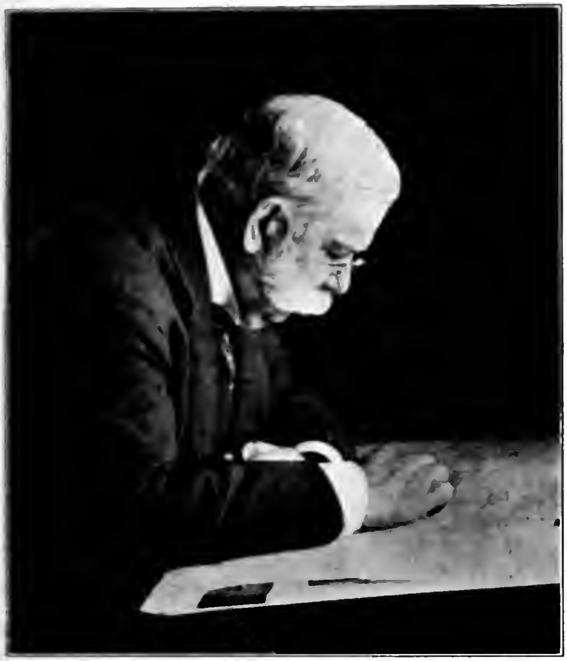
The Life of Westinghouse

By Henry G. Prout, C.E., A.M., LL.D.

A Review by Harrison W. Craver, Director Engineering Societies' Library

SOME years ago the American Society of Mechanical Engineers published the autobiography of John Fritz. It is now responsible for recording in permanent fashion the record of another great engineer, by the publication of this handsome volume.

George Westinghouse was a man of great endowments. Strong of body, distinguished in appearance, he possessed mental powers far superior to those of most men. Formal education he never had: before he was seventeen he enlisted during the Civil War and after being mustered out, two years later, he preferred work in his father's machine shop to a college course. From the close of his military career in 1865, until his death in 1914, he was never idle, but was absorbed in a life of inventing and manufacturing.



A Familiar Picture of George Westinghouse at Work

Such a busy life it was. Merely as an inventor, his record of a patentable invention every six weeks for forty-eight years is one that few inventors have equaled. But invention was for Westinghouse only a preliminary to manufacturing. His patents were for things to be made in his shops or used in his industries, and upon them he based a series of companies. His biographer lists 103 which he organized or assisted during their formative years. They covered America and Europe, and most of them, in one form or another still exist.

The two great achievements by Westinghouse were his solution of the problem of power braking, and his early grasp of the advantages of the alternating current for power distribution. The story of the air brake, from its inception to the perfected mechanism, is well and graphically recounted in this book. It was the first activity that brought Westinghouse into prominence and gave him fame, its supremacy has never been seriously challenged and it remains a monument to its inventor which seems to possess every quality of permanence.

No less interesting is the account of the founding, and development of Westinghouse's electrical interests. The possibilities of the alternating current were seen at an early date, and Westinghouse spent money freely and boldly to uphold his opinion. The story occupies a large portion of the book, and shows how Westinghouse, early interested in electric lighting, turned his attention from direct to alternating current machinery and proceeded confidently and doggedly to prove that his judgment was sound. Step by step the motor, the rotary converter and the distributing system were brought to commercial success, and applied to power production and railroads.

These two main lines of activity by no means exhaust the record. Westinghouse was a pioneer in the development of railway signaling and interlocking, in the natural gas industry and in perfecting the steam turbine. Many minor industries grew up under his care. Wherever he went, he observed, thought and contributed.

Colonel Prout has done a difficult piece of work with great skill. Westinghouse wrote no letters, kept no notebooks and seldom delivered addresses. He left no records to assist his biographer, who has been forced to rely upon the material obtainable from his associates and his personal acquaintance. In spite of the handicap, the record is full and coherent; the man lives, and his achievements are shown in their proper proportions. The picture given places Westinghouse in his proper place in his generation, giving the book value, not only as a biography, but as a contribution to that history of American engineering which is so greatly needed.

The reader will derive additional pleasure from the style in which the book is written. Every line shows the author's intimate acquaintance with the matters of which he speaks, and his ability to express himself appropriately. Any one interested in the lives of our engineers and the history of technical progress in our country, will lay down this book with the hope that its author and the Society will undertake further work of this kind without delay.

[The Life of George Westinghouse was first published in a subscription edition offered to the membership of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers. A popular edition has been published by Charles Scribner's Sons and may be procured through your book seller.—Editor]

Book Notes

Airplane Engine. By Lionel S. Marks. First edition, McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 454 pp., diagrams., tables, $6.

This volume attempts to formulate existing knowledge of the functioning of the airplane engine and its auxiliaries, and to present and discuss the essential constructive details of those engines whose excellence has resulted in their survival. Most of the material is new, being based on the researches and developments that originated during the war. Professor Marks has summarized and arranged the detailed data on the engine designs used in various countries, so that it is in convenient form for the designer.

Atomic Theories. By F. H. Loring. E. P. Dutton and Co., New York, 1921. Cloth, 6×9 in., 218 pp., illus., $5.

The leading facts and theories relating to the atom, particularly those which, owing to their newness, have not yet been treated at any length in textbooks, are brought together in one volume for the convenience of students and investigators. The book covers a wide range of subjects. These include the quantum theory, Sir. J. J. Thomson's recent views of mass, matter and radiation, the Bohr theory, the octet theory, isotopes, the Brownian movement, ionization, potentials, solar phenomena and other subjects. References are given throughout, which enable the reader to follow any subject of special interest.

Construction, Cost Keeping and Management. By Halbert Powers Gillette and Richard T. Dana. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 5×8 in., 572 pp., forms, $5.

This book has been prepared in response to requests for a second edition of Cost Keeping and Management Engineering. It contains nearly all the original material, supplemented by that developed in the last twelve years. It is intended to assist in reducing construction costs to the minimum, by explaining the rules of management and setting forth suitable methods of cost keeping, adapted to engineering construction.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Industrial. The Prodigious Cost of Industrial Accidents, Sanford DeHart. Am. Mach., vol. 56, no. 1, Jan. 5, 1922, pp. 11–13, 3 figs. Statistics on cost of accidents. Instances of reductions in absenteeism and monetary losses. Examples of simple but efficacious safety methods and appliances.

ACCOUNTING

Municipal Utilities. Standard Accounting for Municipally Owned Public Utilities. Jl. Electricity & Western Industry, vol. 48, no. 1, Jan. 1, 1921, pp. 15–16. States that merits or demerits of municipal ownership cannot be determined until there is an adequate basis of comparison of cost of operation. No such basis exists today. Discusses possibility of concealment, challenging of statements, etc.

Power Plants. Power-Plant Accounts—XVI, Wilfred A. Miller. Power, vol. 54, no. 26, Dec. 27, 1921, pp. 1013–1015, 2 figs. General scheme of accounts. (Concluded.)

AIR

Liquefaction. Recent Developments in Low-Temperature Technique (Neuere Entwicklung der Tieftemperaturtechnik), F. Pollitzer. Zeit. für die gesamte Kälte-Industrie, vol. 28, no. 9, Sept. 1921, pp. 125–133, 12 figs. Deals with development of air liquefaction and its applications. Discusses the Linde process for production of very low temperatures, and gives examples of hydrogen-recovery and oxygen plants by the Linde Ice Machine Co., Höllriegelskreuth, Germany.

AIR COMPRESSORS

Displacement, Code for. Code for Displacement Compressors and Blowers. Mech. Eng., vol. 44, no. 1, Jan. 1922, pp. 45–48 and 70. Preliminary draft of fifth in series of 19 codes in course of preparation by A.S.M.E. Committee on power tests codes.

Electrically Driven. Modern Aspects in the Construction of Compressed-Air Power-Transmission Plants (Neuere Gesichtspunkte in der Ausführung von Pressluft-Kraftubertragungen). Elektrotechnische Rundschau, vol. 38, no. 11, June 7, 1921, pp. 63–65, 3 figs. Describes electric compressor constructed by German Gen. Elec. Co. (AEG) for 6000 cu.m. output per hr and 7 atmos. excess pressure, with driving motor of 1485 r.p.m. and 1000 hp.

Machining Components. Machining Air Compressor Components. Machinery (Lond.), vol. 19, no. 480, Dec. 8, 1921, pp. 277 284, 17 figs. Review of methods employed by Reavell & Co., Ltd., Ranelagh Works, Ipswich

Marine Diesel Engines. Design of Air Compressors for Marine Engines, David Bruce. Motorship, vol. 7, no 1, Jan. 1922, pp. 22 24, 11 figs. Discusses compressing and cooling, single-stage and multiple-stage, compressor capacity, spring loads on compressor valves, etc.

AIRCRAFT

British. Modern British Aircraft. Flight, vol 13, no. 45, Nov. 10, 1921, pp. 726 740, 36 figs. Deals with all the British firms at present engaged in airplane and seaplane construction.

AIRCRAFT CONSTRUCTION MATERIALS

Fabric Coverings. The Aging of Aircraft Fabric Coverings (Das Altern des Flugzeugbespannungsstoffes), Fr. Wendt. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 22, Nov. 30, 1921, p. 325. Based on results of tensile tests with old cellonized covering fabric from upper and lower part of aerofoil and body of an airplane, the loss of strength due to meteorological influences are critically discussed.

AIRPLANE ENGINES

American Pursuit. Development of an American Pursuit Engine. Aviation, vol. 11, no. 26, Dec. 26, 1921, pp. 735–738, 2 figs. Describes developments from the Hispano to the Wright super-fighter developing 400 hp. at 2000 r.p.m. and weighing 610 lb.

British. Modern British Engines. Flight, vol. 13, no. 46, Nov. 17, 1921, pp. 750–757, 21 figs. Describes all the British aero engines being manufactured at present.

Curtiss. The Curtiss Model CD-12 400 hp. Aeronautical Engine. Aerial Age Weekly, vol. 14, no. 12, Nov. 28, 1921, pp. 273–276, 4 figs. Designed primarily for a pursuit engine to give super-performance in high-speed airplanes and now considered past the experimental stage. Detailed description and specifications.

Requirements. The Aeroplane Engine, P. E. Biggar. Eng. Inst. Can. Jl., vol. 5, no. 1, Jan. 1922, pp. 15–21, 8 figs. Requirements of aircraft propulsion and their effect on engine design.

AIRPLANES

Aerofoils. Aerodynamic Characteristics of Aerofoils—II. Nat. Advisory Committee for Aeronautics, report no. 124, 1921, pp. 89–140, 165 figs. Collection of data on aerofoils made from reports of number of leading aerodynamic laboratories of United States and Europe, and presented in a uniform series of charts and tables suitable for use of designing engineers and purpose of general reference. Continuation of Report no. 93.

Developments in Aircraft Design by the Use of Slotted Wings, F. Handley Page. Flight, vol. 13, nos. 51 and 52, Dec. 22 and 29, 1921, pp. 844–846 and 860–861, 17 figs. Deals with applications of slotted aerofoils. Results of tests.

Caproni Triplane. The 2000-Hp. Caproni Triplane (Funfmotoren-2000-PS-Caproni-Dreidecker), E. Meyer. Zeit. für Flugtechnik u. Motorluft-schiffahrt, vol. 12, no. 22, Nov. 30, 1921, pp. 331–332, 4 figs. Machine, which is development of Caproni 3-engine commercial airplane, has five Isotta-Fraschini 400-hp. engines, speed of 140 to 150 km. per hr., and fuel consumption of 200 kg. per hr.; carrying capacity, 30 passengers and 2 pilots. Comparison with German airplanes with 4, 5 and 6 engines.

Commercial Operation. Commercial Operation of Airplanes, L. B. Lent. Mech. Eng., vol. 44, no. 1, Jan. 1922, pp. 33–37. Analysis of record of Air Mail Service of U. S. Post Office Dept. for year ending Sept. 30, 1921. Author points out possible improvements, most important being use of efficient commercial planes equipped with thoroughly reliable power plant. Total operating cost, it is claimed, should not exceed 70 cents per plane-mile for single-engine planes of not over 400 hp.

Landing. The Maneuvers of Getting Off and Landing, R. M. Hill. Aerial Age Weekly, vol 14, nos. 10, 12, 13 and 15, Nov. 14, 28, Dec. 5 and 19, 1921, pp 228 230, 277–278, 300–302 and 348–350. Discusses in detail factors which influence getting off and landing. Lecture delivered before British Aeronautical Soc. See also discussion of above paper in Aeronautical Jl., vol. 25, no. 132, Dec. 1921, pp. 665–671.

Langley. The Langley Machine and the Hammondsport Trials. Aeronautical Jl., vol. 25, no. 132, Dec. 1921, pp. 620–647 (includes discussion), 20 figs. Discusses original Langley flying machine of 1903, and shows that the wings collapsed through faults in design and not from any failure in launching mechanism.

Mars I. Mars I's Wonderful Performance at Martlesham—212 M.P.H. Flight, vol. 13, no. 51, Dec. 22, 1921, p. 838, 1 fig. Built by Gloucestershire Aircraft Co. Results of tests.

Netherlands. New Dutch Airplanes (Neue holländische Flugzeuge), Werner v. Langsdorff. Motorwagen, vol. 24, no. 31, Nov. 10, 1921, pp. 688–692, 4 figs. Details of various models with special reference to the Fokker F III model brought out in 1921, with following specificatious: Span, 16 m.; length, 10.3 m.; height, 3.2 m.; supporting surface, 42 sq. m.; engine, 185-hp. B.M.W. or 230-hp. Siddeley Puma; weight empty, 1200 kg.; loaded, 1900 kg.; carrying capacity, 5 passengers.

New Types. Work of McCook Field in 1921, T. H. Bane. Aviation, vol. 12, no. 2, Jan. 9, 1922, pp. 41–42. Describes new types of airplanes, engines and equipment developed and tested.

Pressure Distribution over Tail Surfaces. The Pressure Distribution over the Horizontal Tail Surfaces of an Airplane—I. Nat. Advisory Committee for Aeronautics, report no. 118, 1921, 86 pp., 264 figs. Account of investigation to determine pressure distribution over two horizontal tail surfaces in uniform free flight.

The Pressure Distribution over the Horizontal Tail Surfaces of an Airplane—II. Nat. Advisory Committee for Aeronautics, report no. 119, 1921, 40 pp., 85 figs. Shows that results obtained upon model tail surfaces can be used to accurately predict loads upon full-sized tail and also to find distribution of load when large elevator angles are used.

Tropical Countries. Aeroplanes in Tropical Countries, Brooke-Popham. Aeronautical Jl., vol. 25, no. 131, Nov. 1921, pp. 563–577 and (discussion) 577–580, 1 fig. Discusses particular troubles that are experienced with airplanes and engines in tropical climates, especially in Egypt and Mesopotamia, viz. timber shrinkage, propellers, tires, shock absorber petrol supply, and hangars.

Wind-Tunnel Tests. Using Results of Tests in the Wind Tunnel for Calculating Full-Size Airplanes (Utilisation des résultats des essais faits sur petits modèles au tunnel aérodynamique pour le calcul des avions en vraie grandeur), E. Dorand. L'Aerophile, vol. 29, no. 19 20, Oct. 1 15, 1921, pp. 290–292. States that the laws of similitude do not apply exactly as between small and large models and proposes corrections necessary.

Zeppelins. Giant Airplanes of the Staaken Zeppelin Works (Grossflugzeuge der Zeppelinwerke Staaken), E. Meyer. Schweizerische Bauzeitung, vol. 78, nos. 24 and 26, Dec. 10 and 24, 1921, pp. 283–286, and 307 309, 13 figs. Dec. 10: Characteristics of Staaken R VI: Span, 42.2 m.; length, 22.2 m.; height, 6.5 m.; engines, four 260-hp. Mercedes, and one 12-hp. Mercedes for drive of a compressor installation; weight empty, 9000 kg.; total weight, 11,600 kg.; max. speed, 160 km. per hr.; climb to 3000 m., 66 min. Dec. 24: The 1000-hp. all-metal com-

---

Note.—The abbreviations used in indexing are as follows.

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

mercial monoplane, type 1920, with 31 m span and 3500-kg carrying capacity, weight empty, 5000 kg; speed, 211 km. per hr., cabin capacity, 12 passengers.

AIRSHIPS

Colonial Service. Organisation of a Colonial Airship Service, V. C. Richmond. Aeronautical Jl., vol 25, no. 131, Nov 1921, pp. 588-615, 3 figs. Reviews activities in America, France and Germany; comparative value of airships and airplanes for an imperial air service, discusses general, technical, flying, and financial organisation, etc.

Mooring Masts. A Portable Airship Mooring Mast. Aviation, vol. 11, no. 26, Dec. 26, 1921, p. 732, 1 fig. Describes U. S. Army Air Service mast consisting of four sections of 18 ft. each, capable of mooring ships up to 1,200,000 cu. ft. capacity.

Vacuum as Lifting Power. The Variable Vacuum Dirigible, System Vaugean-Gargiulo (Projet de dirigeable, système Vaugean-Gargiulo, à raréfaction variable), E. Garuffa. Le Génie Civil, vol. 79, no. 25, Dec. 17, 1921, pp. 536-541, 13 figs. Describes model exhibited at International Exposition and discusses principle of application of partial vacuum as an ascensive force. A crude-oil two-stroke engine used for driving.

Vacuum Dirigibles (I dirigibili a rarefazione—Il sistema Vaugean a rarefazione variabile), E. Garuffa. L'Industria, vol. 35, no. 19, Oct. 15, 1921, pp. 421-425, 10 figs. Describes the Vaugean system of airships depending on a partial vacuum for lifting power, which is variable and adjustable.

Zeppelin. The Zeppelin Commercial Airship "Nordstern" (Das Verkehrsluftschiff "Nordstern" des Luftschiffbau Zeppelin). Luftfahrt, vol. 25, no. 8, Aug. 1921, pp. 136-139, 6 figs. Specifications of airship built in 1919 and delivered to France in June 1921. Max length, 130.8 m; max. diam. of supporting structure, 18.71 m; max. cross-section, 268.7 sq. m., max height, 21.62 m; gas capacity, 22,550 cu. m., covering is of cotton material entirely cellonised, engine plant includes one 2-engine and two single-engine nacelles, carrying capacity, 30 passengers, crew, 16 to 18.

ALLOYS

Fusible. Fusible Alloys (Les Alliages fusible), Sigma. La Metallurgie, vol. 53, no. 46, Nov. 17, 1921, pp. 2145-2147. Gives list of compositions for anti-friction metals, solders, and other alloys.

[See also ALUMINUM ALLOYS, IRON ALLOYS; LEAD ALLOYS.]

ALUMINUM ALLOYS

Aluminum-Iron, etc. Aluminum Alloys (Note supplémentaire sur les alliages d'aluminium), Léon Guillet. Revue de Metallurgie, vol. 18, no. 10, Oct. 1921, pp. 681-684, 4 figs. Deals with aluminum-iron, aluminium-chromium, aluminium-manganese, and aluminium-cerium.

Aluminum-Zinc. The Thermal Expansion of Aluminum-Zinc Alloys (Ueber die Wärmeausdehnung der Aluminum-Zink-Legierungen), Alfred Schulze. Physikalische Zeit., vol. 22, no. 14, July 15, 1921, pp. 403-406, 1 fig. Results of experimental determinations which were made according to the tube method.

Mechanical Properties. Aluminium and its Alloys—IV, F. A. Livermore. Metal Industry (Lond.), vol. 19, no. 22, Nov. 25, 1921, pp. 420-421 and 422, 1 fig. Alloys of aluminum and copper, and aluminum and zinc, and their mechanical properties and application.

Melting. Aluminium and Its Alloys—V, Frank A. Livermore. Metal Industry (Lond.), vol. 19, no. 25, Dec. 16, 1921, pp. 496-500, 7 figs. Deals with difficulties in melting and discusses the question of pyrometric control.

Ternary Systems. Ternary Aluminum Alloys (Ueber ternäre Aluminiumlegierungen), M. Wachlert. Metall u. Erz, vol. 18, no. 12, June 22, 1921, pp. 298-307, 7 figs. From the ternary systems, copper-zinc-aluminum, copper-tin-aluminum, and iron-zinc-aluminum, alloys with maximum content of 12 per cent of heavy metal in question were produced by means of ingot casting. With their help, structure, specific weight, physical properties and formation of cutting are determined.

AMMONIA

Ammonia-Soda Process. The Heat Balance in the Ammonia-Soda Process (Die Wärmebilanz im Ammoniaksodaprozess), H. Voss. Chemiker-Zeitung, vol. 45, nos. 117 and 120, Sept. 29 and Oct. 6, 1921, pp. 940-942 and 968-970, 1 fig. Notes on chemical part and working order of process, for which attempt is made to formulate a heat balance. Lime-kiln operation, carbonic-acid compressor, ammonia compressor, etc.

Liquid, Specific Volume. Specific Volume of Liquid Ammonia, C. S. Cragoe and D. R. Harper. U. S. Bur. of Standards Sci. Papers, no. 420, Oct. 15, 1921, pp. 287-315, 3 figs. Specific volume—that is, numerical reciprocal of density—of pure liquid ammonia under pressure corresponding to saturation conditions was determined throughout temperature interval −78 to +100 deg. cent., with accuracy of about 1 part in 10,000. Review of previous work is included. Tables of specific volume and density in both metric and English units are appended.

Synthesis. The Claude Synthetic Ammonia Process, Nov. 26, 1921, pp. 665-666 and (discussion) 666-668, J. H. West. Chem. Age (Lond.), vol. 5, no. 128, Discusses catalyst vessels, catalyst material, removal of ammonia from catalyst tubes, cheap hydrogen, and industrial uses of synthetic ammonia.

ANEMOMETERS

Testing. The Testing of Anemometers, James Cooper. Trans. Instn. Min. Engrs., vol. 62, Part I, Nov. 1921, pp. 90-99, 9 figs. Discusses results of tests showing that anemometric measurements are unreliable, especially at the working-faces where exact knowledge is necessary. See also Min. Inst. of Scotland Trans., vol. 42, Part 2, 1921-1922, pp. 44-53, 9 figs.

APPRENTICES, TRAINING OF

Present Scope, U. S. The Training of Workers in manufacture, J. V. L. Morris. Am. Mach., vol. 56, no. 3, Jan. 19, 1922, pp. 85-86. Present scope of apprenticeship in United States. Number of apprentices in various industries. Importance of apprentices in metalworking field.

ASH HANDLING

Power Plants. Ash Handling in Large Generating Stations, L. R. Lee. Power, vol. 55, no. 3, Jan. 17, 1922, pp. 86-90, 6 figs. Deals with handling and disposition of furnace ash, describes several designs of ashpits and points out merits or demerits of each. Describes different methods of ash disposal and provisions that must be made in case there is a failure in operation of ash-disposal system employed.

AUTOGENOUS WELDING

Acetylene Pressure Apparatus. Acetylene Pressure Apparatus in Switzerland (Acetylendruckapparate in der Schweiz). Autogene Metallbearbeitung, vol. 14, no. 21, Nov. 1, 1921, pp. 303-306, 8 figs. Details and operating experiences with high-pressure acetylene plants constructed by Kneubühler & Co., Zürich. Plants installed by Escher-Wyss, Zürich, and other firms have given satisfactory service.

Pipe. Autogenous Pipe Welding, H. B. Iglehart. Welding Engr., vol. 6, no. 11, Nov. 1921, pp. 21-24, 16 figs. Describes tests on welded pipe construction and shows advantages of welded joints.

AUTOMOBILE ENGINES

Chemical Control. A Chemically Controlled Automobile, George Granger Brown. Jl. Indus. & Eng. Chem., vol. 14, no. 1, Jan. 1922, pp. 6-12, 20 figs. Concludes that the combustion or explosion of a gasoline-air mixture is essentially a complex chemical reaction and as such is susceptible to chemical control. The most important consideration is the velocity of reaction, which is determined by concentration, turbulence, and temperature. Paper read before Am. Chem. Soc.

Detonation, Measuring. Methods of Measuring Detonation in Engines, Thomas Midgley, Jr. and T. A. Boyd. Soc. Automotive Engrs. Jl., vol. 10, no. 1, Jan. 1922, pp. 7-11, 4 figs. Discusses various methods employed to measure detonation or fuel knock, such as the listening indicator, temperature and pouncing pin, and describes latter method.

Mitchell. Entirely New Design Embodied in Mitchell Engine. Automotive Industries, vol. 45, no. 24, Dec. 15, 1921, pp. 1158-1160, 6 figs. New features include balanced crankshaft, hot-spot manifold, unusually light cast-iron pistons, pressure-feed lubrication of main bearings, improved combustion-chamber form and thermostatic valve in cooling system.

Poppet-Valve. Italian Manufacturer Reverts to Poppet Valve Engine. Automotive Industries, vol. 45, no. 25, Dec. 22, 1921, pp. 1205-1208, 9 figs. Rotary valve abandoned in new 176-cu. in. four-cylinder engine which is said to develop 43 hp. at 2500 r.p.m. Large jacket space, aluminum pistons, tubular connecting rods, and four-speed gearset. Integral pressed-steel housing used for axle and propeller shaft.

Radiators. Radiator Vent Pipes. Autocar, vol. 47, no. 1365, Dec. 17, 1921, p. 1245, 3 figs. Shows how it is possible to prevent water from escaping out of radiator through vent pipe.

Rickenbacker. Original Engineering Features in New Six-Cylinder Car, J. Edward Schipper. Automotive Industries, vol. 45, no. 26, Dec. 29, 1921, pp. 1258-1261, 7 figs. Describes new Rickenbacker motor made by Rickenbacker Motor Co., Detroit. Extra flywheel at front of engine is said to minimize vibration and permit wide speed range on high gear. Cone clutch running in oil is employed.

AUTOMOBILE FUELS

Calorific Values. Royal Aircraft Establishments Reports, Nos. H. G. 410 and H. 861. Instn. Petroleum Technologists Jl., vol. 7, no. 28, Oct. 1921, pp. 339-351, 5 figs. Methods of determining calorific values of certain unsaturated hydrocarbons; and calorific values of petrols and of petrol fractions.

Sensible Fuels. Total Sensible Heats of Engine Fuels and Their Mixtures with Air, Robert E. Wilson and Daniel P. Barnard. Soc. Automotive Engrs. Jl., vol. 10, no. 1, Jan. 1922, pp. 65-68, 5 figs. Describes methods used by research laboratory of Mass. Inst. of Technology in determining total sensible heat content of Socony gasoline and kerosene and their mixtures with air at temperatures up to 500 deg. cent.

AUTOMOBILES

Front Axles, Machining. Front Axles and Steering Knuckles, Fred H. Colvin. Am. Mach., vol. 55, no. 25, Dec. 22, 1921, pp. 1011-1013, 10 figs. Machining operations of Peerless axle. Spring actuated drilling fixtures which are quickly handled. Holding long work for milling. Automatic lathe work on steering knuckles.

Gear Boxes. Notes on Motor Car Gear-Boxes., H. F. L. Orcutt. Engineering, vol. 112, nos. 2920, 2921 and 2922, Dec. 16, 23 and 30, 1921, pp. 830-831, 870-872 and 897-899, 8 figs. In writer's opinion, based on over 10 years' experiences, gear boxes, generally speaking, are not well designed and are badly made. Discusses defects in design, workmanship and material, and summarizes gear-tooth requirements. Paper read before Instn. Automobile Engrs. (British.)

Halley Chassis. The 35 Hp Halley Chassis. Automobile Engr., vol. 11, no. 156, Nov. 1921, pp. 370-377, 21 figs. Has six-cylinder engine of 1,200 r.p.m. Describes clutch, gearbox, transmission and rear axle, etc.

L. Paulet. The Six Cylinder L. Paulet (La Six Cylindres L. Paulet), H. Petit. La Vie Automobile, vol. 17, no. 743, Dec. 10, 1921, pp. 467-469, 4 figs. Describes engine, speed gear, transmissions, brakes and wheels, etc.

Painting and Varnishing. Manufacture and Application of Automobile Varnishes and Paints, L. Valentine Pulsifer. Soc. Automotive Engrs. Jl., vol. 10, no. 1, Jan. 1922, pp. 12-16. Specifies five basic materials necessary in automobile painting. Engineering systems of application and methods of application, including drying and surfacing. Care of finish.

Rolls-Royce Works. Rolls-Royce Methods. Eng. Production, vol. 3, nos. 63, 64 and 65, Dec. 15, 22 and 29, 1921, pp. 565-569, 589-596 and 613-618, 44 figs. Details of plant and production methods.

Service Methods. Automotive Service Methods and Equipment, Howard Campbell. Am. Mach., vol. 55, no. 26, Dec. 29, 1921, pp. 1026-1028, 10 figs., and vol. 56, no. 2, Jan. 12, 1922, pp. 59-61, 8 figs. Servicing the Rolls-Royce. Describes interesting grinding job. Kelly-Springfield truck service methods and tools. Servicing the Mack truck. Operation in a New York taxicab station.

AVIATION

Commercial. State of Commercial Aviation (Ou en est l'aviation commerciale), Roger Couturier. L'Aérophile, vol. 29, no. 21-22, Nov. 1-15, 1921, pp. 322-332, 7 figs. Discusses landing facilities, air posts, signals, French air regulations and air-lines in operation.

Development. The Trend of Aviation Development, J. G. Vincent. Soc. Automotive Engrs. Jl., vol. 10, no. 1, Jan. 1922, pp. 25-30. Discusses influences that are retarding development of aviation in an effort to point out the limitations that exist as differentiated from misconceived non-existent limitations and to indicate remedial measures to stimulate a vigorous growth of aviation.

B

BARRELS

Steel. The Making of Steel Pitch Barrels. Sheet Metal Worker, vol. 12, no. 25, Jan. 6, 1922, pp. 841-843, 15 figs. Describes equipment and operations for fabricating steel pitch barrels as modern shipping containers.

BEAMS

Broad-Flange. Production of Broad Flange Beams of the Grey Type at the Differdange Works [La fabrication des poutrelles a larges ailes du type Grey, aux Usines de Differdange (Luxembourg)], J. Audigé. Le Génie Civil, vol. 79, no. 21, Nov. 19, 1921, pp. 437-439, 9 figs. Discusses characteristics of Grey profiles; successive passes through different rolls for broad parallel flange beams.

Continuous. Calculation of Continuous Beams (Le calcul des portiques continus), L. Descans. Le Génie Civil, vol. 79, nos. 21 and 22, Nov. 19 and 26, 1921, pp. 439-443, and 461-464, 12 figs. Nov. 19: Discusses characteristics of continuous beams, calculation of loads, etc. Nov. 26: Analytical formulas.

Deflection. Deflections of Beams by the Conjugate-Beam Method, H. M. Westergaard. Jl. Western Soc. of Engrs., vol. 26, no. 11, Nov. 1921, pp. 369-396, 28 figs. Discusses standard methods, statically determinate beams, and statically indeterminate beams.

BEARINGS, ROLLER

Railway Cars. Ball and Roller Bearings for Railway Cars (Kugel- und Rollenlager für Schienenfahrzeuge), H. Behr. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 49, Dec. 3, 1921, pp. 1260-1264, 20 figs. Explains reasons for introducing roller bearings. Suggestions for selection of suitable bearings. Roller bearings are said to have better load conditions than ball bearings. Describes new German types of bearings and discusses foreign types and their defects.

BELTING

Leather. Problems In Connection with Leather Belting, J. Edgar Rhoads. Can. Machy., vol. 26, no. 25, Dec. 22, 1921, pp. 24-25. Use of roller and ball bearings; common causes of trouble; humidity and its effect.

Reclaimed Leather. Reclaimed Leather Belting. Machy. (N. Y.), vol. 28, no. 5, Jan. 1922, pp. 363-365, 6 figs. Use of salvaged leather belts reinforced with woven cotton fabric. Processes employed by Syracuse Belting Co. in manufacture of reclaimed belting.

BENDING MACHINES

Cup-Leather Sleeve Friction. Friction of Cup-Leather Sleeves, Eugen Irlon. Mech. Eng., vol. 44, no. 1, Jan. 1922, pp. 59-60, 2 figs. Presents data of tests of friction carried out in a 75-ton hydraulic bending machine water-driven by a three-piston electric pump. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 39, Sept. 24, 1921, pp. 1016-1017.

BLIND

Employment. Employment of War-Blinded in German Industries, Hubert Hermanns. Am. Mach., vol. 55, no. 26, Dec. 29, 1921, pp. 1023-1025, 6 figs. Methods used to enable blind ex-soldiers to live inde-

pendent of charity. Machine operation in manufacturing plants.

BOILER FEEDWATER

Distilled. Distilled Water for Boiler Feed at River Rouge Plant. Power, vol. 54, no. 26, Dec. 27, 1921, pp. 998–1003, 10 figs. Elaborate two-effect high-heat-level evaporator system furnishes distilled makeup to an amount up to 25 per cent of boiler feed.

Softening. Softening and De-oxygenation of Boiler Feed Water. Chem. Age (Lond.), vol. 5, no. 130, Dec. 10, 1921, pp. 726–728. Discusses comparative merits of water-softening systems, importance of effecting oxygen removal, and chemical and physical methods for performing de-oxygenation.

BOILER OPERATION

Efficient. Better Boiler Room Operation, C. W. De-Forest. Combustion, vol. 5, no. 6, Dec. 1921, pp. 246–248 and 260. Discusses investment cost; cost of fuel; and organization, personnel, supplies and maintenance costs. Paper read before Stoker Manufacturers Assn.

BOILER PLANTS

Battle Creek Sanitarium. New Boiler Plant for Battle Creek Sanitarium. Power, vol 55, no. 2, Jan. 10, 1922, pp. 46–49, 6 figs. Installation of modern boiler house saved 10 tons of coal a day and eliminated services of 9 men from operating force. Includes full complement of instruments giving all essential operating data.

Electricity in. Electricity in Steam-Boiler Plants (Elektrizität in Dampfkesselanlagen), W. Philippi. Siemens-Zeit., vol. 1, nos. 9 and 10, Sept. and Oct. 1921, pp. 312–321 and 373–380, 21 figs. Sept.: Deals with pneumatic ash-removal installations. Oct.: Electrolytic protection of boilers against scale and corrosion. Describes method, success of which is said to have surpassed all expectations. Consists of externally generated direct current, applied through electrodes into boiler.

Management. Boiler House Management, David Brownlie. Proc. South Wales Inst. Engrs., vol. 37, no. 5, Nov. 10, 1921, pp. 405–438. Types of boilers and their relative advantages and disadvantages; mechanical stoking; economizers and feedwater heaters; superheaters; forced and induced draft; auxiliary machinery.

BOILER ROOMS

Air Supply. The Air Supply to Boiler Rooms, Richard W. Allen. Eng. & Indus. Management, (Cassier's Marine No.), Dec. 1921, pp. 35–42, 9 figs. One of most important points is that there should be equal distribution of preheated air to furnaces, so that no currents are set up and each furnace receives equal supply of air. Author deals with this problem. Results of trials taken under same conditions on one class of ship over period of four years show gains effected in each year as experience is accumulated.

BOILERS

Design. Boiler Design and Other Fuel Efficiency Factors, F. G. Lister. Ry. Rev., vol. 70, no. 1, Jan. 7, 1922, pp. 5–8, 4 figs. Discusses fuel efficiency of locomotives by attention to mechanical details. Longer combustion chambers; flexible staybolts; tight front ends; floating bushings; automatic stokers; etc.

BOMBS

Bombing and Bomb Sights. Bombing and Bombing Sights, E. J. Loring. Sci. Am., vol. 126, no. 1, Jan. 1922, pp. 49–51, 6 figs. How aiming from unstable platform of airplane is made possible.

BORING MACHINES

Standardization. Standardization and Assimilation—II, H. Varley. Eng. & Indus. Management, vol. 6, no. 23, Dec. 8, 1921, pp. 650–652, 1 fig. A scheme of standardized boring practice.

BRASS

Corrosion. The Problem of Selective Corrosion and Dezincing of Brass (La problème des corrosions sélectives et de la dézincification des laitons), F de. Wurstemberger. Révue de Metallurgie, vol. 18, no. 11, Nov. 1921, pp. 689–712, 26 figs. Discusses in detail dezincing process and concludes that it consists of two factors, anodic dissolving of the metal and cathodic deposition of copper. Gives results of tests and indicates protective means.

BRONZE CASTINGS

Manganese. Investigation of Methods of Making Manganese Bronze Castings to Meet Air Service Specification No. 11021. Air Service Information Circular, vol. 3, no. 275, Oct. 15, 1921, 28 pp., 9 figs. For purpose of developing satisfactory method for making manganese bronze in small foundry; standardizing method of separately casting test specimens as a check on melts of small castings of this metal; and determining best physical properties obtainable in manganese bronze as determined by this standard test bar, and comparing these with results obtained on test bars cut from actual castings.

BRONZES

Manganese. Manganese Bronze, Frank A. Livermore. Metal Industry (Lond.), vol. 19, no. 23, Dec. 2, 1921, pp. 445–446. Shows that manganese bronze may be manufactured from scrap metal without resorting to use of high grade virgin metal.

C

CAR LIGHTING

Methods. Railway Car Lighting (L'éclairage des voitures de chemins de fer), M. Bougrier. L'Électricien, vol. 52, nos. 1287 and 1288, Nov. 1, and 15, 1921, pp. 481–488 and 505–513, 11 figs. Nov. 1: Describes the various methods in use in different countries, including lighting by candle, oil, gas, acetylene, and electricity, and gives cost data. Nov. 15: Describes the Brown-Boveri individual electric equipment, its operation and upkeep.

CAR WHEELS

Foundry. A Unique Foundry for Production of Car Wheels. Can. Foundryman, vol. 12, no. 11, Nov. 1921, pp. 17–20, 6 figs. Molds are placed on semi-automatic moving platform and taken to place of pouring; shaking out and annealing with very little effort.

Tires, Sorbitic Steel. Sorbitic Steel for Tires. Engineer, vol. 132, no. 3442, Dec. 16, 1921, p. 636, 4 figs. on p. 657. Includes tables showing results of tests made with three railway and three tramway tires, one of each set being treated by the Sandberg Sorbitic steel process. Results show that process is successful in obtaining improved ultimate tensile strength and hardness of tires.

CARS

Connectors. The Development of the Robinson Connector. Ry. Age, vol. 71, no. 26, Dec. 24, 1921, pp. 1259–1263, 9 figs. Detailed description of new design incorporating a number of improvements.

CARS, COAL

Electric Tippers. Electrically Equipped Railway Truck Tippers, E. H. Rousham. Electrician, vol. 87, no. 2276, Dec. 30, 1921, pp. 822–825, 10 figs. Describes the Babcock & Wilcox tipping ram, and the tipper manufactured by Ed. Bennis & Co., Ltd.; also overhead winch type, hydraulic tipping rams, electric rotary tipplers, clamping methods, automatic clamping gear, etc.

CARS, FREIGHT

Wood Construction. The Use of Wood in Freight Car Construction, H. S. Sackett. Ry. Mech. Engr., vol. 96, no. 1, Jan. 1922, pp. 27–32, 6 figs. Advantages of composite design as against all-steel construction; relative advantages of double and single sheathed box car; composite gondola car; refrigerator car.

CARS, PASSENGER

Electric Railway. New Stock For Tynemouth Electrified Branches, North Eastern Railway. Ry. Gaz., vol. 35, no. 24, Dec. 9, 1921, pp. 877–884, 12 figs. Passenger vehicles of improved design built for this important electrified passenger service.

Sleeping. New Sleeping Cars for the Canadian Pacific. Ry. Age, vol. 71, no. 27, Dec. 31, 1921, pp. 1301–1394, 7 figs. Composite cars of 12-section and compartment types have special facilities for comfort of passengers.

CASE-HARDENING

Iron and Steel. Case Carburizing of Iron and Steel (Härtung von Eisen und Stahl), Willy Hacker. Metall-Technik, vol. 47, no. 14, Sept. 15, 1921, pp. 85–87. Review of development and processes during last few years.

CASTING

Metal Molds. Casting in Metal Moulds, S. A. E. Wells. Metal Industry (Lond.), vol. 19, no. 25, Dec. 16, 1921, pp. 501–502. Discusses the three classes, viz., (1) that in which metal flows into mold under force of its own weight, (2) die castings, and (3) part chills in ordinary sand molds. From paper read before joint meeting of Inst. of Metals and Instn. British Foundrymen.

Permanent Molds. Permanent Moulds, Edward D. Gleason. Metal Industry (Lond.), vol. 19, no. 20, Nov. 11, 1921, pp. 377–379. Description of methods of making plaster molds for finished castings to eliminate machining operations.

CELLULOID

Manufacture. Manufacture of Pyroxylin Plastics, J. R. DuPont. Chem. & Met. Eng., vol. 26, no. 2, Jan. 11, 1922, pp. 65–70, 6 figs. Properties of celluloid; methods of mixing cellulose nitrate with camphor and alcohol; stabilizing; filtering; rolling; baking; sheeting; polishing; etc.

CHROME STEEL

Ball-Bearing. The Manufacture of Chromium Ball-Bearing Steel in the Heroult Furnace, F. T. Sisco, Chem. & Met. Eng., vol. 26, no. 2, Jan. 11, pp. 71–76, 2 figs. Description of melting and processing of electric ball-bearing steel, with a view of the most serious defects in this class of material. Recommended pratice for elimination and control of these defects.

Chrome-Molybdenum. Chrome-Molybdenum-Steel Applications from the Consumer's Viewpoint, C. N. Dawe. Soc. Automotive Engrs. Jl., vol. 10, no. 1, Jan. 1922, pp. 47–50 and 62, 2 figs. Gives results of physical tests, comparing medium-carbon, chrome-molybdenum, chrome-vanadium, chrome-nickel and chrome steels. Discusses case-hardening grades of Steel.

COAL HANDLING

Equipment. Springdale Mine Furnishes Fuel to West Penn Power Co. Plant, Cleaning Every Car of Coal Before Weighing, D. J. Baker. Coal Age, vol. 20, no. 25, Dec. 22, 1921, pp. 993–999, 6 figs. Power plant situated next to headframe. For weighing, coal is screened to lump, nut and slack before picking; nut and slack are united and reassembled; lump is then crushed and with nut and slack goes to boilers.

Plants. Up-to-Date Coal and Ash Handling Plant at the Cordite Factory, Poole. Eng. & Indus. Management, vol. 6, no. 24, Dec. 15, 1921, pp. 701–704, 8 figs. Railway sidings on which coal arrives and on which ashes leave, run alooside of and parallel with boiler house; full trucks arrive on inner track and pass an unusually large track hopper into which coal is dumped by truck tippler.

COAL STORAGE

Concrete Bins and Pits. Economy of Concrete Bins and Pits for Coal Storage, A. C. Irwin. Elec. Rev. (Chicago), vol. 79, no. 22, Nov. 26, 1921, pp. 811–816, 16 figs. Storage requirements and methods, including submerged pits; effect of storage on properties of coal; spontaneous combustion.

COMBUSTION

Gas Mixed with Air. Perfect Combustion of Gas by Mixing With Air (Réalisation de la combustion par faite du gaz par son mélange préalable, incomplet avec de l'air), A. Grebel. Chaleur et Industrie, vol. 2, no. 20, Dec. 1921, pp. 794–802, 14 figs. Recent progress in construction and operation of gas apparatus and gas burners, application in welding, annealing, etc.

COMPRESSED AIR

Handling Material by. Handling Material by Compressed Air, F. A. McLean. Can. Machy., vol. 26, no. 25, Dec. 22, 1921, pp. 19–23, 10 figs. Time is saved and economy effected. Notes on single acting air hoists, capacities of straight lift hoists, and operating costs.

Intercooling. Value of Intercooling Compressed Air, C. K. Bennett. Nat. Engr., vol. 25, no. 12, Dec. 1921, pp. 613–616, 6 figs. Advantages of intercooling. How saving in power is effected and safety maintained.

CONVEYORS

Machinery for Elevators and. Conveying and Elevating Machinery, Gardiner Mitchell. Engineering, vol. 112, no. 2921, Dec. 23, 1921, pp. 866–870, 17 figs. Deals with the various types of conveyors and elevators, and includes tables giving standard details and particulars, and standard elevator chains.

Steel-Band. The Use of Steel Bands for Power Transmitting and Conveying Purposes, Bernard Kruger. Jl. Western Soc. of Engrs., vol. 26, no. 12, Dec. 1921, pp. 428–432. Discusses increased use of steel bands, avoiding breaks in band, composition and tensile strength of bands, and compares leather, rope, chain and steel band systems.

COPPER

Working and Annealing. Experiments in the Working and Annealing of Copper, F. Johnson. Engineering, vol. 112, no. 2922, Dec. 30, 1921, pp. 899–901, 7 figs. Results of rolling and hardness tests and specific gravity tests. Notes on annealing of rolled strips, and influence of impurities on effective annealing temperature of cold-drawn copper. (Abstract.) Paper read before Inst. Metals (British).

CORK

Artificial. Artificial Cork, Ismar Ginsberg. Sci. Am., vol. 126, no. 2, Feb. 1922, p. 91, 5 figs. Waste materials used in its manufacture and applications found for it.

CORROSION

Investigations. Corrosion Investigations, D. M. Strickland. Sci. Am., vol. 126, no. 2, Feb. 1922, p. 104, 2 figs. Some of controlling factors, and how account is best taken of them.

COST ACCOUNTING

Idleness Expense Charts. The Cost of Mismanagement, E. A. Lucey. Management Eng., vol. 2, no. 1, Jan. 1922, pp. 25–28, 4 figs. How it can be measured through idleness. Shows examples of Gantt idleness charts.

COSTS

Construction. Calculation of Costs in Engineering Construction (Die Kostenberechnung im Ingenieurbau), Hugo Ritter. Schweizerische Bauzeitung, vol. 78, nos. 10 and 11, Sept. 3 and 10, 1921, pp. 116–119 and 131–133. Suggestions as to how the separate expense items which go to make up total cost of a work can best be determined. Deals with cost of labor and material, mechanical equipment, transportation, general expenses, etc.

Foundry. Foundry Costs and Establishment Charges, Daniel Adamson. Engineering, vol. 112, no. 2922, Dec. 30, 1921, pp. 891–895. Author endeavors to arrive at a reliable method of estimating cost of many varieties of castings in green sand, dry sand or loam, that are produced in foundry attached to a general engineering business. Notes introducing discussion before Manchester Assn. Engrs.

CRANES

Hooks for, Strength of. The Strength of a Hook or "Clivvy," Charles D. Mottram. Quarry & Surveyors' & Contractors' Jl., vol. 26, no. 297, Nov. 1921, pp. 447–449, 4 figs. Discusses safety load and factor of safety; gives curves and formulas.

Overhead Drives. Overhead Crane Drives, A. W. Knight. Machinery (Lond.), vol 19, no. 482, Dec. 22, 1921, pp. 352–354, 4 figs. Describes some typical cranes and works out amount of movement of one side of crane in advance to the other, when the crab and its suspended load is at opposite end to drive on cross shaft.

Shifting Gear on Gantry. Use Shifting Gear on German Cranes. Iron Trade Rev., vol. 70, no. 2, Jan. 12, 1922, pp. 140–142, 5 figs. Describes gantry cranes equipped with swivel trucks and lifting jacks by means of which whole crane may be quickly and readily transferred from one runway to another. Built by Fried. Krupp Corp., Magdeburg-Buckau.

CRANKSHAFTS

Manufacture. The Manufacture of Crankshafts. Engineering, vol 112, nos 2919 and 2920, Dec. 9 and 16, 1921, pp 777-778, 9 figs partly on supp plate, and pp. 811-813, 14 figs Describes works and manufacturing methods of Clarke's Crank & Forge Co., Ltd., Lincoln, England

CUTTING TOOLS

Diamond. Manufacture and Use of Diamond Cutting Tools, Ellsworth Sheldon Am Mach., vol 56, no 2, Jan 12, 1922, pp 53-56, 8 figs Study of structure necessary to secure keen cutting edges Cleaving the diamond.

D

DIE CASTING

Plant Organization. Modern Production of Die-Molded Castings (Neuzeitliche Pressgussherstellung), Harry Bachme Elektrotechnische-Rundschau, vol. 38, no. 18, Sept 21, 1921, pp 105-107, 1 fig Describes organization of modern plant for making die-molded castings and reviews metals now commercially used in die-casting practice.

DIES

Continuous Rolling. Continuous Die Rolling, G. R Norton Soc Automotive Engrs Jl., vol. 10, no. 1, Jan. 1922, pp 43-46, 11 figs Describes process of continuous die rolling, improvements made, physical characteristics of steels, cost of operation, equipment used, etc. See also Iron Age, vol. 109, no 3 Jan 19, 1922, pp 207-209, 11 figs

DIESEL ENGINES

Air Compressors. See AIR COMPRESSORS, Marine Diesel Engines.

Generator Drive. Oil-Engine-Driven Ship Generators in the Germany Navy (Der ölmotorische Antrieb von Borddynamos in der deutschen Kriegsmarine), W. Landah Schiffbau, vol. 22, no 34, May 25, 1921, pp 813-819 and vol 23, no 12, Dec 21, 1921, pp 329-339, 10 figs Notes, including official data, on development of high-speed Diesel engines for dynamo drive May 25 Fundamental principles of construction Dec. 21 Results of tests with different types; engines of 300-kw. output. The opposed-piston-type engines built by Weser Corp., Bremen, for the liner, Markgraf. (To be continued.)

Investigations. Investigations of Diesel Engines (Untersuchungen an der Dieselmaschine), Kurt Neumann Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no 245, 1921, 42 pp., 18 figs. Based on tests, results of which are presented in tables and diagrams, progress of combustion and interchange of heat between gas and cylinder wall are determined. Progress of combustion is determined by means of indicated diagrams and from composition of gas specimens taken from working cylinder of engine Thermodynamical calculations are based strictly on measurements and are entirely free from arbitrary assumptions. Analysis of injection and combustion process. Calculation of loss of work due to conduction through walls of cylinders.

DRILLING MACHINES

Heavy-Duty. Economy of Heavy-duty Drilling, Fred R. Daniels Machy. (N. Y.), vol. 28, no. 5, Jan. 1922, pp. 349-355, 16 figs. Examples of work for which heavy-duty drilling machine is adapted.

DROP FORGINGS

Heat Treatment. Heat-treatment of Drop-forgings. Machy (N Y), vol 28, no. 5, Jan. 1922, pp 384-388, 6 figs Furnace design and fuels suitable for treating drop forgings.

DUST

Collectors. Mechanical Methods of Allaying Dust, P H Warren Australasian Inst. Min & Metallurgy Proc., no 42, June 30, 1921, pp. 31-47 and (discussion) 47-100, 10 figs. Describes tests carried out at Broken Hill South mine with the Clifton dust, collector

E

EDUCATION, ENGINEERING

Industrial Needs. Engineering Education. Mech. Eng., vol 44, no 1, Jan 1922, pp 1-7 and 42. Group of papers in which are presented particular needs of industries and problems that confront engineering faculties Professional Engineering Education for the Industries, Francis C. Pratt. A National Policy on Engineering Education, A. G. Christie Engineering Education as Viewed by the Industrialist, J E Otterson.

EDUCATION, INDUSTRIAL

Germany. The Training Schools of the German Mechanical Industry (Die Werkschulen der deutschen mechanischen Industrie). Betrieb, vol. 3, nos. 23, 25 and 26, Aug. 27, Sept. 15 and 25, 1921, pp. 53-56, 57-64 and 65-76, and vol. 4, no. 2, Oct. 22, 1921, pp. 1-9. Notes on training schools of most important German industrial works.

ELECTRIC DRIVE

Sugar Mills. Electric Drive for Sugar Mills, Charles Griffith. Sugar, vol. 24, no 1, Jan. 1922, pp. 33-34. This type of power development has advantage of flexibility and many economies are effected by unit drive.

Wool Cards. Group vs. Individual Drives on Wool Cards, Alonzo B. Reed. Textile World, vol. 61, no. 1, Jan 7, 1922, pp. 63-65 and 81, 2 figs General comparison of first cost, power consumption, maintenance, cleanliness and flexibility of operation with different systems of driving. Tests made under actual mill conditions before and after cards were equipped with individual motors.

ELECTRIC FURNACES

Arc, Operation of. The Operation of Basic Electric Furnaces M W Caruthers. Iron Age, vol 109, no. 1, Jan 5, 1922, pp. 17-19 How to avoid delays in each of the eight major operations of making steel in furnaces having movable electrodes.

Basic. Basic Electric Furnace for Cast Iron Can. Foundryman, vol 12, no 11, Nov. 1921, pp. 32-34. Important characteristics of refining in the basic-hearth electric furnace are: (1) it is strongly reducing, (2) it is degasifying to an appreciable extent, (3) it is cleansing of entrained slags and oxides, and (4) it is intensely desulphurizing.

Electrodes. Electric Furnace Electrode Has Undergone Marked Development, A. T. Hinckley. Elec. World, vol 78, no 26, Dec. 24, 1921, pp. 1263-1265. Reviews uses of carbon electrodes from 1800 to present day applications in electric furnace.

Forging. Builds Electric Forging Furnace, G. M. Little. Iron Trade Rev., vol. 69, no. 26, Dec. 29, 1921, pp. 1689-1692, 3 figs. Discusses difficulties encountered in construction of carbon resister-type furnace for heat treating and forging work Gas or oil used to prevent resister oxidation. Insulation problem solved.

Gray-Iron. Practical Aspects of Electric Gray Iron, C H Vom Baur Iron Age, vol. 109, no. 1, Jan. 5, 1922, pp. 51-52. Advantages over the cupola. Actual results from heats made recently. Effect of nickel and chromium. Comparative costs.

Induction. Melting Steel in an Induction Furnace, H A Winne. Iron Trade Rev., vol. 70, no. 2, Jan. 12, 1922, pp 138-139, 2 figs. Describes induction furnace of 4000-lb. hearth capacity in successful operation at Pittsfield works of Gen. Elec. Co for more than a year. It is a single-phase, single-ring (horizontal) type; lining consists of two essential parts, an outer layer of insulating and refractory brick, and inner rammed lining, or hearth proper.

Railway Shops. The Electric Furnace on Railroad Work, Larry J. Barton. Western Machy. World, vol. 12, no. 11, Nov. 1921, pp. 444-446, 4 figs. Describes installation of Southern Pacific Co. at their Sacramento shops; 6-ton Heroult furnace.

Reactance Requirements. Furnace Reactance Requirements Need Consideration, P. B. Short. Elec. World, vol 79, no. 2, Jan 14, 1922, pp. 81-83, 4 figs. Discusses growing tendency to use higher operating voltages and the importance which public utilities are attaching to power factor.

Steel. Electric Furnace Best for Conditions on the Pacific Coast, L. J. Barton. Jl. Electricity & Western Industry, vol. 47, no. 12, Dec. 15, 1921, pp. 463-464, 1 fig. In iron and steel manufacture efficiency of electric furnace and high quality of product offset absence of coking coal necessary for blast furnace methods.

ELECTRIC LOCOMOTIVES

Paulista Railway D. C. 3000 Volt Direct-Current Locomotives for the Paulista Railways, John A. Clarke, Jr. Elec. Jl., vol. 19, no. 1, Jan. 1922, pp. 17-23, 11 figs. Discusses electrification of Jundiahy-Campinas section of the Sao Paulo state railway, and gives data on passenger and freight locomotives and auxiliaries.

Storage-Battery. Data on Operation of Storage Battery Locomotive, Jerome C. White. Coal Industry, vol. 4, no. 12, Dec. 1921, pp. 581-583, 2 figs. Costs and operating data obtained from a storage-battery locomotive used as a main haulage machine. Paper read before Coal Min. Inst. of Am.

Explosion Proof Electric Mine Locomotives, L. C. Illsley. Coal Industry, vol. 4, no. 12, Dec. 1921, pp. 588-591, 9 figs. Description of work being carried on by Bur. of Mines in connection with investigations of storage-battery locomotives; requirements for approved equipment; rules for inspection.

Haulage Work with Storage-Battery Locomotives Without Driver (Förderbetrieb mit fuhrerlosen Akkumulator-Lokomotiven), H. Trautvetter. Fördertechnik u Frachtverkehr, vol. 14, no 23, Nov. 11, 1921, pp. 287-289, 4 figs. Maximum speed of locomotive is 1 m. per sec.; efficiency, 80 to 100 km. per 8 hr.; under these conditions capacity of batteries is sufficient for 8000 to 10,000 m. Enumerates advantages of driverless locomotives.

ELECTRIC PLANTS

Automatic. Automatic Plant Permits Development of Small Power Site, C. M. Gilt. Elec. World, vol 78, no. 25, Dec. 17, 1921, pp. 1213-1214, 3 figs. Generator started simply by energizing line connecting automatic plant to main station.

Commonwealth Edison Co., Chicago. Calumet Station of the Commonwealth Edison Co., A. D. Bailey. J. Western Soc. of Engrs., vol. 26, no. 12, Dec. 1921, pp. 420-427, 9 figs. Discusses station now under construction, with ultimate capacity of 180,000 kw.; present installation consists of one 30,000-kw. Westinghouse Tandem compound unit and one 30,000-kw. General Electric unit Boiler station to consist of seven 1,500 hp. Babcock & Wilcox boilers fired with forced-draft chain-grate stokers and augmented with superheaters and steel-tube economizers.

Hartford Electric Light Co. Station Electrical Layout for Supplying Local and Regional Service. Elec. World, vol. 78, no. 26, Dec. 24, 1921, pp. 1269-1273, 9 figs. Flexibility and simplicity of design effectively combined in South Meadow station of Hartford Elec Light Co Symmetrical development by sections to meet dual service.

Possible Economies. Possible Economies in Large Electric Generating Stations, Emile Rauber Engineer, vol 132, no 3444, Dec. 30, 1921, pp 669-670. States that considerable progress may still be made in economizing fuel by (1) using higher steam pressures; (2) employing higher degree of superheat; (3) heating feedwater by "bleeding" turbines; and (4) preventing all losses of heat. (Abstract.) Report of Commission appointed by French Minister of Pub. Works, printed in Journal Officiel.

ELECTRIC POWER

Industrial Load, Pennsylvania. The Industrial Load in Pennsylvania. Elec. World, vol. 78, no. 27, Dec. 31, 1921, pp. 1313-1317, 3 figs. Electrical energy consumed by all industrial plants of Pennsylvania during 1920 is estimated at 4,666,928,000 kw-hr., 50.3 per cent of which is purchased from central generating and distributing systems.

ELECTRIC WELDING, ARC

Boiler Repairs. Electric Arc Welding for Boiler Repairs. Ry. Elec. Engr., vol. 12, no. 11, Nov. 1921, pp. 415-420, 19 figs. Special committee of Master Boiler Makers' Assn. reports best methods of reconditioning boilers.

Cyc-Arc Process. The "Cyc-Arc" Process of Automatic Electric Welding, L. J. Steele and H. Martin. Electrician, vol. 87, no. 2273, Dec. 9, 1921, pp. 734-735. Discusses development; and the three essential variables, viz., (a) amount of current through the arc, (b) length of arc upon striking, and (c) length of time it had to be maintained before making the weld. Results of welding experiments and tests with the cyc-arc apparatus.

ELECTRIC WELDING, RESISTANCE

Methods and Apparatus. Electric Resistance Welding (La soudure électrique par résistance), R. Verdier. La Nature, no. 2480, Oct. 15, 1921, pp. 246-251, 7 figs. Describes the three methods and apparatus used.

Railway Shops. Experiences with Machines for Electric Resistance Welding in Railway Shops (Erfahrungen mit Maschinen zum Schweissen durch elektrischen Widerstand in Eisenbahnwerkstätten), W. Bastänier. Organ für die Fortschritte des Eisenbahnwesens, vol 76, no. 17, Sept. 1, 1921, pp. 177-179, 5 figs. Describes machines by Moll Works Corp., Chemnitz, Germany, for butt-welding and spot welding, and experiences therewith in railway shop.

EMPLOYEES' REPRESENTATION

Advantages. Pulling Together Through Representation, John T. Broderick. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 331-334 and vol. 2, no. 1, Jan. 1922, pp. 31-36. Dec. Points out that right understanding comes from joint conference of employer and employee. Jan. Manufacturer explains plan adopted in his plants. Describes how general committee is formed, how wage problem is solved, and production helped, attitude of organized workers, problem of unemployment, welfare work, etc.

EMPLOYMENT MANAGEMENT

Adaptability Tests. How to Develop Psychological Adaptability Tests (Wie entwickelt man phychologische Eignungsprüfungen), Hans Rupp. Betrieb, vol. 4, no. 4, Nov. 26, 1921, pp. 96-105, 15 figs. The most important practical fundamentals for development of reliable adaptability tests are set forth.

Psychotechnical Adaptability Testing of Prospective Female Workers for Mass Production in the Electrical Industry (Psychotechnische Eignungsprüfung von anzulernenden Arbeiterinnen der elektrotechnischen Massenherstellung), M. Waldau. Betrieb, vol. 4, no. 4, Nov. 26, 1921, pp. 110-117, 27 figs. Describes methods and testing apparatus and their evaluation.

ENAMELING

Cast Iron and Steel. Enameling Cast Iron and Steel Materials, F. L. Prentiss. Iron Age, vol. 109, no. 1, Jan. 5, 1922, pp. 13-16, 9 figs. Methods and apparatus used. Care needed in preparing surfaces for treatment. Burning on the enamel.

ENAMELS

White, for Copper. The Production of Some White Enamels For Copper, R. R. Danielson and H. P. Reinecker. Am. Ceramic Soc. Jl., vol. 4, no. 10, Oct. 1921, pp. 827-834. Describes investigations for developing white enamels for copper watch dials, thermometer scale plates, and signs. Preparation of enamels; application and firing of enamels.

ENGINEERING

Western Home for. Proposed Western Home for Engineering and Industry, Robert Sibley. Jl. Electricity & Western Industry, vol. 47, no. 11, Dec. 1, 1921, pp. 426-427, 1 fig. Discusses plans for financing and managing a large building in San Francisco to be used as center for all classes of engineering.

ENGINEERING SOCIETIES

Engineering Association Plans. The Engineering Association and Its Plans, C. S. Kimball. Elec. Ry. Jl., vol. 59, no. 1, Jan. 7, 1922, pp. 18-20, 1 fig. Discusses work of reorganization of Am. Elec. Ry. Assn.; outlines committee problems and activities; participation in national standardization; etc.

ENGINEERS

License Law, N. Y. State. The New York State License Law, S. G. George. Cornell Civil Engr., vol. 30, no. 4, Jan. 1922, pp. 53-54. Professional engineers and land surveyors required to obtain

licenses to practice in New York State from May 5, 1923.

ENGINEHOUSES

Enterior Turntable. Rectangular Enginehouse with Interior Turntable. Eng. News-Rec., vol. 87, no. 26, Dec. 29, 1921, pp. 1064–1066, 4 figs. Two Canadian railways adopt novel plan to reduce winter trouble at terminal by putting turntable under cover

EXHAUST STEAM

Utilization. Utilization of Exhaust Steam in Industries (Abdampfausnutzung in der Industrie), J. Gramberg. Gesundheits-Ingenieur, vol. 44, no. 51, Dec. 17, 1921, pp. 633–638 and (discussion) pp. 638–641, 8 figs. Discusses conditions essential for design and efficient operation of plant for utilizing exhaust steam. Address before Heating & Ventilating Congress at Munich.

F

FACTORIES

Layout. Factory Lay-out as an Aid in Reducing Costs. Machinery (Lond.), vol 19, no. 480, Dec. 8, 1921, pp. 293–296, 8 figs. Describes new plant of Colburn Machine Tool Co., Cleveland, Ohio, which has been laid out with a view to economy in manufacturing.

Laying Out a Factory for Production Work, Frank W. Curtis. Am. Mach., vol. 56, nos. 2 and 3, Jan. 12 and 19, 1922, pp. 56–58 and 97–99, 8 figs. How kind and amount of equipment are estimated. Arranging machines. Uses of operation sheets, equipment records, and conveyors.

Telephone. Methods in a Telephone Factory. Eng. Production, vol. 3, no. 64, Dec. 22, 1921, pp. 583–587, 14 figs Describes works and practice of British L. M. Ericsson Mfg. Co., Ltd., at Beeston, for manufacture of telephones, telephone exchange and private branch switchboards and allied apparatus cabinet work, etc.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FILING SYSTEMS

Z Charts. Filing the Z Chart, Arthur R. Burnet. Management Eng, vol. 2, no. 1, Jan. 1922, pp. 47–50, 2 figs. Describes system of filing which, it is claimed, follows principles best suited to classification and indexing of accounting records.

FLIGHT

McCook Field Altitude. Functioning of Supercharger in Altitude Flight. Aviation, vol. 12, no. 2, Jan. 9, 1922, p. 51. Excerpt of report of John A. MacReady on his record-breaking altitude flight at McCook Field, dealing with technical aspects of flight and giving summary of data obtained with respect to supercharger, engine and propeller.

Soaring. The Starting of Soaring Airplanes (Start von Segelflugzeugen), E. Offermann. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol 12, no. 22, Nov. 30, 1921, pp. 327–331, 13 figs. Investigation of following problems is said to be necessary in order to diminish danger to life and material: Improvement in airplane construction that will render it possible to start and fly with as low a wind as possible; training of pilot especially for motorless or soaring flight; study of relationships between formation of land and nature of soil and air movements, and their dependence upon one another.

FLOW OF LIQUIDS

Resistance in Glass Tubes. The Resistance of Liquids Flowing in Short Tube Sections (Ueber den Widerstand strömender Flussigkeit in kurzen Rohrstucken), L Schiller and H. Kirsten. Physikalische Zeit., vol. 22, no. 19–20, Oct. 1–15, 1921, pp. 523–528, 7 figs. Discussion of experimental results obtained by W. Sorkau in investigation of friction of liquids in glass tubes.

FLOW OF WATER

Spiral Riveted Pipe. Flow of Water Through Spiral Riveted Steel Pipe, F. W. Crewe and R. R. Martin. Eng & Contracting, vol. 57, no. 2, Jan. 11, 1922, pp. 41–42, 2 figs. Data and results of investigation upon flow of water through 4, 6, 8 and 10-in. galvanized spiral riveted steel pipes, dealing primarily with relation of friction loss to velocity in straight runs, both when flow was directed with and against lap. (Abstract.) Bul. Eng. Experiment Station of Purdue University.

FORGING

Instruction Sheets. Instruction Sheets for Forging (Schmiedeakkorde), F. Lohage. Werkstattstechnik, vol. 15, nos. 10 and 11, May 15 and June 1, 1921, pp. 281–291 and 317–327, 48 figs. Instruction sheets for forging various machine parts, etc., with line allowance for each operation. Illustrations of forging tools and their application.

Mild Steel. Forging Experiments with Mild Steel, Paul J. Junkers. Forging & Heat Treating, vol. 7, nos. 10 and 11, Oct. and Nov. 1921, pp. 518–523 and 553–556, 22 figs. Oct.: Results of experiments to determine resistance of steel to deformations and influence of kneading and forging temperatures upon physical properties of a 0.13 and 0.50 C steel Nov.: Improvement in structure due to forging is greater in 0.50 than in 0.13 carbon steel; finishing temperatures important.

FOUNDRIES

Brass. Casting Small Parts in Production Foundry, Gerard Frazar. Iron Age, vol. 108, no. 26, Dec. 29, 1921, pp. 1653–1656, 7 figs. Describes new foundry of Gilbert & Barker Mfg. Co., Springfield, Mass., equipped for continuous pouring which when run at capacity will give employment to about 300.

Chilled Rolls. New Foundry for Casting Chilled Rolls, George F. Tegan. Iron Age, vol. 109, no. 1, Jan. 5, 1922, pp. 38–42, 7 figs. Raw material charged in air furnaces direct from stock pile at Garrison foundry, Pittsburgh.

Core Mixing. Core and Sand in the Foundry, G. Pouplin. Brass World, vol. 17, no. 12, Dec. 1921, pp. 345–350. The making and mixing of cores as practiced today in the best French foundries. Notes on core drying, glutrin and avebene, and action of tar-oil on sand. (Abstract.) From Fonderie Moderne.

Engineering Costs. Obtaining Engineering Costs in Foundry and Machine Shop, Howell B. May. Iron Trade Rev., vol. 69, nos. 19, 21, 23 and 25, Nov. 10, 24, Dec. 8 and 22, 1921, pp. 1218–1221, 1356–1358, 1456–1458, 1485–1489 and 1619–1622 and 1630, and vol. 70, no. 3, Jan. 19, 1922, pp. 206–210, 30 figs. Survey of needs and advantages of adequate costs with detailed application of cost system to plant having iron and brass foundries, machine shop and sheet-metal department. Nov. 10: General outline of plan. Nov. 24: Cost plan in detail. Dec. 8: Burden and expense account. Dec. 22: Consolidation of cost and general accounting. Jan. 19: Financial statements, graphics and control.

Railway Iron and Steel. Control in a Railway Iron and Steel Foundry, G. N. Shawcross. Engineering, vol. 112, no. 2920, Dec. 16, 1921, pp. 832–836, 6 figs. Outlines examples of control of men, methods and materials in well-known locomotive works of Lancashire & Yorkshire Ry. at Horwich, England, showing what output is produced and by what methods work is turned out. Address delivered before Cambridge University Eng. Soc.

Sand-Dressing Plants. Automatic Sand-Dressing Plant (Selbsttätige Sandaufbereitungsanlagen), H. Kalpers. Zeit. für die gesamte Giessereipraxis, vol. 42, no. 37, Sept. 10, 1921, pp. 481–484, 8 figs. Describes new plant by the Gustav Zimmermann Machine Works, Düsseldorf, which is said to produce a sand of always uniform and excellent quality which contributes greatly to production of good castings.

FRAMES

Rigid, Calculation of. A New Calculating Method for Rigid Frames (Ein neues Berechnungsverfahren für biegungsfeste Rahmen nach H. Bronneck), H. Marx. Dinglers polytechnisches Jl., vol. 336, no. 21, Oct. 22, 1921, pp. 301–302, 2 figs. Describes new method by Hugo Bronneck, with which, it is claimed, calculation of most complicated frame forms (for which few or no formulas exist) can be made without referring to formulas or making new derivations.

FREIGHT HANDLING

Electric Apparatus for. Electrically Operated Apparatus for Handling Railway "General Goods," George Bulkeley. Electrician, vol. 87, no. 2276, Dec. 30, 1921, pp 819–821, 3 figs. Discusses principle of loading general merchandise; limitations of overhead gantry crane; electric platform trucks; etc.

FUELS

America's Resources. America's Fuel Resources, Robert G. Skerrett. Sci. Am., vol. 126, no. 2, Feb. 1922, pp. 86–87, 3 figs. Data on deposits and consumption. Presents charts showing how consumption of petroleum and coal has increased since 1880.

Gaseous Products, Composition of. Formulas for the Control of Gas Composition in Combustion and Gasification Processes and for the Calculation of Air and Exhaust-Gas Volumes (Formeln für die Kontrolle der Gaszusammensetzung bei Verbrennungs- und Vergasungsvorgängen und für die Berechnung der Luft- und Abgasmengen), Gustav Neumann. Stahl u. Eisen, vol. 41, no. 50, Dec. 15, 1921, pp. 1811–1817. Relations between chemical composition of fuels and chemical composition of the gaseous products resulting from their combustion, carbonization or distillation, are numerically determined and expressed in closed formulas.

Ignition Temperatures. The Ignition Points of Fuels According to Recent Tests (Die Zündpunkte von Brennstoffen nach neueren Versuchen), E. Daiber. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 50, Dec. 10, 1921, pp. 1289–1290, 3 figs. Account of tests on ignition temperatures of liquid and solid fuels. Notes on apparatus used, influence of time on ignition point, values and other results obtained. Comparison of described processes of Moore and Hawkes.

FURNACES

Oxy-Acetylene. An Oxygen-Acetylene High-Temperature Furnace, Hewitt Wilson. Am Ceramic Soc. Jl., vol 4, no. 10, Oct. 1921, pp. 835–841, 2 figs. Detailed description to show use of oxy-acetylene gas in a small furnace for using refractory cones. Advantages of furnace.

FURNACES, BOILER

Solid and Liquid Fuels. The Pace Patent Furnace Door. Iron & Coal Trades Rev., vol. 103, no. 2808, Dec. 23, 1921, p. 917, 1 fig Describes furnace for burning alternatively solid or liquid fuels and gives comparison of cost.

FURNACES, HEATING

Ingot-Reheating. Ingot Reheating Furnace, H. E. Smythe. Iron Age, vol. 109, no. 2, Jan. 12, 1922, pp. 149–150, 1 fig. New design to avoid imperfect and unequal heating by proper control of incoming gases.

FURNACES, INDUSTRIAL

High-Pressure Gas System. High Pressure Gas and Its Application to Industrial Furnaces, F. J. Evans. Am. Soc. for Steel Treating Trans., vol. 2, no. 3, Dec. 1921, pp. 213–222, 7 figs. Discusses low-pressure air and gas system with two-valve control and manual proportioning, and with single-valve control and automatic proportioning, and high-pressure gas system with single-valve control and automatic proportioning.

G

GAS PRODUCERS

Corrosion of Cooling System. Corrosion of a Producer-Gas Cooling System, Lloyd E. Jackson. Chem. & Met. Eng., vol. 26, no. 2, Jan. 11, 1922, pp. 60–64, 5 figs. Cooling water of high acidity and containing much dissolved oxygen and suspended coke dust causes deterioration of cooling system at plant of Providence Gas Co., Providence, R. I. Remedial measures are suggested

Tests with Alberta Coals. Gas Producer Trials with Alberta Coals, John Blizard and E. S. Malloch. Canadian Dept. of Mines, Bul. no. 33, 1921, 40 pp., 23 figs. Tests were carried out in Westinghouse, double-zone, gas producer. Aim of trials was to ascertain suitability of the various fuels for giving a clean combustible gas when burned in the producer. Results show that all fuels except one are suitable but that less than one-half can be recommended for continuous operation in producer.

GAS TURBINES

Efficiency, Determination of The Thermodynamic Principles for Determination of the Expected Efficiency of Gas Turbines (Die thermodynamischen Grundlagen für die Bestimmung des von Gasturbinen zu erwartenden Wirkungsgrades), H. Schmolke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 44, Nov. 4, 1921, pp. 351–354, 4 figs. Review of works on this subject which have appeared in last ten years. Presents diagrams developed by W. Schüle showing process and efficiency of Holzwarth turbines.

Impulse Type. Prospects of the Gas Turbine in Competition with Other Prime Movers (Die Aussichten der Gasturbine im Wettbewerb mit unseren bisherigen Kraftmaschinen), Hans Kasparek. Oel- u. Gasmaschine, vol. 18, nos. 8, 9, 10 and 11, Aug., Sept., Oct. and Nov. 1921, pp. 121–123, 142–146, 161–164 and 177–179, 5 figs. Notes on impulse gas turbines with turbo-compressors, piston compressors, etc.

GASES

Pump and Mixer. The Roturbo Gas Pump and Mixer. Engineer, vol. 132, no. 3444, Dec. 30, 1921, p. 704, 1 fig. Describes Rees Roturbo gas pump and mixer for creating a very intimate mixture between gases and liquids and so effecting required solution or chemical action in smallest possible time and space. It is designed to draw large volumes of gas from comparatively low vacuum and to mix them with the entraining liquid.

GEAR CUTTING

Broaching Machine. Gear Cutting or Broaching Machine. Eng. Production, vol. 3, no. 65, Dec. 29, 1921, p. 621, 1 fig. Patented method of producing gears, circular cutters, saws, etc., particularly adapted for manufacture on extensive basis, chief feature being cutting of number of teeth simultaneously.

Spur-Gear Machine. Cutting Spur Gears on the Shaper. Eng. Production, vol. 3, no. 64, Dec. 22, 1921, p 587, 1 fig. Describes new gear-cutting attachment, for generation of spur gears having correct tooth form, no matter what the number of teeth.

GEARS

Involute. Design of Bevel, Helical and Worm Involute Gears, A. B. Cox. Am. Mach., vol. 56, no. 3, Jan. 19, 1922, pp. 104–107, 8 figs. Application of data of author's previous articles. Determination of helix and tooth angles. Relation between interference, number of teeth and sliding action.

The Evolution of the Involute Gear Tooth—X, A. Fisher. Machinery (Lond.), vol. 19, no. 483, Dec. 29, 1921, pp. 380–384, 6 figs Discusses relation between tooth depth and thickness; backlash; generating teeth of conjugate thickness.

Tooth Shape. Gear Tooth Shape and Its Relation to Standardization, E. W. Miller. Automotive Industries, vol. 45, no. 24, Dec. 15, 1921, pp. 1167–1173, 26 figs. Discusses properties of involute form of gear tooth. True involute teeth with a certain pressure angle and relation between addendum and diametral pitch will not interfere with pinions down to 12 teeth. Such a system would facilitate universal interchangeability. Condensed from paper read before Am. Gear Manufacturers' Assn.

Worm. Worm Gear Generator. Machy. (Lond.), vol. 19, no. 481, Dec. 15, 1921, pp. 325–327, 9 figs. Describes in detail machine built by Smith & Coventry, Ltd., Manchester.

GIRDERS

Bending Moments. Graphic Determination of Bending Moments in a Girder Supporting Traffic Loads by Means of Cross Bars (Détermination Graphique des moments fléchissants maxima dans une poutre supportant des charges mobiles par l'intermédiaire des traverses), Smoukovitch and Barbillion. Le Génie Civil, vol. 79, no. 25, Dec. 17, 1921, pp. 533–535, 5 figs.

GRAIN ELEVATORS

Explosions. The Northwestern Elevator Explosion, David J. Price. Jl. Western Soc. of Engrs., vol 26, no. 12, Dec 1921, pp. 401–417 and (discussion) 417–419, 7 figs. Discusses in detail damage done to elevator operated by Armour Grain Company, South Chicago, theories advanced as to cause of explosion, lessons to be learned from the explosion, recommendations.

Pneumatic. Pneumatic Grain Elevators, R. E. Knight. Engineering, vol 112, no 2921, Dec 23, 1921, pp. 864–866, 1 fig. Deals with pneumatic discharge of grain from ships, and more particularly with two modern examples of floating and quayside plants in which oil engines or motors, and high-speed rotary exhausters, have replaced vertical or horizontal compound steam engines and reciprocating exhausters, as main power plant of installation. Paper read before Instn. Mech. Engrs. (British). See also Engineer, vol 132 no 3443, Dec 23, 1921, pp. 655–657, 1 fig.

GRINDING

Differential Spider Arms. Grinding Differential Spider Arms, Charles Kotersall. Am. Mach., vol 55, no. 25, Dec 22, 1921, pp. 1009–1010, 3 figs. Method which eliminates use of centers and an inspection gage for insuring accuracy in alignment.

Surface. Why Work Curls Towards the Wheel While Being Surface Ground, E. A. Dixie. Am. Mach., vol 55, no 25, Dec 22, 1921, pp. 1006–1007, 4 figs. Plausible theory deduced from long experience. Work heated beyond critical point in numberless places takes permanent set when quenched by coolant.

GRINDING MACHINES

Railroad Shops. The Grinding Machine in the Railroad Shop, Frank A. Stanley. Am. Mach., vol. 56, no. 2, Jan. 12, 1922, pp. 64–65, 10 figs. Advantages of grinding for finishing parts to size. Grinding operations on locomotive parts. Increasing efficiency of motion mechanism.

H

HANDLING MATERIALS

German Mechanical Devices. Development of Mechanical Handling Devices in Germany during and since the War, George P. Zimmer. Eng. & Indus. Management, vol. 6, nos. 18, 22, 24 and 26, Nov. 3, Dec. 1, 15 and 29, 1921, pp. 514–515, 1 fig.; 645–646, 2 figs.; 706–707, 7 figs. and 760–761, 1 fig. Information resulting from author's visit to German industrial centers. Points out that band conveyor has been superseded by other devices owing to high cost of bands. Nov. 3: Improved automatic colliery tippler. Dec. 1: Mechanical removal of ashes from locomotives. Dec. 15: Latest developments in coal-face conveyors. Dec. 29: Pneumatic handling.

Textile Mills. Material Handling in the Textile Industry, R. M. Gates. Management Eng., vol. 2, no. 1, Jan. 1922, pp. 13–17, 8 figs. Shows types of electric trucks, belt conveyors, gravity conveyors, inclined elevators, etc., employed in textile mills. Points out importance of material handling.

HEAT

Recovery from Earth. Ground Heat as the Most Important Source of Energy (Die Erdwärme als wichtigste Energiequelle). Rauch u. Staub, vol. 12, no. 3, Dec. 1921, pp. 16–18. Review of developments in study of the recovery of heat from earth interior for technical purposes.

HEAT BALANCE

Electric Plants. Heat Balance of the Connors Creek Plant of the Detroit Edison Company, C. Harold Berry and F. E. Moreton. Mech. Eng., vol. 44, no. 1, Jan. 1922, pp. 22–25, 8 figs. Describes briefly apparatus in plant, followed by discussion of ideal operating conditions, and presents actual results. Includes table showing thermal balance sheet for April 1921.

HEAT INTERCHANGERS

Experiments With. Experiments with Heat Interchangers, F. Russell Bichowsky. Jl. Indus. & Eng. Chem., vol. 14, no. 1, Jan. 1922, pp. 62–64, 3 figs. Discusses the Linde, Hampton, and Nelson types of interchangers.

HEAT PUMPS

Evaporators With. Experiences on Evaporators with Heat Pumps, E. Wirth. Mech. Eng., vol. 44, no. 1, Jan. 1922, pp. 49–51, 5 figs. Points out that whereas until now investigations have been made only with regard to liquids with low-boiling point, data are now available on heavier liquids. Account of author's experiences with heat pump operation. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 46, Nov. 12, 1921, pp. 1183–1186.

HEAT TRANSMISSION

Problems. Heat Transfer, W. H. McAdams and T. H. Frost. Jl. Indus. & Eng. Chem., vol. 14, no. 1, Jan. 1922, pp. 13–18, 2 figs. Problems arising in the field of heat transfer and rational method for studying them. Results of preliminary experiments to determine numerical value of coefficient of heat transfer between condensing vapors and a pipe.

HEAT TREATING

Plant Operation., The Complete Operation of a Modern Heat Treat Department, Thomas B. Fordham. Factory, vol. 28, no. 1, Jan. 1922, pp. 31–34, 6 figs. Method of control which has been successful in reducing scrap loss and bringing down manufacturing cost.

HEATING, ELECTRIC

Hot-Water. Comparative Investigations of Domestic Heating and Cooking Arrangements (Vergleichende Untersuchungen an häuslichen Heiz- und Kocheinrichtungen), J. Rutishauser and P. Schläpfer. Schweiz. Elektrotechnischer Verein Bul., vol 12, nos 10, and 12, Oct. and Dec. 1921, pp. 259–270 and 376–406, 27 figs. Oct.: Comparative tests on hot-water installations with coke and electric heating. Dec.: Comparative tests on different cooking devices, and comparative cooking tests with a coal oven and electrically heated tipping boilers in the Claradel Sanatorium, Zürich, Switzerland.

HEATING, FACTORY

Bleeder Steam. Using Bleeder Steam in Factory Heating, J. A. McGillivray. Power House, vol. 14, no 22, Nov 21, 1921, pp. 21–27, 11 figs. Bleeder type is especially furnished where low pressure steam is required for heating, in combination with electric motive power. Bleeder types are designed for a variety of conditions of operation, both in condensing and non-condensing units, or any combination of the two.

HEATING, STEAM

Central-Station. Present State of Central Heating Station Practice (La technique actuelle des centrales à vapeur). Le Génie Civil, vol. 79, no 21, Nov. 19, 1921, pp. 433–437. Discusses report of Commission for Utilization of Fuels, types of boilers, economizers, superheating, pre-heating, feedwater, etc. From Journal Officiel.

Equipment. Features of Central Steam Heat Plant Equipment, W. A. Scott. Elec. Rev., (Chicago), vol 79, no 21, Nov. 19, 1921, pp. 759–760, 1 fig. Underfeed stokers provide for boiler operation at 250 per cent of rated capacity; modern coal and ash handling apparatus reduces operating labor; water softener used to treat well water.

Exhaust. House Heating with Exhaust Steam (Raumheizung durch Abdampf), W. Pauer. Archiv für Wärmewirtschaft, vol. 2, no. 10, Oct. 1921, pp. 128–130, 2 figs. Gives fundamental principles for economic arrangement of heating installations, and discusses useful scope of the three types, namely, back-pressure, discharge and condensation.

Heat Utilization. Economic Utilization of Heat in Steam-Heating Plants (Wirtschaftliche Wärmeausnutzung bei Zentralheizungen), H. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 40, 42–43 and 44, Oct. 7, 28 and Nov. 4, 1921, pp. 324–327, 342–344 and 355–357, 24 figs. Review of latest developments in steam-heating plants. Reconstruction of steam heaters in dwelling houses.

HOISTS

Electric. Choice of Anuglar Velocity of a Winding Engine Driven by a Three-Phase Asynchronous Motor (Du choix de la vitesse angulaire d'une machine d'extraction commandée par moteur asynchrone triphasé), Georges Hacault. Révue Générale de l'Électricité, vol. 10, no. 22, Dec. 3, 1921, pp. 813–816, 2 figs. Discusses angular velocity from the point of view of slowing down without loss of energy or mechanical braking.

Mine. Scraping and Loading in Mines With Small Compressed-Air Hoists, Ward Royce. Eng. & Min. Jl., vol. 112, nos. 24, 25 and 26, Dec. 10, 17 and 24, 1921, pp. 925–931, 973–977 and 1014–1019, 50 figs. Use of slushers in underground loading applicable to various mining methods. Types of scrapers in successful use in Joplin, and Lake Superior iron and copper districts, and their application.

HYDRAULIC TURBINES

Bavarian Installations. The Turbines of the Walchensee Plant, Bavaria (Die Turbinen des Walchenseewerks), Georg v. Troeltsch. Elektrotechnische Zeit., vol. 42, no. 47, Nov. 24, 1921, pp. 1351–1354, 5 figs. Preliminary report of hydraulic equipment of unfinished plant in Bavaria. Turbines of total output of 168,000 hp. are being installed, two different types being used in same station, namely, four 24,000-hp. 500-r.p.m. Francis spiral turbines and four 18,000-hp. 250-r.p.m. Pelton wheels, both types operating under head of about 195 m. Comparison of described turbines with others of Francis and Pelton types.

Castings, Making. Making Water Turbine Castings, H. E. Diller. Foundry, vol. 49, nos. 22 and 23, Nov. 15 and Dec. 1, 1921, pp. 873–878 and 920–925, 19 figs. Nov. 15: Describes molding the large scroll-case castings; skeleton patterns keep down expense of equipment. Dec. 1: Method of molding small runners with vanes of curved steel plate and larger sizes with cast-iron vanes.

Efficiency, Determination of. Calorimetric Determination of Efficiency of Hydraulic Turbines (Sur la détermination de rendement des turbines hydrauliques par voie calorimétrique), L. Barbillion and A. Poirson. La Houille Blanche, vol. 20, no. 57–58, Sept.-Oct. 1921, pp. 161–166, 2 figs. Discusses the Rappel method of determining efficiency, based on the transformation into heat of all power losses.

Impulse Type. Caribou Power Plant Has World's Largest Impulse Wheel, W. M. White. Jl. Electricity & Western Industry, vol. 47, no. 12, Dec. 15, 1921, pp. 465–466, 4 figs. Describes machinery installed in Caribou plant of Great Western Power Co., having normal capacity of 30,000 hp. each under 1008-ft. head, at 171 r.p.m.

Reaction. Hydraulic Reaction Turbines, D. J. McCormack. Elec. Jl., vol. 19, no. 1, Jan. 1922, pp. 11–16, 13 figs. Discusses runners, casing, bearings, shaft, gate mechanism, etc.

Recent Developments. High Speed Hydraulic Turbines (Om snabblöpande vattenturbiner). Teknisk Tidskrift (Mekanik), vol. 51, no. 12, Dec. 14, 1921, pp. 155–160, 18 figs. Discusses recent developments in design, especially profile, to increase degree of efficiency.

HYDRAULICS

Eddy Curves. New Method for the Determination of Eddy Curves (Nouvelle méthode pour la détermination des croubes de remous), E. Batiele. Le Génie Civil, vol. 79, nos. 23 and 24, Dec. 3 and 10, 1921, pp. 488–492 and 515–516, 7 figs. Reviews methods in use and develops formulas for an improved method which tests made show to be satisfactory.

Laboratory. The Hydraulic Laboratory, S. G. Roberts. Sci. Am., vol. 126, no. 1, Jan. 1922, pp. 10–11, 5 figs. Describes equipment and experimental work done at hydraulic laboratory at Petty's Island, Pa.

HYDROELECTRIC PLANTS

England. Nidd Valley Hydro-Electric Installation. Engineering, vol. 112, no. 2920, Dec. 16, 1921, pp. 817–818, 18 figs. partly on supp. plate and p. 824. Small hydroelectric plant built for purpose of supplying power for cranes, wire ropeways crushing plant, etc., to be employed in construction of new Scar House dam. See also Elec. Rev. (Lond), vol. 89, no. 2299, Dec. 16, 1921, pp. 810–812, 5 figs.; and Elec. Times, vol. 60, no. 1574, Dec. 15, 1921, pp. 531–533, 4 figs.; also Engineer, vol. 132, no. 3442, Dec. 16, 1921, pp. 639–641, 10 figs. partly on p. 650.

Silt-Removal Plants. Silt-Removal Plants for Hydroelectric Stations (Entsandungsanlagen nach Patent H. Dufour). Schweizerische Bauzeitung, vol. 78, nos. 25, 26 and 27, Dec. 17, 24 and 31, 1921, pp. 295–299, 310–312 and 323–325, 13 figs. Describes automatic and continuous silt-removal system patented by H. Dufour. Experience with sedimentation tanks, reconstructed according to described system, of hydroelectric plant supplying light and power to Santiago de Chile. Its employment in Swiss plants. Its effect on efficiency and economy of hydroelectric plants.

Storage Reservoirs. Hydroelectric Plants and Storage Reservoirs (Impianti idroelettrici e serbatoi), Aristide Zenari. Giornale dell'Associazione Nazionale degli Ingegneri Italiani, vol. 2, no. 14, Sept. 1, 1921, pp. 210–213, 1 fig. Discusses variation in water level and makes calculations.

I

ILLUMINATION

Calculation of Intensities. Illumination Calculations for Various Planes, J. H. Kurlander. Elec. Rev. (Chicago), vol. 79, no. 24, Dec. 10, 1921, pp. 885–887, 3 figs. Derivation of equation showing simple relations between illumination intensities, source candlepower, and dimensions that can be easily determined in the field or from room plans.

Factory. Factory Illumination. Eng. Production, vol. 3, no. 63, Dec. 15, 1921, pp. 570–571. Notes on installation of lighting systems. Discusses varieties of glass used for windows of industrial works, and different systems of artificial lighting, consisting of direct, semi-direct and indirect lighting.

INDICATORS

Steam-Engine. The Detection of Errors in the Steam-Engine Indicator. Power, vol. 55, no. 3, Jan. 17, 1922, pp. 103–105, 5 figs. Deals with most probable errors.

INDUSTRIAL MANAGEMENT

Factories. Technical Service at the Factory (Les Services d'études dans les usines), Emm. La Langlois. La Vie Technique et Industrielle, vol. 3, no. 26, Nov. 1921, pp. 132–133. Preparation of new installations; improvements in material, tools and processes; study of upkeep and repairs; filing of information and documents on all matters.

Gantt Charts. How a Manager Uses Gantt Charts, Frank W. Trabold. Management Eng., vol. 2, no. 1, Jan. 1922, pp. 28–30. Discusses use of the Gantt load, idleness-expense, and man-record charts, some things they disclosed, and their value to executive.

Inspection System. The Delco Inspection System—II and III. Machinery (Lond.), vol. 19, nos. 473 and 475, Oct. 20 and Nov. 3, 1921, pp. 71–75, 14 figs. and pp. 122–125, 12 figs. Typical examples of gaging fixtures used by Dayton Engineering Laboratories Co. in manufacture and inspection of company's product.

Planning. Departmental Collaboration, James Edgar. Eng. & Indus. Management, vol. 6, no. 24, Dec. 15, 1921, pp. 690–692. Explains scientific planning of output, which has become essential with introduction of quantity-producing methods, consequent upon development of automatic machine.

Process Charts. Process Charts and Their Place in Management, Frank B. and L. M. Gilbreth. Mech. Eng., vol. 44, no. 1, Jan. 1922, pp. 38–41 and 70, 4 figs. Device for visualizing process as means of improving it. Authors point out place of process chart in management and present established working data used successfully in numerous working installations for many years; also its simplicity, field of application, its relation to standardization, etc.

Production Order Quantity. Determining the Production Order Quantity, W. E. Camp. Management Eng., vol. 2, no. 1, Jan. 1922, pp. 17–18, 2 figs. Writer derives formula for determining production order quantity such that total cost per unit for

setting up plus interest on stores investment will be minimum.

Routing. A Term-Delivery System (Ein Terminabgabesystem), H. Hempel. Werkstattstechnik, vol. 15, no. 20, Oct. 15, 1921, pp. 600–605, 10 figs. Describes practical tried-out system for term delivery. Routing of work is carried out from a central office in close touch with all employees.

Service Department. Service Work As a Phase of Production, S. Harold Greene. Management Eng., vol. 2, no. 1, Jan. 1922, pp. 7–11. Outlines system of service work which, it is claimed, should be recognized as a necessary and integral part of production.

Stores Control. Some Notes on Stores Control. Eng. & Indus. Management, vol. 6, no. 24, Dec. 15, 1921, pp. 682–684, 2 figs. Notes on systematic recording and disposal of defective parts.

Small Factories. Management Problems of the Small Factory, Ernest Cordeal. Indus. Management, vol. 63, no. 1, Jan. 1922, pp. 43–49, 2 figs. Machines, tools and appliances.

Organization and Management of the Small Shop, E. W. Leach. Am. Mach., vol. 55, nos. 17, 19 and 22, Oct. 27, Nov. 10 and Dec. 1, 1921, pp. 671–673, 754–756 and 883–885. Oct. 27: Small shop office work; why bookkeeping is essential; classifications of entries; value of credit. Nov. 10: Going after business; cause and effect of readjustment; function of advertising. Dec. 1: Qualifications of successful executive; coöperation between producers and management; modern business ethics.

Tool-Engineering Department. How Tool Engineering Cuts Costs, Joseph Lannen. Indus. Management, vol. 63, no. 1, Jan. 1922, pp. 12–20, 9 figs. System of supervising jigs, fixtures, gages and other equipment. Describes methods that have given satisfactory results in process of ascertaining costs in tool-engineering department.

Workshops. Workshop Management (Le controle à l'atelier), C. B. Thompson. L'Outillage, vol. 234, no. 46, Nov. 17, 1921, pp. 1232–1233. Discusses scientific management and its various applications.

[See also TAYLOR SYSTEM; TIME STUDY.]

INDUSTRIAL ORGANIZATION

British Works. An Efficient Works System. Eng. Production, vol. 3, nos. 60, 61, 62, Nov. 24, Dec. 1, 8 and 15, 1921, pp. 493–498, 517–522, 539–544 and 557–562, 59 figs. Detailed description of successful organization and system in works of Barr & Stroud, Ltd., Glasgow, manufacturers of high-grade precision instruments.

Knitting Mill. The Organization of Knitting Mills, Carle M. Bigelow. Management Eng., vol. 2, no. 1, Jan. 1922, pp. 37–42, 5 figs. Solving problem of labor control.

INDUSTRIAL RELATIONS

Human Factor. The Human Factor in Industry—IV, Clarence H. Northcott. Indus. Management, vol. 63, no. 1, Jan. 1922, pp. 36–41. What industry owes workers as members of the community. Notes on wage principles; rate fixing; organization to guarantee fair wages; security against unemployment; work preparatory school; care for working conditions; vocational selection; etc.

Improvement of. Various Plans to Improve Industrial Relations, Ray Vance. Can. Foundryman, vol. 12, no. 8, Aug. 1921, pp. 32–35. Discusses human elements, stock selling plans, bonus plans, industrial democracy, shop committee plans, etc.

Workmen's Control. The Workman in Control (Le Contrôle ouvrier). La Métallurgie, vol. 53, no. 46, Nov. 17, 1921, pp. 2141–2142. Discusses attitude of workers, industrial democracy, consent of labor, etc.

INDUSTRIAL TRUCKS

Electric. The Electromobile. Motor Transport, vol. 33, no. 879, Jan. 2, 1922, p. 13, 3 figs. Describes a battery-propelled vehicle of the 1 and 2-ton and the 4 and 5-ton types, the latter having a four-wheel drive.

INTERNAL-COMBUSTION ENGINES

Compound. Compounding the Combustion Engine, Elmer A. Sperry. Mech. Eng., vol. 44, no. 1, Jan. 1922, pp. 27–32 and 74, 14 figs. Presents results of research by author extending over series of years, during which it is claimed that not only has high-pressure principle been thoroughly established, but all important requirements have been worked out, and an engine embodying practically all advantages has been subjected to long continuous runs.

Development. Internal Combustion Engine, Charles E. Lucke. Nat. Engr., vol. 25, no. 12, Dec. 1921, pp. 604–607. Rising importance of oil-injection type. Review of development.

Working Process. The Working Process of Internal-Combustion Engines (Die Darstellung des Arbeitsvorganges der Brennkraftmaschinen), P. Meyer. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 48, Nov. 26, 1921, pp. 1234–1238, 7 figs. Writer points to defects of temperature-entropy diagram for representation of heat movement in internal-combustion engines, and describes a method for making the same determinations without employment of the terms entropy and kilogram-molecule, by sole use of well-known technical measurement units, and of presenting them in uniform dependence on volumetric value.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Electrolytic. Electrolytic Iron a Commercial Product, Bradley Stoughton. Iron Age, vol. 109, no. 1, Jan. 5, 1922, pp. 32–36, 5 figs. Eustis process compared with others. An ore instead of scrap as anode. Tests and properties, fields of usefulness.

IRON ALLOYS

Iron-Carbon. Study of Iron-Carbon Alloys (Zur Kenntnis der Eisen-Kohlenstofflegierungen), Rudolf Ruer. Zeit. für anorganische u. allgemeine Chemie, vol. 117, no. 4, July 27, 1921, pp. 249–261, 4 figs. Notes on solubility of cementite in molten iron; complete equilibrium between austenite, ferrite and graphite corresponding to equilibria of pearlite.

IRON AND STEEL

Production Cost, China. Cost of Iron and Steel Production in China. Colliery Guardian, vol. 122, nos. 3167 and 3168, Sept. 9 and 16, 1921, p. 714 and p. 818. Sept. 9: Gives tables of monthly figures of Hanyang and Penghsihu works and discussses them. Sept. 16: Gives cost of steel manufacture, and cost and labor. Concludes that cost of iron and steel production in China cannot be lowered unless there are better and cheaper means of transportation. From Peking Daily News.

L

LABOR

Eight-Hour Laws. The Eight-Hour Day (Autour de la journée de huit heures), Georges Lafond. L'Outillage, vol. 232, no. 44, Nov. 3, 1921, pp. 1165–1167. Discusses conditions in France and other countries, showing that it cannot be maintained.

Rules for Railway Shop Crafts. New Rules for Shop Crafts Issued by Labor Board. Ry. Mech. Engr., vol. 96, no. 1, Jan. 1922, pp. 9–16. Gives complete text of new rules, including special rules for each craft. Provisions made more elastic; rights of minorities recognized; many old rules retained.

LABORATORIES

Research. Finding the Better Way—III, Charles E. Ruby. Indus. Management, vol. 63, no. 1, Jan. 1922, pp. 26–29, 3 figs. How research laboratories assist business. Users of industrial laboratories.

LATHES

Capstan. A 5$^1/_2$-Inch Capstan Lathe. Engineer, vol. 132, no. 3443, Dec. 23, 1921, pp. 684–685, 4 figs. Describes new design of lathe by Pollock & Macnab, Ltd., Bredbury, England, which is said to be much more powerful than lathes of this size usually are.

Turret. Turret Lathe Tooling, I. F. Yeoman. Machy. (N. Y.), vol. 28, no. 5, Jan. 1922, pp. 356–358, 4 figs. Equipment for machining differential gear housings on foster turret lathes.

LEAD ALLOYS

Frary Metal. The Electrolytically Produced Calcium-Barium-Lead Alloys Comprising Frary Metal, William A. Cowan, L. D. Simpkins and G. O. Hiers. Chem. & Met. Eng., vol. 25, no. 26, Dec. 28, 1921, pp. 1181–1185, 13 figs. Equilibrium diagram and microstructure of barium-lead and calcium-lead alloys. Ternary alloy hardens and strengthens on aging; is hard at moderate temperature; can be melted without change in analysis, and is a very fine bearing metal. Paper, slightly condensed, read before Am. Electrochem. Soc.

LIFTING MAGNETS

Use in Workshops. Lifting Magnets and Their Use in Workshops (Die Lasthebemagnete und ihre Anwendung im Werkstättenbetriebe), Richard Hänchen. Betrieb, vol. 4, no. 5, Dec. 10, 1921, pp. 157–162, 13 figs. Discusses their useful field, operation and efficiency, and describes newest types.

LIQUIDS

Corrosive, Handling. Anti-Corrosive Chemical Engineering Plant. Canadian Chemistry and Metallurgy, vol. 5, no. 12, Dec. 1921, pp. 341–342, 2 figs. Some English chemical equipment designed for special service in handling acids and corroding liquids.

LOCOMOTIVES

Design. Modern Locomotive Engine Design and Construction—LXXVI. Ry. Engr., vol. 42, no. 503, Dec. 1921, pp. 458–463, 7 figs. Practical considerations affecting production of an economical form of coupling rod.

Electric. See ELECTRIC LOCOMOTIVES.

Missouri and Northern Pacific. Operating Capacity Increased With Modern Motive Power. Ry. Rev., vol. 69, no. 25, Dec. 17, 1921, pp. 817–821, 8 figs. Describes Mikado, Mountain, and Pacific types, constructed by Am. Locomotive Co. for Missouri and Northern Pacific roads.

Mountain Roads. Shay Geared Locomotives for Mountain Roads. Ry. Age, vol. 71, no. 25, Dec. 17, 1921, pp. 1198–1210, 4 figs. 150-ton Shay for Greenbriar, Cheat & Elk R. R. High sustained tractive effort compared with Mikados.

Rebuilding. Rebuilding Old Locomotives, Carl B. Smith. New England Railroad Club, Dec. 13, 1921, pp. 207–214 and (discussion) 215–228. Discusses replacing of boilers, superheater equipment, cylinders, valve gears, frames, automatic fire doors, and other parts.

Superheater. Locomotives of the Pacific Type of the Midi Company, France (Note sur les locomotives Pacific à deux cylindres à simple expansion et surchauffe de la Compagnie des Chemins de Fer du Midi), M. Leboucher. Révue Générale des Chemins de Fer et des Tramways, vol. 40, no. 11, Nov. 1921, pp. 291–303, 7 figs., partly on supp. plate. Superheater, two cylinder twin-action type. Complete specifications and data.

LUBRICANTS

Reclamation and Distribution. Supplying Oil to 2,000 Automatic Screw Machines, E. C. Henn. Am. Mach., vol. 56, no. 1, Jan. 5, 1922, pp. 4–7, 10 figs. Oil pumped from tank cars to storage tanks; centrifugal machines separate used oil from chips; elaborate system of reclamation and distribution.

Viscosity and Friction. Viscosity and Friction, Winslow H. Herschel. Soc. Automotive Engrs. Jl., vol. 10, no. 1, Jan. 1922, pp. 31–41, 2 figs. Discusses viscosity effect in complete-film-lubrication régime; viscosity estimation at one temperature from observed viscosity at another temperature; friction testing of bearing metals; oiliness of lubricants; oil-friction testing machines; etc.

LUBRICATING OILS

Steam-Turbine. Essential Qualities of Oil for Steam Turbine Lubrication, J. Y. Dahlstrand. Elec. Rev. (Chicago), vol. 79, no. 21, Nov. 19, 1921, pp. 770–772, 3 figs. Definition of viscosity of oil; tests required to determine quality of oil; auxiliary oil pump and its operation and use.

The Viscosity of Steam-Turbine Oils, V. M. Hatch. Power, vol. 54, no. 26, Dec. 27, 1921, pp. 1011–1012. Factors controlling friction in bearings. Viscosity at operating temperature is said to be most important consideration.

M

MACHINE GUNS

Browning .50-Caliber. The Super-Machine Gun, Herbert O'Leary. Army Ordnance, vol. 2, no. 9, Nov.-Dec. 1921, pp. 129–132, 7 figs. Describes the Browning .50-caliber machine gun and its successful development.

MACHINE SHOPS

British. Famous British Works. Eng. Production, vol. 3, nos. 64 and 65, Dec. 22 and 29, 1921, pp. 578–580, 6 figs. and 602–604, 4 figs. Dec. 22: Describes Siemens Works, Stafford, of the English Elec. Co., Ltd., for manufacture of medium sizes of electrical equipment, particularly rotary converters for industrial purposes and electric traction, and switchgear of all kinds. Dec. 29: The Hoffmann Mfg. Co., Ltd., Chelmsford, for manufacture of ball and roller bearings.

MACHINE TOOLS

Drives. The Driving of Machine Tools, Hubert Bentley. Eng. & Indus. Management, vol. 6, no. 24, Dec. 15, 1921, pp. 688–689. Practical advice on efficient driving of modern machine tools. Deals with increased employment of chain and direct-gear drive in transmitting power, and advent of direct drive from lineshaft to single-pulley all-gear-driven machine.

Feeds and Speeds. Feeds and Speeds as Production Factors, Albert A. Dowd and Frank W. Curtis. Machy. (N. Y.), vol. 28, no. 5, Jan. 1922, pp. 381–383, 5 figs. Importance of recording; installing a system of and setting speeds and feeds; savings made possible by increasing rate of feed on a lathe; savings effected by change of tools.

MACHINERY

Special and Automatic. When Is It Economical to Install Special and Automatic Machinery? A. L. DeLeeuw. Management Eng., vol. 2, no. 1, Jan. 1922, pp. 19–24, 1 fig. Includes chart showing various conditions met in grouping special machinery. Notes on determining costs under part-time operation; figuring value of machinery; single-purpose machines; operating automatic machinery in cycles; etc.

MALLEABLE CASTINGS

Foundry Problems. Pertinent Facts Concerning Malleable-Iron Castings, Enrique Touceda. Soc. Automotive Engrs. Jl., vol. 10, no. 1, Jan. 1922, pp. 53–61, 12 figs. Discusses foundry difficulties; casting defects; shrinkage and machinability; improvements in annealing-oven construction and operation.

MANGANESE STEEL

Electric. Manganese Steel Made in Electric Furnace, Larry J. Barton. Iron Age, vol. 109, no. 1, Jan. 5, 1922, pp. 4–8 and 109, 11 figs. Discusses melting practice for castings. Use of manganese steel scrap. Deoxidizing with manganese ore Heat treatment.

Welding. Welding Manganese Steel, H. R. Pennington. Welding Engr., vol. 12, Dec. 1921, pp. 21–23 and (discussion) 23–24, 2 figs. Frogs and crossing layouts put in service at a fraction of cost of new installation. Gives table showing effect of varying quantities of manganese and carbon on physical quality of steel. Discusses arc welding methods. Paper read before Am. Welding Soc.

MARINE STEAM TURBINES

Blading Failures. Low Pressure Turbine Blading Failures in Destroyers, D. F. Ducey. Jl. Am. Soc. Naval Engrs., vol. 33, no. 3, Aug. 1921, pp. 512–540, 39 figs. The turbines are of the impulsive type having five rows of moving blades. The first and second are of monel metal, the third, fourth and fifth of chrome-vanadium and chrome-nickel steel Describes failures in detail and gives illustrations.

MATERIALS

Thermal Conductivity of Wearing. Thermal Conductivity of Some Wearing Materials, Emily S. Rood. Physical Rev., vol. 18, no. 5, Nov. 1921,

pp. 356-361. Results of measurements made with samples of woolen, cotton, and silk materials

METALS

Colloidal State. Colloidal State in Metals and Alloys—I, Jerome Alexander Chem & Met Eng., vol. 26, no. 2, Jan 11, 1922, pp 54-58 Molten metal. Shows that many of important phenomena of metals and alloys are due to colloidal state of subdivision, and that portion of the metal or alloy tends to remain in the colloidal state and exert a powerful influence upon physical properties of final solid magma.

Electro-deposition. The Electro-Deposition of Metals—VIII, W E Hughes Beama, vol. 9, no 6, Dec 1921, pp. 555-562 Discusses electrodeposition of lead Applications, properties, lead-plating solutions, and macrostructure

Fatigue. Fatigue of Metals Under Repeated Stress, Moore and Kommers Chem. & Met Eng., vol. 25, no. 25, Dec 21, 1921, pp 1141-1144, 6 figs. Results of experiments. Carbon steels will not fail by "fatigue" if stressed below a definite amount, quickly determined by measuring heat generated in specimen during test.

Grain Structure. Grain Structure in Metals (Ueber Faserstruktur bei Metallen), Margarete Ettisch, M. Polanyi and K Weissenberg Zeit fur Physik, vol. 7, no 3, Nov 3, 1921, pp. 181-184, 4 figs. Investigation of hard-drawn copper and tungsten wires, results of which show crystallographic directions in which wires are grained.

Metallographic Testing. Metallographic Testing. U S. Bur of Standards Circular, no 42, Aug 29, 1921, 11 pp., 4 figs. Study of fundamental conditions, structure, constitution, and treatment of metals and alloys. Discusses different lines of metallographic testing carried out by Bur of Standards.

Structure. Structure and Related Properties of Metals, U. S. Bur. Standards Circular, no. 113, Sept. 7, 1921, 104 pp., 71 figs. Discusses general nature of structure of metals, methods for revealing it, and dependence of properties of metal as a whole upon its structural features. Describes methods in use for revealing chemical unhomogeneity, crystalline heterogeneity, physical unsoundness, and mechanical nonuniformity. Discusses principles underlying action of etching reagents; conditions affecting structure, chemical composition, application of heat, and mechanical working of metal; and dependence of mechanical properties and chemical behavior upon structure condition of material.

Surface Flaws. Influence of Surface Flaws on Strength of Metals, Horace C. Knerr. Automotive Industries, vol. 45, no. 25, Dec. 22, 1921, pp. 1216-1217, 6 figs. Shows that surface flaws have a pronounced effect upon metals subjected to fatigue through repeated stresses, but that such flaws do not always decrease strength under constant load conditions.

Testing. Testing Metal by Repeated Stress, H. F. Moore and J. B. Kommers. Iron Trade Rev., vol. 69, no. 25, Dec. 22, 1921, pp. 1623-1630, 7 figs.; also Eng. News-Rec., vol. 88, no. 2, Jan. 12, 1922, pp. 76-78, 3 figs. Fatigue investigation is broadened to include variety of steels and several heat treatments. Results show definite relation between Brinell hardness and endurance limit. Rise of temperature test used to predict limit. (Abstract.) Bul. no. 124. Engineering Experiment Station, University of Illinois.

METRIC SYSTEM

English System vs. A Digest of "The Metric versus the English System of Weights and Measures." Nat. Indus. Conference Board, Special Report No. 20, Dec. 1921, 11 pp. Presents facts and arguments on whether metric system should be substituted for English system of weights and measures in the United States.

MILLING CUTTERS

Backed-Off. Backed-Off Milling Cutters (Ueber hinterdrehte Fräser), Paul Zietung. Werkstattstechnik, vol. 15, no. 20, Oct. 15, 1921, pp. 593-595, 32 figs. Notes on production of backed-off profile cutters with a forming tool and different separate tools in various relief stages: control of backed-off milling cutters. Discusses copying with backed-off milling cutters.

Sharpening. How to Sharpen Milling Cutters, Fred B. Jacobs. Abrasive Industry, vol 2, no. 12, Dec. 1921, pp. 395-401, 19 figs. Cutter grinding operations are expedited by using a machine designed for the purpose; form cutters require careful attention.

MILLING MACHINES

Manufacturing Operations. Manufacturing Operations on Milling Machines, Robert Mawson. Am. Mach., vol. 55, no. 25, Dec. 22, 1921, pp. 996-997, 10 figs. Special toolholders for facing four-step cones. Fixtures and tools for machining milling machine heads. A unique angle-facing fixture.

MOLDING MACHINES

Modern Types. The Present Status of Molding Machine Construction—I (Der heutige Stand des Formmaschinenbaues), U. Lohse, Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 48, Nov. 26, 1921, pp. 1220-1223, 17 figs. Deals with hand-molding machines, including machines with lifting carriages, stripping-plate machines, and turnover-type machines.

Rollover. Rollover Jarring Machines (Der Gutmannsche Umrollrüttler), U. Lohse. Giesserei-Zeitung, vol. 18, no. 32, Nov. 15, 1921, pp. 423-424, 1 fig. Machine constructed by A. Guttmann Machine Constr. Corp., Hamburg, is said to differ from American types in that all the movements (jarring, rolling over and taking out) are effected by a single pneumatic cylinder by means of a single regulating cock.

MOLDING METHODS

Flour-Mill Rolls. Molding and Casting Chilled Flour-Mill Rolls, G. O. Vair. Can Foundryman, vol 12, no. 8, Aug 1921, pp 20-21 and 25, 5 figs Designs for molds; casting; machining.

MOLYBDENUM STEEL

Annealing. Constituents Observed in Tungsten and Molybdenum Steels (Constituants observés dans les aciers au tungstène et les aciers au molybdène) Albert Portevin. Révue de Métallurgie, vol 18, no 11, Nov. 1921, pp. 713-716, 6 figs. Effects of annealing and subsequent very slow cooling on structure. Paper read before Iron & Steel Inst., Paris.

MOTOR TRUCKS

Manufacturing Methods. Manufacturing Parts of Northway Trucks, Robert Mawson. Am. Mach., vol 56, no 3, Jan 19, 1922, pp 101-103, 10 figs. Work on pistons and connecting rods; turning and inspecting camshafts; crankshaft balancing; fixture for assembling chassis; pressing on rubber tires.

MOTORCYCLES

Single-Cylinder Solo. The Development of the Single-Cylinder Solo Motor Cycle, H. D. Teage. Automobile Engr., vol. 11, no. 156, Nov. 1921, pp. 382-386, 12 figs. Distinguishes between the luxurious go-anywhere touring mount, the purely sporting machine, and the machine for the multitude. Discusses weight, valve gear, two-cycle engines, cooling, lubrication, ignition, transmission, etc Paper read before Instn. Automobile Engrs.

N

NOZZLES

Measuring Pulsating Flow. The Use of Nozzles in Measuring Pulsating Flow. Chem. & Met. Eng., vol. 26, no 1, Jan. 4, 1922, pp. 32-34, 3 figs. Discusses errors resulting from use of nozzles for measuring differential pressure unless the flow curve is known as a function of time.

O

OIL ENGINES

High-Compression. The Recent Development of High-Compression Oil Engines Without Air Pumps, Especially As Small Oil Engines (Die neuere Entwicklung der Hochdruckölmaschine ohne Luftpump, insbesondere als Kleinölmaschine), F. Modersohn. Oel- u. Gasmaschine, vol. 18, nos. 9, and 11, Sept. and Nov. 1921, pp. 140-142, and 169-173, 2 figs. Deals only with such engines whose practicability has been demonstrated, which are divided into three groups, namely, those operating with pure pressure injection; with combustion-chamber action; and with eddy production.

Manufacturing Methods. Cutting Costs in a Crude-oil Engine Manufactory. Machy. (Lond.), vol. 19, no. 481, Dec. 15, 1921, pp. 315, 11 figs. Reviews methods employed by Vickers-Petters, Ltd., Ipswich, including machining component parts, operations on cylinder casing and cylinder liners, elimination of non-productive machine time, etc.

OIL FUEL

Burning. The Burning of Oil Fuel and the Arrangement of Machinery Necessary, together with Observations and Comments Drawn from Actual Conditions, A. Keens. Trans. Inst. Mar. Engrs., vol 33, Oct. 1921, pp. 337-363 and (discussion) 363-375, 12 figs. Discusses advantages of fuel oil; storage spaces; oil fuel pumps; piping, holders and burners; furnaces and combustion chambers; pumping arrangement; etc.

Glass Industry. The Application of Oil Fuel in the Glass Industry. Jl. Soc. Glass Technology, vol 5, no. 19, Oct. 1921, pp. 286-300 and (discussion) 300-307. Symposium. Comparison with gas firing.

Injection and Combustion. Injection and Combustion of Fuel-Oil—VI and VII, C. J. Hawkes. Motorship, vols. 6 and 7, nos. 10 and 2, Oct. 1921 and Jan. 1922, p. 820, 4 figs. and p. 34, 6 figs. Experiments with solid-injection and air-blast in marine Diesel engines.

Mexican. The Production and Combustion of Mexican Fuel Oil—VIII, J. M. Pettinbell and J. R. Carlson. Combustion, vol. 5, no. 6, Dec. 1921, pp. 254-257, 6 figs. Discusses economy in oil burning operation.

Steam Generation. Liquid Fuel and Its Application for Steam Generation, J. H. Anderson. Inst. of Mar. Engrs. Trans., vol. 33, Dec. 1921, pp. 521-563 and (discussion) 563-568, 27 figs. Discusses fractional and continuous distillation, and use of fuel oil. Describes a number of oil fuel heaters and systems of fuel-oil burning.

Sulphur in. Effects of Sulphur in Fuel Oil, Allen F. Brewer. Power, vol. 55, no. 2, Jan. 10, 1922, pp. 50-51. States that presence of sulphur is detrimental, but its deteriorating effect can be largely avoided by adopting proper precautions.

OILS

Vegetable, Machines for Producing. Machinery for Vegetable Oil Prodiction. Eng. Rev., vol. 35, no. 6, Dec. 1921, pp. 182-187, 8 figs. Reviews development of these machines and compares the various designs.

OPEN-HEARTH FURNACES

Fuels Used. Fuels Used in Open Hearth Practice, Edwin F. Cone Iron Age, vol 108, no. 25, Dec. 22, 1921, pp 1589-1591 Analysis of 1920 ingot and castings production. Producer gas chiefly employed for ingots and oil for castings. Results of answer to questionnaire sent to producers of open-hearth steel ingots and steel castings.

OXY-ACETYLENE WELDING

Bronze Condenser Sheets. Bronze Condenser Sheets, H. I. Walsh. Welding Engr., no 12, Dec. 1921, pp 27-28 and 40, 7 figs. Gas welding gives practical solution of problem arising from increase in size of ships. Paper read at Internat Acetylene Assn Convention

P

PIPE, STEEL

Hammer-Welded. Hammer-Welded Steel Pipe—How It Is Made and Wherein It Excels. Raw Material, vol. 4, no 11, Nov. 1921, pp. 384-391, 11 figs. Discusses advantages over butt-weld and lap-weld methods, and methods used by Nat. Tube Co.

PIPE, WROUGHT-IRON

Chart for. Wrought Pipe Data Sanitary & Heat. Eng., vol. 96, no. 14, Dec. 30, 1921, p. 395. Chart containing valuable information for the sanitary and heating engineer.

PISTONS

Machining Castings and Rings. How a British Foundry Specializes, H. Cole Estep. Foundry, vol 49, no. 22, Nov. 15, 1921, pp. 879-887, 22 figs. Describes English methods of making piston castings and pots for piston rings.

PLANERS

Testing. Planing Machine Studies. Engineering, vol. 112, no. 2922, Dec. 30, 1921, p. 886. Results of experimental work carried out in Germany by G. Schlesinger on a horizontal planing machine, driven by electric motor running at 1460 r.p.m. with toothed gear and belting. Various improvements were tested and it was possible to greatly reduce power absorbed and almost completely overcome power fluctuations. Translated from pamphlet by G. Schlessinger and M. Kurrein.

POWER

Costs. How to Follow Up Power Costs—III, N. A. Craigue. Indus. Management, vol. 63, no. 1, Jan. 1922, pp. 55-59, 1 fig. Various methods of distribution. Meters may be used to actually measure power as consumed; cost rate applied, and final cost obtained is charge against product.

POWER PLANTS

Design. Developments in Power Station Design. Engineer, vol. 132, nos. 3441, 3443 and 3444, Dec. 9, 23 and 30, 1921, pp. 613-614, 5 figs., partly on supp. plate.; 668-669, 3 figs.; 702-704, 10 figs. Dec. 9: Describes extensions being made to boilerhouse of the Neasden power station of Metropolitan Ry. by John Thompson Water-Tube Boilers, Ltd., Wolverhampton. Dec. 23: 12,000-kw. turbo-generator installed at Neasden power station, and other important additions. Dec. 30: Application of air heaters to central-station boilers.

Modern European Tendencies in Power-Plant Design, A. W. H. Griepe. Power, vol. 55, no. 2, Jan. 10, 1922, pp. 54-56. European tendency is now to supply large cities at high voltage from large generating stations near mines, and gradually to shut down small, inefficient local plants. Notes on modifications in boiler proportions, types of boilers in use, boiler tubes and superheaters, economizers, stokers, cinder and soot disposal, preheating of air, use of low-grade fuels, etc. The Bone-Schnabel surface-combustion process in Germany. Only horizontal types of turbines used.

Maxim Silencers, Use of. The Maxim Silencer in the Power Plant. Power, vol. 55, no. 3, Jan. 17, 1922, p. 91, 3 figs. Describes use of such silencers, patents for which are now pending, as power-plant apparatus, for application to exhausts of oil and gas engines, oil- and gas- engine suctions, compressed-air unloaders, unaflow-engine exhausts, steam safety valves, air hoists, steam and air discharges from special apparatus.

Progress in 1921. The Year's Progress in the Power Plant Field. Power, vol. 55, no. 1, Jan. 3, 1922, pp. 2-14, 11 figs. Boiler efficiencies of 90 per cent when burning pulverized coal, seven notable steam plants put into operation, unusual interest in hydroelectric development, 220,000-volt electric power equipment, are some of outstanding features of 1921.

PRESSES

Hydraulic and Hand-Forcing. Hydraulic and Hand Forcing Presses in a Locomotive Shop, J. V. Hunter. Am. Mach., vol. 56, no. 3, Jan. 19, 1922, pp. 108-109, 5 figs. Horizontal press for forcing brasses in boxes. Method of using air pumps for boosting pressures. Self-contained portable press.

Fixtures. Some Examples of Fixtures Used on Profiling Machines, J. M. Henry. Am. Mach., vol. 55, no. 26, Dec. 29, 1921, pp. 1040-1043, 11 figs. Points out that with suitable fixtures, machines may be used for many different operations; and two or more operations may be preformed at one setting.

PULVERIZED COAL

Air Furnaces. Apply Powdered Coal to Air Furnace, Pat Dwyer Foundry, vol. 49, no. 24, Dec. 15, 1921, pp. 955-962, 15 figs. Malleable-iron melting furnaces and annealing ovens have been converted

from hand-firing to use of powdered coal without involving radical changes in design.

Application to Boilers. Application of Pulverized Coal to Boilers, J. W. Fuller. Trans. Am Inst. Min & Metallurgical Engrs., no. 1106–C, 1921, 4 pp Gives a few instances of many successful installations burning pulverized coal that were made under various types of boilers and using many fuels. Abstract of paper in Min. & Metallurgy, no 180, Dec. 1921, pp 35 36.

Metallurgical Furnaces. Powdered Fuel, J. S. Atkinson. Iron & Coal Trades Rev., vol 103, no. 2805, Dec. 2, 1921, p. 802. Recent developments in connection with firing of metallurgical furnaces. Relative costs of gas firing and powdered fuel firing, cost of powdering, etc. (Abstract.) From Fuel Economy Rev.

Preparation and Combustion. The Preparation, Transportation, and Combustion of Powdered Coal, John Blizard. Canada Dept. of Mines, no. 564, 1921, 131 pp., 42 figs. Discusses distribution; feeder, mixers and burners; advantages and disadvantages; use for steam raising, costs of preparing and delivering to furnace; operating and repair costs; etc.

Small-Plant System. Pulverized-Coal System for Small Plants. Power, vol. 54, no. 26, Dec. 27, 1921, pp. 1016–1017, 2 figs. System consisting of self-contained crusher and blower allows pulverized coal to be used in small plants.

Turbo Pulverizer. The Turbo Pulveriser. Iron & Coal Trades Rev., vol. 103, no. 2807, Dec. 16, 1921, p. 877, 1 fig. Describes apparatus built by The Powdered Fuel Plant Co., Ltd., Lond., which is a pulverizing mill and fan combined.

PUMPING PLANTS

Hydroelectric Reservoirs. Pumping Plants for Water-Power Reservoirs (Les installations d'accumulation hydraulique par pompage), Jacques Godin. Révue Générale de l'Électricité, vol. 10, no. 24, Dec. 17, 1921, pp. 881–887, 7 figs. Discusses pumping plants for supplying additional water power to hydroelectric plants which desire to increase beyond their capacity, and gives successful examples in France and Italy.

PUMPS

Mammoth. Mammoth Pumps Eng. Progress, vol. 2, no. 12, Dec. 1921, pp. 277–278, 3 figs. Describes construction and operation of the pump and its application to raising water, chemical liquids, and solid substances that can be moved in currents of fluids.

PUMPS, CENTRIFUGAL

High-Pressure. The Operation of High-Pressure Centrifugal Pumps (Die Betriebsweise der Hochdruck-Zentrifugalpumpen). Wärme- u. Kälte-Technik, vol. 23, no. 22, Nov. 15, 1921, pp. 253–257, 8 figs. Includes table giving results of tests with a 3-stage high-pressure centrifugal pump for raising 2000 liters of water per minute to height of 112 m., directly coupled with a 75-hp. asynchronous motor with 1480 r.p.m. at 50 periods. Points out advantages and useful field of centrifugal pumps.

Parallel Operation. Operating Pumps or Fans in Parallel, J. C. Hobbs. Power, vol. 55, no. 2, Jan. 10, 1922, pp. 58–60, 6 figs. Discusses problems encountered in parallel operation of centrifugal pumps and explains why pumps must have correct characteristics.

PYROMETERS

Radiation. A New Radiation Pyrometer for the Measurement of High Temperatures (Ein neues Strahlungspyrometer zur Messung hoher Temperaturen), Georg Keinath. Elektrotechnische Zeit., vol. 42, no 48, Dec 1, 1921, pp. 1384–1387, 10 figs. With temperatures exceeding 1200 deg. cent. the wear of thermocouple armors is said to be considerable, so that it appears advisable to carry out measurements with radiation pyrometers. A new construction type and its properties are described.

PYROMETRY

Liquid-Fuel-Fired Boilers. Pyrometry of Boilers Fired with Liquid Fuel, E. C. Reed Eng. & Indus. Management, vol. 6, no. 26, Dec. 29, 1921, pp. 743–746, 4 figs. Describes the Foster fixed focus pyrometer and its application. Writer claims that expense of installation of pyrometer system may be saved many times over in year.

R

RAILS

Reclaiming Worn-Out. Worn-Out Rails –Their Resurrection from Uselessness to Usefulness. Raw Material, vol 4, no. 11, Nov. 1921, pp. 392–395, 11 figs. Describes operations at Sweet's Steel Co.'s rail reclamation plant, Williamsport, Pa.

Sink-head Ingot Rolling. Sound Steel in Rail Manufacture, Cecil J. Allen. Ry. Engr., vol. 42, no. 503, Dec 1921, pp 468–470, 3 figs. Comparison of results obtained by Pennsylvania Railroad with rails rolled from sink-head and ordinary ingots, respectively.

Sorbitic Steel. Wear of Railroad and Street Car Rails (L'Usure des rails de chemins de fer et de tramways), J. Gouttier Révue Universelle des Mines, vol. 11, no. 5, Dec. 1. 1921, pp. 524–513, 12 figs. Describes Sandberg process of producing sorbitic steel and its successful application to rails.

The Latest in Steel Rails, Frederic C. Carl. Sci Am., vol 126, no 1, Jan. 1922, p. 44. Notes on sorbitic steel rail manufactured according to Sandberg process, which is said to double life of rail while increasing cost only by 20 per cent.

Wear. Causes of Premature Wear of Rails (Les causes de l'usure prématurée des rails). Le Génie Civil, vol. 79, no. 21, Nov. 19, 1921, pp. 429–433, 26 figs. Discusses cracks, fissures, segregation, etc., in rails; effect of tempering, and of natural wear.

RAILWAY CONSTRUCTION

Canada. Development of Canadian Railway Construction, H. K. Wicksteed. Can. Engr., vol. 42, no. 1, Jan. 3, 1922, pp. 104–108. Describes early trade routes and economic conditions which resulted in construction of railways in Canada. Problems solved by engineers when locating trans-continental road. Paper before Am. Assn. for Advancement of Sci.

Grade Reduction. Justifying Expenditures for Grade Reductions, George J. Ray. Ry. Age, vol. 71, no. 26, Dec. 24, 1921, pp. 1243–1250, 5 figs. Shows that the construction of the Clarks Summit-Hallstead line is fully warranted by operating results. (Abstract.) Paper read before Western Soc. Engrs.

RAILWAY ELECTRIFICATION

Advantages. Railway Electrification, Vincent L. Raven. North-East Coast Instn. Engrs. & Shipbuilders, advance paper, no. 3195-P for meeting, Dec. 16, 1921, 24 pp., 9 figs., partly on supp. plate. Deals with advantages which may result from substitution of electric for steam locomotive operation. See also Engineer, vol. 132, nos. 3443 and 3444, Dec. 23 and 30, 1921, pp. 673–674 and 711, 713, 5 figs., partly on supp. plate.

Steel Plant. Electrification of Steel Plant Railroad, R. B. Gerhardt. Iron Age, vol. 108, no. 26, Dec. 29, 1921, pp. 1663–1666. Difficulties are said to include protection of third rail from hot metal spills. Saving in cost 50 per cent. Investment offset by low operating cost. Paper presented before Assn. Iron & Steel Elec. Engrs.

Superpower Plan. Electric Traction Proposed for 11 Railroads. Ry. Elec. Engr., vol. 12, no. 11, Nov., 1921, pp. 409–414, 9 figs. Discusses Superpower Survey report transmitted to the president containing plan providing for the interconnection of a large number of existing plants. By consolidating power supply, electric operation could be made to show saving of 14 per cent.

RAILWAY OPERATION

North Eastern Railway. Surveys, Diagrams and Other Records Prepared by the Engineer's Department of the North Eastern Railway, Conrad Gribble. Ry. Gaz., vol. 35, no. 23, Dec. 2, 1921, pp. 841–848, 7 figs., partly on supp. plate. Line and siding diagrams as substitutes for surveys. Coördination of field work in measuring distances for statistical, operating and commercial purposes. Systematic recording of strength of bridges. Percentage system for recording equivalent weights of locomotives.

Train Dispatching. Management of Single Track Lines in Great Britain (Note sur l'exploitation des lignes a voie unique dans le Royaume-Uni). Review Génerale des Chemins de Fer et des Tramways, vol. 40, no. 11, Nov. 1921, pp. 304–318, 14 figs. Discusses ticket, tablet, and token systems of train dispatching, and the various apparatus for exchanging used in connection with them.

RAILWAY SHOPS

Montreal, Can. A Railroad Shop Organized for Efficiency. Machy. (N. Y.), vol. 28, nos. 4 and 5, Dec. 1921, and Jan. 1922, pp. 291–293 and 389–392, 8 figs. Description of Angus shops of Can. Pac. Ry. Co., Montreal, Canada, and equipment and methods employed.

RAILWAY SIGNALING

Interlocking. New Interlockings at Jacksonville Terminal, C. J. Kelloway, Ry. Signal Engr., vol. 14, no. 12, Dec. 1921, pp. 462–468, 18 figs. Developments in the construction of a large electro-pneumatic and two electro-mechanical plants with inter-connecting circuits.

RAILWAY SWITCHES

Electric. Electrically Operated Equipment for Car Handling, R. M. Kintzing. Elec. Rev. (Chicago), vol. 79, no. 21, Nov. 19, 1921, pp. 773–775, 6 figs. Interlocking and limit control switches employed to assure proper sequence in cycle of movements; great saving in labor and increase in plant capacity secured by electrical operation.

RAILWAYS

China. The Peking-Suiyuan Railway of China. Sci. Am., vol. 126, no. 2, Feb. 1922, pp. 116–117, 8 figs. Description of road surveyed, constructed and operated entirely by Chinese.

Development 1921. General Railroad Developments During the Year. Ry. Age, vol. 72, no. 1, Jan. 7, 1922, pp. 9–154, 89 figs. Articles on regulation of securities, labor situation, federal valuation, railroad accounts with the government, profit of railroads from lower material costs, recent tendencies in locomotive development, special types of cars introduced in 1921, maintenance of way, cutting freight loss and damage claims, accounting, equipment conditions, electrical developments, repair-shop and enginehouse development, chronological review of year's activities. Also contains articles on railway statistics, including locomotive, freight-car and passenger-car market.

Monorail Suspended Line. Monorail Suspended Railroad Tracks and Canal-Boat Haulage (Système de voies suspendues monorails et systeme de halage des bateaux), M. Mahl. Bul. de la Société Française des Électriciens, vol. 1, no. 7, July 1921, pp. 337–368, 13 figs. Discusses a projected monorail line from Paris to Nice according to the Barmen-Elberfeld system, but with maximum speed of 300 km. per hr., also power transmission and boat haulage as side issues.

REFRACTORIES

Resistance. Resistance Tests on Refractory Products under Load at Different Temperatures, V. Bodin. Quarry & Surveyors' & Contractors' Jl., vol. 26, no. 297, Nov. 1921, pp. 438–440, 3 figs. Results of tests, and table of crushing loads in kg.-cm. (Abstract.) Paper read before Ceramic Soc.

REFRIGERATING MACHINES

Carbon-Dioxide. Carbon-Dioxide Refrigerating Machine, H. J. Macintire. Power, vol. 55, no. 1, Jan. 3, 1922, pp. 24–26, 3 figs. Relative advantages of carbon dioxide *vs.* ammonia as refrigerating medium, in which pressure range, cooling-water limitations, horsepower per ton, relative size and construction are considered.

Tests on a Carbonic-Acid Refrigerating Machine with Additional Compression under High Condenser Pressures (Versuche an einer Kohlensäurekältemaschine mit Zusatzkompression bei hohen Kondensatordrücken), R. Plank. Zeit. für die gesamte Kälte-Industrie, vol. 28, no. 11, Nov. 1921, pp. 157–162, 3 figs. Writer refers to process described by him in previous issue of this journal (p. 189, 1913), by use of which, it was claimed, considerable increase of refrigeration output and economy in cold carriers with low critical temperature (CO_2, N_2O), could be effected under poor cooling-water conditions and correspondingly high condenser pressure. Present article gives brief description of process and results of practical test recently carried out demonstrating its practicability.

REFRIGERATING PLANTS

Temperatures and Pressures. Working Temperatures and Pressures in the Refrigeration Plant, W. H. Motz. Power, vol. 54, no. 26, Dec. 27, 1921, pp. 1005–1007, 3 figs. Notes on suction pressures and temperatures; discharge temperatures and pressures; uses of thermometers.

RESEARCH

Fan Industry. Relation of Research to the Fan Industry. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 27, no. 9, Dec. 1921, pp. 873–881. Research in the Heating and Ventilating Field, by J. I. Lyle; and Research as a Business Proposition, by F. R. Still.

ROLLING MILLS

Adjustable-Speed Motors. Adjustable Speed With Motor Driven Mills, K. A. Pauly. Iron Age, vol. 108, no. 25, Dec. 22, 1921, pp. 1595–1598 and (discussion) pp. 1598–1600, 11 figs. Describes two satisfactory systems, with comments on their relative characteristics and particular work for which each is most adaptable. (Abstract.) Paper read before Engrs., Soc. West. Pa.

Continuous. Continuous Rolling-Mills, John W. Sheperdson. Engrs. Soc. of Western Pa. Proc., vol. 37, no. 4, May 1921, pp. 221–252 and (discussion) 253–257, 15 figs. Discusses advantages of continuous rolling process, and describes the various types of continuous mills, viz., billet mills, sheet-bar mills, wire-rod mills, mills for rolling flat finished products, merchant mills, etc.

Friction. Friction in Rolling Mills, William F. Parish. Iron Age, vol. 108, no. 26, Dec. 29, 1921, p. 1661. Effects of proper lubrication shown in reduced power losses. (Abstract.) Paper read before Am. Soc. Lubrication Engrs.

Mannesmann Inclined Rolls. Formation of Holes with the Inclined Roll (Mannesmann) Process (Ueber die Lochbildung beim Schrägwalzverfahren), J. Gassen. Stahl u. Eisen, vol. 41, no. 49, Dec. 8, 1921, pp. 1767–1771, 13 figs. Writer's experiences with formation of cracks with hollow ingot rolling. It is shown that most favorable but also most difficult position for axis of rolling material is exactly in center of both rolls at point of crossing.

Production and Yield. Production and Yield of Rolling Mills, Joseph F. Shadgen. Iron Age, vol. 109, nos. 1 and 2, Jan. 5 and 12, 1922, pp. 43–46 and 151–152, 1 fig. Jan. 5: Their present state of development. Useful operating data. Losses which should be lessened. European practice leads in yield. Jan. 12: Dependence of material yield on oxidation and on bloom and billet cropping. Temperature limitations are said to govern reheating.

Semi-Continuous Bar. Semi-Continuous Bar Mill for Alloy Steel, F. L. Prentiss. Iron Age, vol. 109, no. 2, Jan. 12, 1922, pp. 141–144, 5 figs. Cooling equipment embodies inclined escapement and horizontal notched bed features. Flat spring steel is self-annealed in packs.

Tandem Rolling. Tandem Rolling of Cold-Rolled Steel. Iron Age, vol. 109, no. 3, Jan. 19, 1922, pp. 211–213, 7 figs. Special equipment developed for this purpose, including rolls and their housings, wire straighteners, edge rolls, Turk's head and cross slides.

RUBBER

Stress-Elongation Curve. The Stress-Elongation Curve of Vulcanized India-Rubber, Emil Hatschek. Jl. Soc. Chem. Industry, vol. 40, no. 21, Nov. 15, 1921, pp. 251T–253T, 3 figs. Compares curves for samples of a definite rubber-sulphur mixture cured for definite lengths of time, and deduces formulas.

Testing. The Testing of Rubber Goods. U. S. Bur. of Standards Circular, no. 38, Sept. 28, 1921, 127 pp., 47 figs. Gives methods used at Bureau in testing of rubber goods. Describes various physical tests commonly applied and machines used for this purpose, many of which were designed in Bureau.

ZELCO
RING
100% 1 PIECE PISTON RING
Coated

The goal of every automotive engineer—of every first class mechanic—has been a quick seating piston ring.

In the ZELCO we have it—we have scientifically applied a well-known mechanical principle (patents pending) and ZELCOS mark a new era in piston ring development.

ZELCOS are made of a special grade of tough, white cast iron, peened by a special process so that the ring when installed is a *perfect circle*, thus insuring an absolute fit on the cylinder walls.

The ring is coated on its face with 2/1000ths of an inch of zinc, deposited by a special method by which a uniform surface of this soft metal is obtained. The entire ring is then coated with 1/30th of 1/1000th of zinc. In use this surface wears to a perfect fit in from 30 minutes to an hour, simultaneously filling up any small scores or porosities in the cylinder wells.

ZELCOS do not shopwear—they do not rust.

ZELCO IS THE FINAL ANSWER TO THE
ONE PIECE PISTON RING PROBLEM

Walter A. Zelnicker Supply Co.

1600 Kingsland Ave.
Wellston District
St. Louis, Mo.

Data are given showing effect of various factors on tensile properties of rubber. Effect of temperature on physical tests. Brief outline of methods of collecting crude rubber and processes used in manufacture of various rubber articles.

S

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREWS

Efficiency. Efficiency of Screws, C. D. Albert. Sibley Jl. of Eng., vol. 36, no. 1, Jan. 1922, pp. 2–3, 1 fig. Comparison of correct and approximate expressions.

SEMI-DIESEL ENGINES

Hydroelectric Plant. A Combined Hydro and Semi-Diesel Plant at Minnedosa, Manitoba. Power, vol. 55, no. 3, Jan. 17, 1922, pp. 92–93, 2 figs. Semi-Diesel engines installed in hydroelectric plant to carry load during periods of low water.

SEWAGE DISPOSAL

The Economy of the OMS Sewage Purification Process. (Wirtschaftlichkeit und Frischwasserklärung bei dem OMS-Verfahren in Gegensatz zu uebengelagerten Schlammfaulräumen), H. Schnickel and O. Mohr. Gesundheits-Ingenieur, vol. 44, no. 43, Oct. 22, 1921, pp. 545–547. Schinckel disputes the practicability of the OMS process, because the fresh-water settling tank is in constant connection with the putrefying chamber. In his reply, Mohr points out that neither is purely fresh sludge recovered from the Kremer purification process, according to which the putrefying chamber is located parallel to settling tank.

SHAFTS

Oscillations. Calculation of Torsional Oscillations of Shafts (Zur Berechnung der Verdrehungsschwingungen von Wellenleitungen), J. Geiger. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 48, Nov. 26, 1921, pp. 1241–1242, 6 figs. Describes new and very simple method of determining coefficient of torsional oscillation and the true angle of deviation; and method of calculating reduced length of crank.

SHEET-METAL WORK

Elbows. New Machine Making Two Elbows a Minute. Sheet Metal Worker, vol. 12, no. 25, Jan. 6, 1922, pp. 854 and 855, 2 figs. Describes Lyon-Conklin elbow machine which turns blank sheets into elbows.

SHIPS, CONCRETE

Resistance. The Resistance of Reinforced-Concrete Ships (Das Eisenbetonschiff und sein Widerstand), L. Kostanjevic. Beton u. Eisen, vol. 20, no. 17–18, Nov. 4, 1921, pp. 199–200. Writer presents a few practical examples supplementary to article by F. Gebers in previous issue of same journal.

SILICA BRICK

Manufacture. The Manufacture of Silica Brick, A. W. McMaster. Iron & Steel of Can., vol. 4, no. 10, Nov. 1921, pp. 267–268. Describes inauguration of the manufacture at Cape Breton from local materials. Operating costs; comparative analyses of quartzites; burning.

SLIDE RULES

Decimal Point Determination. Decimal Point Determination in Slide Rule Operation, James Theron Rood. Wisconsin Engr., vol. 26, no. 2, Nov. 1921, pp. 19–22, 3 figs. Gives examples to show how to secure greater accuracy.

SLOTTING MACHINES

Horizontal. Investigation of a Horizontal Slotting Machine with Electric Separate Drive and Belt Coupling Devices (Untersuchung einer Wagerechtstoszmaschine mit elektrischem Einzelantrieb und Riemenzwischengliedern), G. Schlesinger. Werkstattstechnik, vol. 15, no. 22, Nov. 15, 1921, pp. 645–647, 7 figs. Abstract of comprehensive work giving results of many years of research and experimental work carried out by author in coöperation with Dr Kurrein. Results are shown in diagrams on performance of machine and on manner of power distribution during forward and return stroke.

SMOKE PREVENTION

Devices. The Black Smoke Problem, David Brownlie. Iron & Coal Trades Rev., vol. 103, no. 2807, Dec. 16, 1921, pp. 872–873. Causes and preventive devices; low-temperature carbonization.

SPRINGS

Railway-Car. The Springs of Railway Cars (Om Jernbanevognes Fjedre), Rich. Holm. Ingeniören, vol. 30, no. 67, Aug. 20, 1921, pp. 497–501, 14 figs. Form of plate ends is claimed to be of great influence. Shape of ends should be parabolic and the trapeze shape is inexpedient. A spring with parabolic ends can absorb double the work of one with ends cut off at right angles.

STANDARDIZATION

Place of Laboratory in. The Place of the Laboratory in Standardization, W. P. Dobson. Eng. Inst. Can. Jl., vol. 5, no. 1, Jan. 1922, pp. 11–15, 6 figs. Types of engineering standards; measurement, constants, quality, performance; practice; work of laboratory in determining standards, methods employed by laboratories of Hydroelectric Power Commission of Ontario.

STANDARDS

German N.D.I. Report. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 25, Sept. 15, 1921, pp. 367–379, 18 figs. Accepted standards for blank cylinder, round-head, and countersunk-head screws. Proposals of Board of Directors for drawings for recording dimensions; straight wooden stairs for small dwellings; window and door hinges. Proposed standards for screw joints.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 26, Sept. 25, 1921, pp. 393–406, 21 figs. and supp. table. Proposals of Board of Directors for ball bearings. Proposed new standards for round-head rivets for boiler and structural steel work; countersunk-head rivets and countersunk oval heads.

STEAM

Generation and Utilization. Fuel Economy by the Adoption of Scientific Management in Steam Generation and Utilisation, David Brownlie. Eng. & Indus. Management, vol. 6, nos. 23, 24 and 25, Dec. 8, 15 and 22, 1921, pp. 653–656, 7 figs.; 685–687, 4 figs.; and 719–722, 5 figs. Dec. 8: Feedwater heaters. Dec. 15 and 22: Superheaters, and boiler and pipe covering.

STEAM-ELECTRIC PLANTS

Equipment. Rauber's Report to the Commission for Utilization of Fuels (Rapport de M. Rauber a la Commission d'utilisation des combustibles). Chaleur et Industrie, vol. 2, no. 19, Nov. 1921, pp. 727–735. Discusses steam-electric central stations, their equipment, type of boilers, superheat, economizers, feedwater heaters, etc.

STEAM ENGINES

Unaflow. Unaflow-Engine Guarantees and Tests, L. A. Quayle. Power, vol. 55, no. 3, Jan. 17, 1922, pp. 98–99, 1 fig. Universal unaflow engine exceeds guarantees on acceptance tests made after four years of continuous operation.

STEAM METERS

Kent Marine. The Metering of Steam for Marine Purposes, also of Oil and Air, C. R. Sams. Trans. Inst. Mar. Engrs., vol. 33, Oct. 1921, pp. 375–388 and (discussion) 388–393, 10 figs. Describes the Kent steam meter which consists of an orifice carrier, cooling chambers and pressure piping, and a diagram recorder.

STEAM TURBINES

Design and Operation. Major Turbine Troubles Diminished. Elec. World, vol. 79, no. 2, Jan. 14, 1922, pp. 77–80, 2 figs. Discusses blading, lubrication, and vibration; growth in turbine ratings; improvements in design.

STEEL

Chrome. See CHROME STEEL.

Crucible. Comparison of American and English Methods of Producing High Grade Crucible Steel, T. Holland Nelson. Raw Material, vol. 4, no. 12, Dec. 1921, pp. 424–433, 24 figs. Discusses the merits and shortcomings of American and English practice. Presented before Am. Soc. for Steel Treating.

Deoxidation and Desulphurization. Deoxidation and Desulphurization in the Heroult Furnace, F. T. Sisco. Chem. & Met. Eng., vol. 26, no. 1, Jan. 4, 1922, pp. 17–22. Describes three methods of working up a heat of steel. Discusses composition and characteristics of slags. Believes that good steel from poor scrap is a question of knowledge and skill.

Electric vs. Crucible. Crucible and Electric Tool Steel, W. J. and S. Stuart Green. Iron Age, vol. 109, no. 3, Jan. 19, 1922, pp. 201–205. Some aspects and choice in their manufacture. Points out that electric furnace bids fair to supplant crucible to greater degree than heretofore, though it is possible never completely.

Etched, Strain Figures in. Strain Figures in Etched Steel, A. Fry. Engineering, vol. 112, no. 2920, Dec. 16, 1921, pp. 809–811, 11 figs. Examples of peculiar strain figures observed by author on specimens of mild steel etched according to a modified new method. Author points to parallel between his observations and what is known as "blue brittleness."

Hardening by Overstrain. The Hardening of Steel by Overstrain, R. W. Chapman. Commonwealth Engr., vol. 9, no. 3, Oct. 1, 1921, pp. 74–75, 2 figs. Describes test showing that when steel is overstrained in tension so that its elastic limit in tension is raised, its elastic limit in compression is correspondingly lowered, and vice versa.

Manganese. See MANGANESE STEEL.

Melting. Leaves from a Steel Melter's Notebook, Henry D. Hibbard. Iron Age, vol. 108, nos 17 and 21, Oct. 27 and Nov. 24, 1921, pp. 1065–1067 and 1337 and 1379–1380. Oct. 27: Experience in making hollow ingots for seamless pipe; effervescing and "killed" steel in an acid furnace. Nov. 24: Design of structure to resist shock or overstrain; car-coupler test illustrating necessity of proper distribution of metal.

Molybdenum. See MOLYBDENUM STEEL.

Ordnance. Effect of Sulfur and Oxides in Ordnance Steel, William J. Priestley. Trans. Am. Inst. Min. & Metallurgical Engrs., no. 1109-S, 1921, 15 pp., 3 figs. Describes method by which desired physical properties of steel may be procured—by elimination of certain impurities that inherently exist in steel made by open-hearth process, and without use of expensive alloys. Abstract of paper in Min. & Metallurgy, no. 180, Dec. 1921, pp. 34–35. See also Iron Age, vol. 108, no. 26, Dec. 29, 1921, pp 1658–1661, 3 figs.

Tungaten, Metallography. A Metallographic Study of Tungsten Steel (En metallografisk studie av volframstål), Axel Hultgren. Jerkontorets Annaler, vol. 105, no. 12, 1921, pp. 499–525, 22 figs. Discusses investigations as to transformations, critical points, free carbide, equilibrium diagrams and their signifiance, etc. Bibliography.

STEEL CASTINGS

Railway Rolling Stock. Large Steel Castings for Railway Rolling-Stock, Ry. Engr., vol. 42, no. 503, Dec. 1921, p. 445, 3 figs. Describes production in the form of single castings, of locomotive tender underframes, platform and end members for passenger rolling-stock and trailer trucks for locomotives by Commonwealth Steel Co., St. Louis.

STEEL, HEAT TREATMENT OF

Characteristic Curves. Characteristic Curves for Heat Treatment of Steels (Les "Courbes caracteristiques" des traitments thermiques des aciers), Albert Portevin and Pierre Chevenard. Révue de Metallurgie, vol. 18, no. 11, Nov. 1921, pp. 717–726 and (discussion) 727–728, 11 figs. Discusses the interdependence of temperature of heating and rapidity of cooling, the final state being a function of these two variables. Paper read before Iron & Steel Inst., Paris.

Elements. Elements of the Heat-Treatment of Steel, H. J. French. Am. Mach., vol. 55, nos. 23, and 24, Dec. 8 and 15, 1921, pp. 907–908 and 960–964, 15 figs. Dec. 8: Operations in heat treatment; changes in structure while heating; changes produced by tempering and hardening; seasoning; effect of carburization. Dec. 15: Quenching operations; tempering.

Tool Steel. Volume Changes in Tool Steel on Heat Treating, L. A. Lanning. Forging & Heat Treating, vol. 7, no. 12, Dec. 1921, pp. 610–611, 2 figs. Effect of rates of heating, temperatures and quenching medium upon dimensions of cylindrical pieces of tool steels. Critical rate of heating important in hardening.

STEEL, HIGH-SPEED

Hardness. Hardness of High-Speed Steel, A. H. d'Arcambal. Chem. & Met. Eng., vol. 25, no. 26, Dec. 28, 1921, pp. 1168–1173, 8 figs. Hardness at various temperatures, hardness in the cold after various heat treatments, and cutting efficiency determined in an effort to predetermine usefulness of a modern machine tool.

Various Methods for Hardening High-Speed Steel, A. H. d'Arcambal. Chem. & Met. Eng., vol. 25, no. 25, Dec. 21, 1921, pp. 1150–1151. Discusses salt bath hardening, pack hardening, lead bath hardening, and semi-muffle furnace hardening.

Metallography. The Metallography of High Speed Steel, J. P. Gill and L. D. Bowman. Am. Soc. for Steel Treating Trans., vol. 2, no. 3, Dec. 1921, pp. 184–205, 56 figs. Discusses critical points and constitution of high-speed steels; secondary hardness; etching reagents; nomenclature; etc.

STEEL MANUFACTURE

Basset Process. The Basset Process (Le Procédé "Basset"). L'Outillage, vols. 235 and 236, nos 47 and 48, Nov. 24 and Dec. 1, 1921, pp. 1259–1260 and 1287–1288, 1 fig. Gives copy of Basset's French patent published April 2, 1920, "Rotary furnace system for direct production of iron or steel or of pig iron," and discusses it and its prospects.

STEEL WORKS

Cold-Drawing Plant. LaSalle Co. Completes Cold Drawing Plant, Gilbert L. Lacher. Iron Age, vol. 109, no. 1, Jan. 5, 1922, pp. 27–31, 6 figs. Designed for handling products in maximum lengths. Raw materials protected from elements.

Furnaces and Gas Producers. Steel Works Furnaces and Gas Producers, J. S. Atkinson. Jl. West of Scotland Iron & Steel Inst., vol. 29, Part 1, Oct., Session 1921–1922, pp. 4–11 and (discussion) 11–14, 10 figs. on supp. plates. Discusses the principle of gas firing, mechanical producers, regeneration or recuperation, open-hearth furnaces, soaking pits, etc.

Krupp. Recent Developments in the Krupp Works at Essen. Engineer, vol. 132, no. 3441, Dec. 9, 1921, pp. 611–613, 8 figs. partly on p. 632. Account of its development and details as to its work during war, and peace-time activities.

Power Generation. Power Generation in Steel Plants, D. M. Petty. Engrs. Club of Philadelphia Jl., vol. 38-12, no. 204, Dec. 1921, pp. 302–397, 2 figs. Conclusions drawn from actual operating conditions of steel plant: Cost of power can be effectively reduced by increasing load factor; load factor in steel mills may be increased by careful arrangement of load and by supplying to central stations all surplus power not required during light load periods; etc.

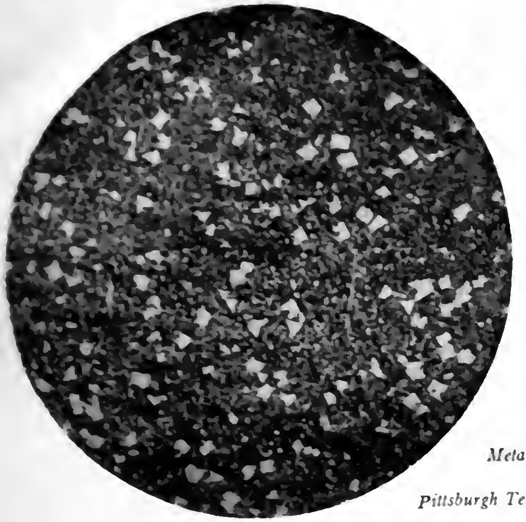
STOKERS

Mechanical vs. Hand. Hand *versus* Mechanical Handling of Coal and Ashes in Municipal Power Plants—II, W. F. Schaphorst. Am. City, vol. 25, no. 5, Nov. 1921, pp. 415–421, 2 figs. Notes on underfeed and hand stokers, and points to be considered in selection of ash-handling system.

Wood-Refuse-Burning. Burning Wood Refuse in Mechanical Stokers, R. L. Beers. Power House, vol. 15, no. 1, Jan. 5, 1922, pp. 30–33, 8 figs. Describes various types of boilers fitted with underfeed stokers for wood and other factory refuse.

SUPERHEATERS

Design. Steam Superheaters, Arthur D. Pratt.



Untreated Metal

Metallographs
by
Pittsburgh Testing Laboratories
Magnification: 100 Diameters

Cadman BEARITE

Mechanically Correct

Cadman Bearing Metals can be guaranteed to double the life of the great majority of bearings largely because they are mechanically correct.

A jealously guarded reputation for 60 years of consistent bearing service to the principal industries of America rests upon the fulfillment of this guarantee.

The microphotograph to the left above is that of a high-grade lead-base babbitt. Antimony, the essential hardening material, instead of being uniformly distributed, is partly scattered through the comparatively soft base in the form of hard brittle crystals.

The microphotograph to the right is Cadman BEARITE. The analysis of the two metals is identical, but the hardening in the Bearite is uniformly distributed through the metal and the objectionable crystals are eliminated.

We ask you, as an engineer, which metal is structurally correct and which will give the better service?

(Clip the coupon or simply enclose your card in an envelope)

A·W·
Cadman
Manufacturing Co.
Pittsburgh
Pa.

Maſter Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletin M-1, samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:...Position:.......................

Company Name:..

Address:...

Steam, vol 28, no. 5, Nov. 1921, pp. 125–127 Discusses design of superheaters and their operation

T

TANKS, MILITARY

Development. Tanks and Chain-Track Artillery, L. A. Legros. Engineer, vol. 132, nos. 3440, 3441 and 3442, Dec. 2, 9 and 16, 1921, pp. 592–594, 625–627 and 659–660, 32 figs. Development during war. Dec. 2: Trial and experimental period; British tanks. Dec. 9: French, Italian and German tanks. Dec. 16: Essential data for designing chain-track vehicles. Possible improvements in chain track.

TAYLOR SYSTEM

Shop Organization. An Intermediate Stage Toward the Taylor System in Shop Organization (Une étape vers le système Taylor dans l'organisation de l'atelier), C. Bonnet. Arts et Metiėrs, vol. 74, no. 13, Oct. 1921, pp. 305–311, 5 figs. Discusses shortcomings of French foreman and his gradual transformation.

TEMPERATURE MEASUREMENT

Below Zero Cent. Temperature Measurement Below 0° Deg. Cent. (Temperaturmessung unterhalb 0°), F. Henning. Zeit. fur Elektrochemie, vol. 27, no. 21–22, Nov. 1, 1921, pp. 494–496. Gives results of measurements carried out with steam-pressure thermometer by Stock and Nielsen, with which saturation pressures of a number of liquids were determined.

TESTING MACHINES

Endurance. Endurance Testing Machines, G. Shapira. Foundry Trade Jl., vol. 24, no. 276, Dec. 1, 1921, pp. 446–447, 2 figs. Describes the Krupp repeated impact machine and the Amsler wear-and-tear testing machine.

TEXTILE INDUSTRY

Automobile Manufacturing Methods Applied to. Are Automobile Manufacturing Methods Applicable to the Textile Industry? Douglas T. Hamilton. Am. Mach., vol. 55, no 25, Dec. 22, 1921, pp. 994–995. How the two industries developed. Contrasting both production methods and machinery involved.

TIDAL POWER

Systems. The Problem of Using the Tides for Power Production (La problème de l'utilisation des marées pour la production de l'energie), Sigma. La Métallurgie, vol. 53, nos. 48 and 49, Dec. 1 and 18, 1921, pp. 2225-2226 and 2265-2266, Dec. 1: Principal systems, single reservoir, double reservoir, etc. Dec. 8: Discusses operations of turbines. Concludes that at present serious difficulties militate against tidal power application.

TIME STUDY

Automatic Machines. Modern Production Methods, W. R. Basset. Am. Mach., vol. 56, no. 3, Jan. 19, 1922, pp. 87–90, 3 figs. Time study on automatic machines. Notes on quality of labor employed, importance of standardization, rules of procedure and an example of rate setting.

Machine Tools. Modern Production Methods, W. R. Basset. Am. Mach., vol. 55, no. 26, Dec. 29, 1921, pp. 1037 1039, 1 fig. Special cases of time studies on engine lathes, surface and chucking grinding machines and semi-automatic turret lathes. Five steps in setting rates.

Punching. Time Study for the Calculation of Small Dies (Die Zeitstudie im Dienste der Kalkulation von Kleinstanzteilen), Walter Marcus. Werkstattstechnik, vol 15, nos. 21 and 22, Nov. 1 and 15, 1921, pp. 621 629 and 647 652, 13 figs. Writer seeks to develop basis for calculation of small dies and to substitute time-job analysis in place of arbitrary piece-rate system.

Premium Work. Time Study for Profitable Piece Work or Premium, Samuel Theaker. Indus. Management, vol. 63, no 1, Jan. 1922, pp. 7–11, 5 figs. Discusses merits and methods of time premium work. Describes a decimal stop watch and gives examples of time study sheets.

TITANIUM

Pig-Iron Mixers. The Occurrence and Behavior of Titanium in Pig Iron Mixers (Das Vorkommen und Verhalten von Titan im Roheisenmischer), Bernhard Osann. Stahl u. Eisen, vol. 41, no. 42, Oct. 20, 1921, pp. 1487 1489. Magnesite fragments of a mixer lining showed small copper colored crystal lumps grown closely together with a basic mass; analysis of this mass showed it to be of pig iron whose sulphur and manganese content was increased, the crystals showed the same carbon nitrogen titanium mixture as found by Wöhler.

TIRES, RUBBER

Giant, Bursting of. Bursting Giant Pneumatics. Motor Transport, vol 33, no. 877, Dec. 19, 1921, pp. 772 773, 5 figs Describes experimental bursting of Goodyear pneumatic truck tires showing that no ill effect occurs at 27 m.p h.

Specifications. Recommended Specifications for Pneumatic Tires, Solid Tires, and Inner Tubes. U. S. Bur. of Standards Circular, no. 115, Oct. 27, 1921, 18 pp. Revision of specifications prepared by Bureau and now used by War and Navy Departments. General Supply Committee, Post Office Department, Panama Canal and Treasury Department. Physical and chemical tests required are such that material purchased under these specifications will be satisfactory.

Stress and Deterioration. Investigations of the Stress and Deterioration of Automobile Tires (Untersuchungen über die Beanspruchung und Abnutzung von Kraftwagenreifen), Otto Enoch. Motorwagen, vol. 24, nos. 25, 26 and 27, Sept. 10, 20 and 30, 1921, pp. 513–519, 550–554 and 591–600, 23 figs. Results of series of investigations to determine effect of additional horizontal springs attached to axle, and of a certain type of laminated spring under difficult running conditions, and also to determine durability of different tires in the case of prolonged tests.

TRANSPORTATION

Factory. Analysis and Control of Factory Transportation, F. A. Pope. Factory, vol. 28, no. 1, Jan 1922, pp. 38–42 and 72, 74, 76 and 78, 6 figs. Methods by which idle time is checked, performance records of tires and batteries best secured, daily service recorded, and final analysis of cost and performance made by clerks without special training.

TUBES

Copper. Copper Tubes Produced by Cold Extrusion Process, A. Ludlow Clayden. Raw Material, vol. 4, no. 9, Sept. 1921, pp. 314–315, 5 figs. Describes method of producing thin-wall copper tubes, developed from experience gained in the production of rifle shells during war.

Seamless Copper. Copper Tube Extrusion and the Manufacture of Radiator Cores, Herbert Chase. Automotive Industries, vol. 45, no. 18, Nov. 3, 1921, pp. 870–873, 8 figs. How seamless tubes are formed from solid stock by cold extrusion, shaped with hex ends and baffles, tested under pressure and finally assembled and soldered into complete radiator cores. Describes apparatus for determining relative efficiency of various types of cores.

Welded, Manufacture. Welded Tube Manufactures Iron Age, vol. 108, no. 20, Nov. 17, 1921, pp. 1274–1276, 7 figs. Machinery required for tubes $^{5}/_{8}$ to 4 in. in diam. from sheets of no. 10 and no. 22 gage.

TURBO-GENERATORS

12,500-Kw. 12,500 KW. Turbo-Generator for the Liverpool Corporation Electricity Works. Engineering, vol. 112, no. 2922, Dec. 30, 1921, pp. 873–876, 34 figs. partly on supp. plate. Steam turbine and generator constructed by Metropolitan-Vickers Elec. Co., Ltd., Manchester, England, is said to embody some very notable departures from normal type of impulse steam turbine.

U

URANIUM

Metallurgical Applications. Uranium and Its Metallurgical Applications. Engineering, vol. 112, no. 2921, Dec. 23, 1921, pp. 841–842. Describes mode of occurrence of uranium ores, isolation of element from such ores, and industrial uses of metal apart from those arising out of radioactive properties.

V

VENTILATION

Barn. A New System of Barn Ventilation, L. J. Smith. Agricultural Eng., vol. 2, no. 12, Dec. 1921, pp 248–249. Report of test made in a barn at Portage La Prairie, Manitoba, regarding the proper control of stable temperature. A portion of report to be presented before Am. Soc. Agricultural Engr.

Calculating Duct Weights. A Quick Method of Taking Off Quantities in Duct Work, J. J. Kojan. Sheet Metal Worker, vol. 12, no. 25, Jan. 6, 1922, pp. 834-835 and 838, 2 figs. Discusses method of estimating a ventilating job and shows how to develop formulas and tables.

Katathermometer. Ventilation and Human Efficiency, Leonard Hill. U. S. Naval Inst. Proc , vol. 47, no. 11, Nov. 1921, 15 pp., 1 fig. Describes the Katathermometer, an instrument for measuring cooling and evaporative power of the air exerted on a surface at approximately body temperature, also the electric kata and the recording kata.

W

WAGES

Payment by Results. Payment by Results, D. Lyon McLarty. Machinery (Lond.), vol. 19, no. 480, Dec. 8, 1921, pp. 289 291. Comparison between piecework and premium bonus systems and their application to working conditions.

WASTE ELIMINATION

Industrial. Prevention of Wastes in Industry, Fred J. Miller. Mech Eng , vol. 44, no. 1, Jan 1922, pp. 9 10 and 42. Defines incentives in industry and itemizes causes of industrial waste. Recognition of human element and better management as factors in reducing waste.

WASTE HEAT

Utilization. The Utilization of Waste Heat (Abwärme-Verwertung), M. Hottinger. Schweizerische Bauzeitung, vol. 78, nos. 21, 22 and 24, Nov. 19, 26 and Dec. 3, 1921, pp 249–252, 257–260 and 276–279, 17 figs. Notes on utilization of high temperatures; protection against heat losses; examples of the economic utilization of waste heat; utilization of waste energy; heat from waste material, obtained from incineration of garbage.

Waste Heat Utilized to Produce Electric Power, C. H. Reeder. Elec. Rev. (Chicago), vol. 79, no. 27, Dec. 31, 1921, pp. 967–970, 15 figs. Hot gases from cement kilns supplied to boilers fitted with superheaters and economizers; equipment proportioned to use all waste heat to provide sufficient energy to operate mill.

WATER PIPES

Corrosion. Prevention of Corrosion in Water Pipes —II. Sanitary and Heating Eng., vol. 96, no. 11, Nov. 18, 1921, pp. 315–316, 2 figs. Explains theory and operation of de-aerating de-activators as used in prevention of corrosion.

Jets. Notes on Water Jets, J. A. Yates. Mech. World, vol. 70, nos. 1820 and 1825, Nov. 18 and Dec. 23, 1921, pp. 404–405 and 504–505, 3 figs. Nov. 18: Discusses relation between maximum horsepower obtainable from a jet issuing from a nozzle at end of a pipe line, length and diameter of pipe line, and supply head available. Dec. 23: Equations and calculations in connection with the efficiency of jets.

WATER POWER

Development in U. S. Federal Water Power Projects Up to December, 1921. Eng. News-Rec., vol. 88, no. 1, Jan. 5, 1922, pp. 24–26. Annual report of Federal Water Power Commission shows half-million horsepower under way. (Abstract.)

Great Britain. Report of the Water Power Resources Committee. Engineer, vol. 132, no. 3442, Dec. 16, 1921, p. 653. Resume of final report of committee appointed by President of Board of Trade in 1918 to inquire into water-power resources of United Kingdom. Committee considers that in Great Britain some 210,000 kw. could be developed continuously from potential water powers at an economic rate, and for Ireland an available water power of 280,000 kw. continuous was estimated.

World's Development. Study of World's Water Powers Completed. Power, vol. 55, no. 1, Jan. 3, 1922, pp. 22–23. More than half of total developed water power is in North America. Africa has 190,000,000 horsepower potential water power and only 11,000 developed. Tables showing development in United States and Canada, and developed and potential water power of world in 1920 in horsepower. (Abstract.) World Atlas of Commercial Geology, issued by U. S. Geol. Survey.

WELDING

See AUTOGENOUS WELDING; ELECTRIC WELDING, ARC; ELECTRIC WELDING, RESISTANCE; OXY-ACETYLENE WELDING

WIND TUNNELS

Göttingen, Germany. Göttingen Wind Tunnel for Testing Aircraft Models, Prandtl. Aerial Age Weekly, vol. 14, nos. 13 and 14, Dec. 5 and 12, 1921, pp. 298–299 and 302 and pp. 324–326, 9 figs. Depends on government and scientific societies for financial support. Describes equipment and operation. Designed for an air speed of 54 m/sec. with maximum of 60 m/sec. corresponding to an air efficiency of about 800 hp. From Zeit. für Flugtechnik und Motorluftschiffahrt.

Research. The Scope of Wind Tunnel Research, E. N. Fales and F. W. Caldwell. Aerial Age Weekly, vol. 14, nos. 11 and 12, Nov. 21 and 28, 1921, pp 248–250 and 270–272, 11 figs. Nov. 21: Discusses extension and importance of aeronautical research and civil engineering problems in construction of wind tunnels. Nov. 28: Desirable characteristics; first cost; freedom from velocity fluctuations; suitability of existing tunnels for attainment of desirable characteristics, etc.

WIRE ROPE

Standard Specification. Standard Specification for Wire Rope. Contract Rec., vol. 36, no. 1, Jan. 4, 1921, pp 13 16. Canadian Engineering Standards Assn drafts code covering wire rope mining, dredging and steam shovel purposes.

WOOD

Infected. The Chemical Changes Involved during Infection and Decay of Wood and Wood Pulp, Mark W. Bray and Joseph A. Staidl. Jl. Indus. & Eng. Chem., vol. 14, no. 1, Jan. 1922, pp. 35–40, 1 fig Concludes that in all cases infected woods produce less pulp per unit weight of wood than sound woods Paper read before Am. Chem. Soc.

Spiral Grain, Effect of. The Effect of Spiral Grain on the Strength of Wood, Thomas R. C. Wilson. Jl. of Forrestry, vol. 19, no. 7, Nov, 1921, pp. 740-747, 4 figs. Describes a series of tests made on the effect of deviation of the grain of wood from parallelism with the edge.

Substitutes in Shipbuilding. Substitutes for Natural Wood for Shipbuilding Purposes, Horace Holden Thayer. Mar. Eng., vol. 26, no. 12, Dec. 1921, pp. 931-932. Principal characteristics and uses of composition boards, plywood, and a combination of wood and metal which is called plymetal.

WOODWORKING MACHINES

Planes, New Types of. Old and New Types of Planes, Oskar Spohr. Eng. Progress, vol. 2, no. 12, Dec. 1921, pp. 265 267, 12 figs. Compares old and new rabbet planes, describing the greatly improved features.

MECHANICAL ENGINEERING

Volume 44 April, 1922 Number 4

The Strength of Mechanically Welded Pressure Containers

By R. J. ROARK,[1] MADISON, WIS.

This paper describes pressure tests made on electrically welded, gas-welded, and riveted pressure containers, and tension and shear tests made on specimens cut from such containers and on specially prepared specimens of welded metal. The tests were made for the Vilter Manufacturing Company of Milwaukee, Wis., and had for their purpose the demonstrating of the strength and uniformity of construction in which the electric weld is employed

The results of the tests indicate that in containers of the type studied, electrically welded head joints are sufficiently strong to develop the full strength of the shell and heads; that it is practicable to make electrically welded joints which are uniform in respect to tensile strength, shearing strength and structure of fused metal; that for the particular combination of metals tested, the tensile strength of such welded joints is about 28,500 lb. per sq. in. and the shearing strength about 25,500 lb. per sq. in.; that for the combination tested, the metal in the weld is less strong and less ductile than either the base metal or the filling metal before fusion; that the electrically welded joints tested were stronger in shear but weaker in eccentric tension than the riveted joints tested.

THE investigation which forms the subject of this paper was made by the writer for the Vilter Manufacturing Company of Milwaukee, who furnished all test specimens. The tests on the containers were carried out at the works of the company. The tests on the specimens cut from the containers and on the specially prepared specimens were made in the Materials Testing Laboratory of the University of Wisconsin.

The writer wishes to acknowledge the helpful coöperation of the officers of the Vilter Manufacturing Company, their readiness to submit their product to any test suggested and their promptness in furnishing the necessary specimens and appliances. Thanks are due for helpful suggestions to Prof. G. L. Larson, Professor of Steam and Gas Engineering at the University of Wisconsin, who witnessed the test on containers.

PURPOSE AND SCOPE OF THE INVESTIGATION

The primary purpose of this investigation was to demonstrate the strength and uniformity of a certain type of commercial pressure container with electrically welded head joints. These containers were made of lap-welded pipe and were provided with spherical flanged heads. Their dimensions are given in Fig. 1. The average physical and chemical properties of the steel used, as reported by the company furnishing it, were as follows: Yield point, 38,000; ultimate, 64,000; elongation, 27 per cent; carbon, 0.17 per cent; manganese, 0.44 per cent; phosphorus, 0.010 per cent; sulphur, 0.027 per cent. It was proposed to determine the absolute strength of such containers by pressure tests on representative samples and to establish a comparison with vessels of like form and dimensions, but with gas-welded and riveted heads, by similar tests on such containers. In order to secure a more positive check on the uniformity of the joints and more specific information as to their strength under various conditions of stress, it was planned to cut from the containers specimens of such form as to give, when subjected to laboratory tests, the desired information. Partly to determine the best form for such specimens and the best method of testing them, and partly to aid in the interpretation of results, strain measurements were made on certain of the specimens during the tests. From these measurements relations were established between the internal pressure in a vessel of the standard type and the resulting stresses on the head joint.

In order to gain still more detailed information concerning the physical properties of welded joints, various special specimens of welded metal were made up and tested as subsequently described.

It is thus seen that the investigation comprised three more or less distinct series of tests, namely, tests on containers, tests on specimens cut from containers and tests on special specimens of welded metal.

TESTS ON CONTAINERS

In all, nine containers were tested. In each case, the tests consisted of subjecting the specimen to an internal hydraulic pressure which was gradually increased until rupture resulted or such rapid leakage developed as to make further increase of pressure impracticable. Pressure was in most cases applied in predetermined increments by a hand pump, and was measured by an indicating gage which had been calibrated immediately before its use in these tests.

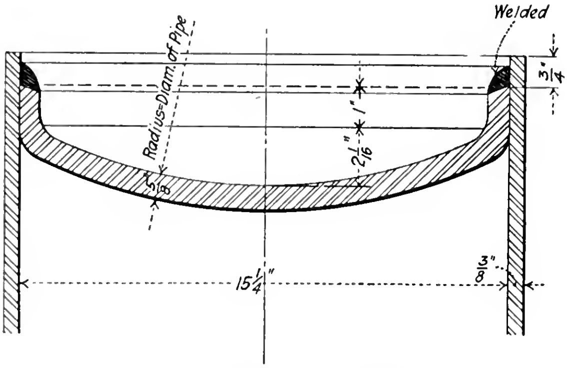


FIG. 1 SHAPE AND DIMENSIONS OF SPECIMEN CONTAINERS

Some of the specimens were of standard design. Some were so made as to secure failure of a particular sort, in order to provide information on some specific point. In order to compare the work of different operators, two similar gas-welded specimens were made up, the welds being made by different operators. On certain of the containers of standard design, strain measurements were made as mentioned above.

A few of the tests described separately below and a summary of the complete results obtained, is presented in Table 1. Accompanying photographs show the appearance of some specimens after testing, and indicate the manner of failure.

Specimen No. 1 was subjected to successive pressures of 200, 400, 800, 1200, 1600 and 1750 lb. per sq. in. Strain measurements were taken at each pressure which was then reduced to zero. The maximum pressure was then applied. At a pressure of 1750 lb. per sq. in. the coupling started to leak. The tank had visibly increased in diameter and the elastic limit had evidently been

---

[1] Asst. Prof. Mechanics, University of Wisconsin.

Abstract of paper for presentation at the Spring Meeting, Atlanta, Ga. May 8 to 11, 1922 of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Copies of the complete paper may be obtained gratis upon request. All papers are subject to revision.

exceeded. At a pressure of 1925 lb. per sq. in. leakage occurred at the weld of the nipple. A new nipple was welded on and the pressure increased to 2150 lb. per sq. in., when the specimen ruptured. Failure was due to circumferential tension in the shell. The heads did not reverse. (Fig. 2.)

Successive pressures of 500, 1000, 1500 and 1800 lb. per sq. in. were applied to specimen No. 2. Strain measurements were made at each pressure up to and including 1500 lb. The pressure was not reduced to zero after each application but was maintained and increased to the maximum without release. No leakage developed, but at a pressure of 2150 lb. per sq. in. one head reversed. At a pressure of 2200 lb. per sq. in. the specimen ruptured and the reversed head was violently forced off. Failure was due to combined longitudinal tension and bending, a crack in the outside face of the welded metal, indicating a local failure due to bending. (Fig. 3.)

Fig. 2 Specimen No. 1 (Electrically Welded), Showing Fracture After Testing

In testing specimen No. 3, successive pressures of 200, 400, 800, 1200, 1600, and 1800 lb. per sq. in. were applied. Strain measurements were made at each pressure before being reduced to zero. The maximum pressure was applied by power on the second day of the test. At a pressure between 1200 and 1600 lb. per sq. in. leakage was observed at both ends next the rivets and in the weld at the nipple. The nipple was replaced and the test continued. When 1800 lb. per sq. in. was reached the leakage became so bad that it was impossible to increase the pressure further by hand. By means of a power pump a pressure of 2100 lb. per sq. in. was attained but leakage prevented further increase. The container did not rupture nor did the heads reverse.

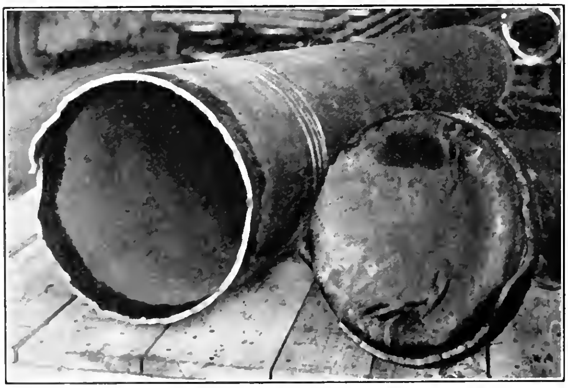


Fig. 3 Specimen No. 2 (Gas Welded) Showing Fracture and Inner Side of Reversed Head

The testing of specimens Nos. 4 and 5 offers an opportunity to compare the work of different gas-welding operators as the two containers were similar in design and dimensions but welded in different shops.

Stress on Head Joints

During the tests on specimens Nos. 1 and 2, strain measurements were made at sections distant 1 in., 2 in., 3 in., and 5 in. from the end. The measurement at the end was made on a diameter by means of a wire-wound dial reading to one ten-thousandth of an inch. The other measurements were made in one case by means of a Berry strain gage, on a 2 in. gage line, and in the other case by means of wires which encircled the container and which were provided at both ends with lugs, between which measurements could be made to one-thousandth of an inch by means of an ordinary micrometer. Owing to the danger of explosive failure, readings were taken only up to about three-fourths the computed bursting pressure.

From the measurement thus made the stress at each section was computed, employing as the value of the modulus of elasticity, 29,000,000 lb. per sq. in. The stress at each section was then expressed as a percentage of the stress which would exist in a similar cylinder having the same internal pressure and not subject to end restraints. By plotting for each section a diagram of stress against pressure up to the maximum pressure at which readings were taken, the probable stress at bursting pressure (taken for this purpose as 2000 lb. per sq. in.) was determined by extrapolation. A diagram was then plotted in which these stresses (expressed as percentages of the normal stress) were used as ordinates and distances from the end of the specimen to where these stresses occurred were used as abscissae. The resulting diagram is shown in Fig. 5. In this diagram a portion of the shell is shown with the radial forces which act upon it. The inward forces (shown acting down) consist of the radial components of the circumferential stresses, determined as explained above. The outward forces (shown acting up) consist of the uniform internal pressure, which of course extends only to the beginning of the weld. The portion of the shell shown is in equilibrium under these forces and the stresses acting, and by applying the appropriate conditions of equilibrium the stresses on each of the important sections A-A, B-B, and C-C, were determined. They are represented in Fig. 6, 7 and 8. In the determination of these stresses the bending moment and shear at the section where the circumferential stress becomes equal to the stress which would exist if there were no end restraint, are assumed to be zero. This is not strictly correct, but it is not believed that the assumption introduces a considerable error.

The stress on section C-C depends upon the tension in the band of welded metal (shown in dotted line), and as the section area of this band is non-uniform and difficult to determine, it is probable that the stresses as computed for this section are more in error than the others. All of the results given are, to be regarded as approximations. They represent the nature of the stresses existing and the order of their magnitude, rather than their precise values. A rough check upon the correctness of these computed stresses is afforded by the manner in which the standard gas-welded container (specimen No. 2) failed and the pressure which caused rupture. This specimen failed on section B-B, and the form of fracture showed very clearly that the failure was principally due to flexure. The corrected pressure at rupture was 2090 lb. per sq. in. Using this as the value of P and computing the maxi-

Fig. 4 Specimen No. 7 (Reinforced Electric Weld) Showing Fracture After Testing

mum fiber stress from the tension and moment indicated by Fig. 7 and the known thickness of the plate, a value of 77,000 lb. per sq. in. is obtained, which agrees very well with the modulus of rupture of the metal as determined by other tests. It will be noted that so far as conditions at the ends are concerned, section B-B is the weak point in the standard containers, as would be expected from the thinness of the metal there and the large bending moment, accompanied by direct tension. Section C-C appears to be the next weakest point. Local failure occurred on this section in specimen No. 2 and in the case of the reinforced specimen No. 7, (Fig. 4) about half the fracture was on section B-B and half on C-C. Apparently the surface of contact between the weld and the shell (section A-A) is stronger than either of the other two sections and in no case did failure take place on this section.

The values given for maximum shearing stress and maximum tensile stress in Table 1 were computed for section A-A. It is to be noted that they do not represent the strength of the material in shear and tension, but simply the approximate shear and tensile stress produced in the welded joint by a pressure which caused failure at some other point.

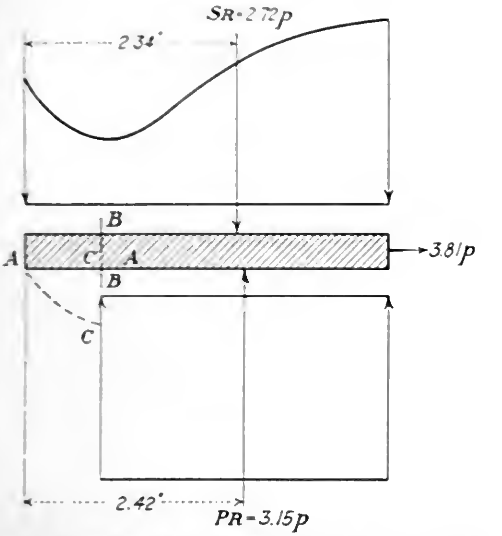


Fig. 5 Stress, Shear and Moment Diagrams of Container

In order to compare the stiffness and elasticity of the welded and riveted types of containers, measurements were made to determine the protrusion and permanent set induced in the heads of certain of the specimens by the pressures applied. These measurements, which were made on containers Nos. 1 and 3, were taken to the nearest one thousandth of an inch by means of Ames dials, readings being taken during the application of each pressure and after its release. The values given for protrusion and set represent respectively the total and the permanent displacement of the center of the head with respect to the end of the cylindrical shell. The data obtained from these measurements were used in plotting the curves of Fig. 9.

Tests on Specimens Cut from Containers

It is apparent from the stresses represented in Figs. 6, 7 and 8 that the important stresses on the head joint are shear and tension, the latter being largely due to flexure. It appeared advisable therefore to cut from the containers specimens of such form as to make it possible to subject portions of the joint included therein to shear and flexure. Two forms of specimens were decided upon. Their form and part of the container from which they were cut are represented in Figs. 10, 11 and 12.

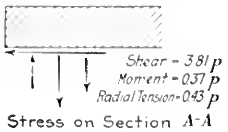


Fig. 6

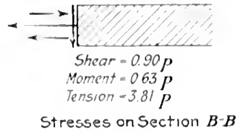


Fig. 7

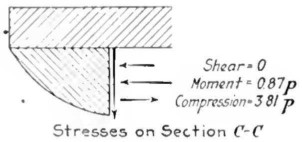


Fig. 8

Figs. 6, 7 and 8 Stress, Shear and Moment Diagrams of Container Sections

Specimens of Type A were tested in tension, the ends being held in wedge grips. The breaking load, eccentricity at rupture and manner of failure were noted. From the data thus obtained, the computed ultimate tensile stresses on the weld was determined. The results of these tests are tabulated in the complete paper while the appearance of the specimens before and after testing are shown in Figs. 13 and 17.

TABLE 1 RESULTS OF PRESSURE TEST ON CONTAINERS

Specimen Number	Description of Specimen	Pressure in Lb. per Sq. in. at			Method of Failure	Stresses on Head Joint at Maximum Pressure					Remarks
		First observed Leakage	Disking of Heads	Maximum		Longitudinal shear lb. per linear inch of joint	Radial tension lb. per linear inch of joint	Bending moment inch-lb. per linear inch of joint	Max. resultant shearing stress lb. per sq. in.	Max. resultant tension stress lb. per sq. in.	
1	Standard commercial container with electrically welded heads, size 16 in. × 10 ft.	1925 (1820)		2150 (2040)	Longitudinal crack, started at nipple	7770	870	1780	9800	15000	
2	Standard type container with gas welded heads, size 16 in. × 10 ft.		2150 (2040)	2200 (2090)	Head forced off	7960	900	1820	10500	16000	Fracture on section B–B
3	Standard type container with riveted heads, size 16 in. × 10 ft.	1200 (1120)		2100 (2000)	Excessive Leakage						
4	Container with gas welded heads and gas welded longitudinal butt joints, size 16 in. × 10 ft. (weld by Le Quelle)			1600 (1540)	Split along long. butt weld						
5	Container with gas welded heads and gas welded longitudinal butt joints, size 16 in. × 10 ft. (weld by Vilter)			1300 (1240)	Split along long. butt weld						
6	Container with electrically welded heads and electrically welded longitudinal butt joints, size 16 in. × 10 ft.			1400 (1340)	Split along long. butt weld						
7	Reinforced container with electrically welded heads (3 concentric shells, concrete filled), size 10 in., 12 in., 14 in. × 3 ft. 2 in.		4500 4800	4800 (4680)	Head forced off	11860			18000		Fracture on sections B–B and C–C
8	Reinforced container with gas welded heads (3 concentric shells, concrete filled), size 10 in., 12 in., 14 in., × 3 ft. 2 in.	4350 (4230)	4100 (3980)	4350 (4230)	Excessive leakage at weld joints	10720					
9	Special container with one electrically welded; one head riveted, size 16 in. × 2 ft.	1750 (1670)		2500 (2390)	Split along lap weld	9100			11600	17600	

Specimens of Type B were tested in shear. The method of testing is shown by the photograph (Fig. 14) of the shear tool with specimen in place. This shear tool was designed to hold the specimen in such a position that the line of action of the applied load passed through the neutral axis of the section being tested. This necessitated inclining the plane of the section slightly and so introduced a small compression, but it eliminated the bending moment which would otherwise have existed. In general, the specimen failed to shear, as was intended, but in some cases it was found impossible to secure a shear failure, the adjacent metal crushing, tearing or bending before the weld gave way. A tabulation of the results secured from these tests is presented in the complete paper. The appearance of the specimens tested is shown in Fig. 15.

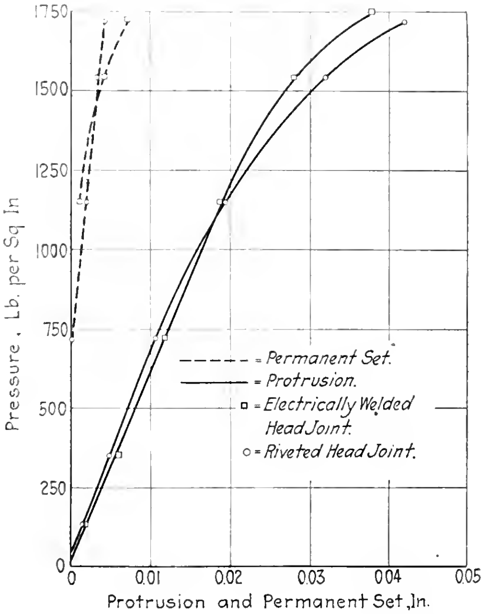


Fig. 9 Protrusion and Permanent Set of Container Heads at Different Pressures

Tests on Specially Prepared Specimens of Welded Metal

Two types of special specimens were tested. One was made by welding together a number of narrow strips of $^3/_8$-in. plate edge to edge and then cutting from the composite plate so formed a number of strips perpendicular to the welded joints. As eight strips were welded together each specimen had seven transverse welds in it. These specimens were tested in tension and the ultimate strength and per cent elongation noted. Eight specimens were thus made and tested, four having gas-welded joints and four having electrically welded joints. The results are presented in a table in the complete paper and the appearance of the specimens is shown by Fig. 16.

The other type of special specimen was made by welding together two $^3/_8$-in. plates edge to edge and cutting two pieces from the composite plate so formed, one along the center line of the weld and one from one of the plates, parallel to, but some distance away from the weld. Two sets of such specimens were prepared from plates electrically welded together and two sets from plates gas-welded together. One set of each kind was tested in tension, an extensometer being used and the proportional elastic limit, yield point, ultimate strength, modulus of elasticity, per cent elongation and per cent reduction of area determined. The results are tabulated in the complete paper while the stress strain diagrams are shown in Fig. 18.

TABLE 3 CHEMICAL CONSTITUTION OF SPECIAL SPECIMENS AND OF WELDING BARS

(Analyses by Robert W. Hunt Co.)

Specimen	Per cent Carbon	Per cent Manganese
Piece from center of electric weld	0.18	0.05
Piece from center of gas weld	0.06	0.08
Piece from plate remote from weld	0.12	0.51
Welding bar No. 1	0.07	0.12
Welding bar No. 2	0.07	0.05

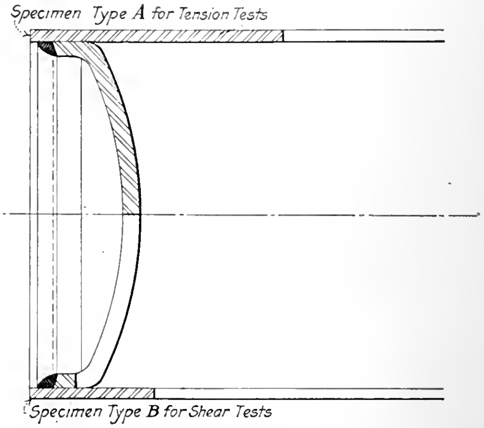


Fig. 10 Form of Specimens Subjected to Shear and Flexure

The remaining specimens were tested in shear. Two welding rods, similar to those used in making up the various containers and other welded specimens, were also tested in shear. The test consisted in subjecting the specimen to double shear while it was rigidly held in a special shear tool that prevented bending. The results of these tests are presented in Table 2.

Chemical analyses were made of each of the specimens of this type and of the two welding rods. The results are presented in Table 3.

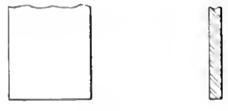


Fig. 11

Fig. 12

Figs. 11 and 12 Sectional Diagrams of Specimens Subjected to Shear and Flexure

TABLE 2 TESTS OF SPECIAL SPECIMENS

Results of Shear Tests on Specimens cut Parallel to Welded Joints

Specimen No.	Location of Specimen	Dimension of cross section (in.)	Area cross section (sq. in.)	Load at failure in double shear (lb.) Load applied parallel to plane of joint 1	2	Load applied normal to plane of joint 1	2	Average of all tests	Average ultimate unit shearing stress (lb. per sq. in.)
1	Along center line of electric weld	0.265 × 0.254	0.0674	5840	5480	5300	5730	5740	42500
2	Along center line of gas weld	0.259 × 0.268	0.0694	6290	6410	6170	6400	6320	45500
3	In plate remote from weld	0.253 × 0.255	0.0645	7500	7500			7500	58100
4	Welding bar No. 1	0.186 Diam.	0.0272	2580				2580	47400
5	Welding bar No. 2	0.186 Diam.	0.0272	2600				2600	47800

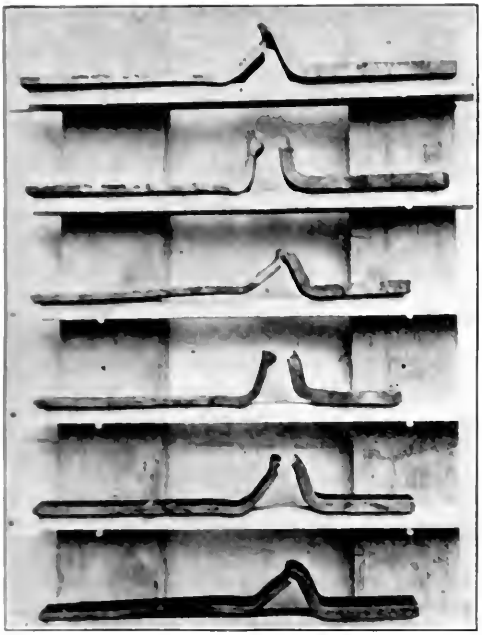


Fig. 13 Specimens of Type A, Welded

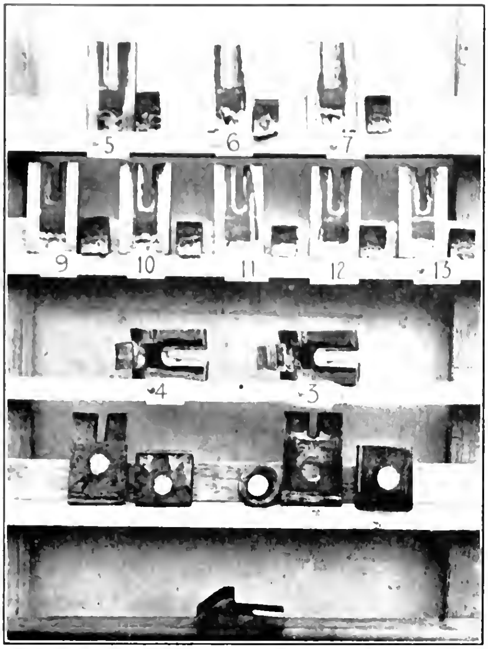


Fig. 15 Specimens of Type B

Conclusions

Some of the more important points brought out by the tests are enumerated and severally discussed below.

1 *Weak points in the containers.* None of the welded containers of standard design failed primarily at the welded head joint. The nature of the fracture shows that the weak points in the containers were, first, the lap weld in the pipe forming the shell, where failure occurred due to circumferential tension, and, second, the body of the shell at its junction with the head flange, where failure occurred due to the combination of longitudinal tension and bending. It appears that leakage is likely to occur first where couplings and nipples are welded in. This is due to the fact that the metal of the shell stretches and pulls away from the nipple, which does not have a corresponding strain induced in it by internal pressure.

Fig. 14 Shear Tool Used in Testing Type B Specimens

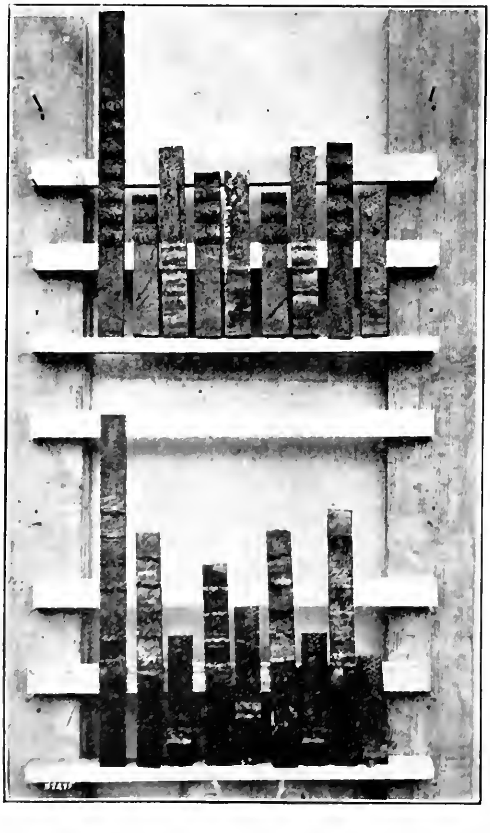


Fig. 16 Special Specimens Cut Transversely to Welded Joints, Tested in Tension

2 *Strength of electric welds.* From the tests on four specially prepared specimens, the average tensile strength of electrically welded joints was found to be 28,500 lb. per sq. in. From tests on five specimens cut from containers, the average shearing strength of electrically welded joints was found to be 25,500 lb. per sq. in. The mean variation from the average tensile strength per linear inch of weld was found to be 2 per cent, and the maximum variation 4.5 per cent. The mean variation from the average shearing strength per linear inch of joint was found to be 5.2 per cent and the maximum variation 7 8 per cent. The results of eccentric tension tests on specimens cut from containers showed that no one of the specimens was markedly weaker than the average for the lot. It is believed that the uniformity of strength thus indicated is of especial interest and importance.

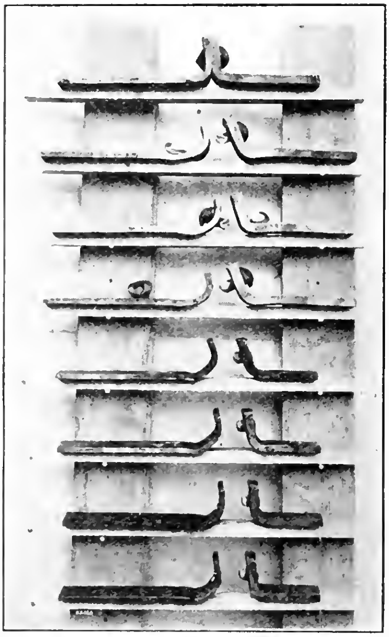


Fig. 17 Specimens of Type A, Riveted

In connection with the values given above for tensile strength, two points should be noted. First, at the section through the weld, where failure took place, the load was eccentric, because of the fact that the specimen is asymmetrically thickened at that point by the joint. This eccentricity undoubtedly made the average stress on the joint at failure less than it would otherwise have been, and so the values obtained were less than the actual tensile strength of the metal. The effective eccentricity was not as great as one half of the excess thickness of the joint, because the ends of the specimen were restrained. No attempt has been made to allow for the effect of this eccentric loading, because it represents a condition inherent in any so-called single-V weld which has an excess thickness.

Second, each of the four specimens had, within its tested length, several transverse welded joints. The strength of each specimen, therefore, represents the strength of the weakest of these seven joints, and so the value given, 28,500 lb. per sq. in., is less than the average strength for all the joints.

3 *Relative strength of electrically welded and riveted joints.* The tension tests on specimens of Type A indicated that the resistance to tension applied with a large eccentricity is greater for the riveted joint than for the welded joint. The shear test on specimens of Type B indicated that the resistance to shear per linear inch of joint is greater for the welded joint. Measurements to determine the elastic and permanent protrusion of the container heads showed that for the two specimens so tested the welded container withstood a somewhat greater pressure without permanent distortion. In the case of the riveted containers, leakage occurred at the head joints under moderate pressures. In the case of the electrically welded containers there was no leakage at the head joint under any pressure.

4 *Efficiency of electrically welded joints.* While it is customary to speak of the efficiency of a joint, whether welded or riveted, meaning the ratio of the strength of joint to strength of plates joined, the writer does not believe that this ratio is especially significant in the case of electrically welded joints nor that any value can be given it that can be regarded as generally applicable.

It is apparent that while the strength of the plates joined is dependent solely on the physical properties of the base metal, the strength of the weld is in great measure dependent on the properties of the filling metal. Furthermore, the per cent excess thickness of the weld, which influences its strength, varies with the thickness of the plates. Accordingly the efficiency of a weld depends on the properties of the base metal, the properties of the filling metal, and the thickness of the plates.

The writer believes that the correct method of computing the efficiency of an electrically welded joint is on the basis of a specified minimum strength of base metal, a specified minimum excess thickness of weld and an experimentally determined average strength (per sq. in.) of the metal, of which the finished weld is composed.

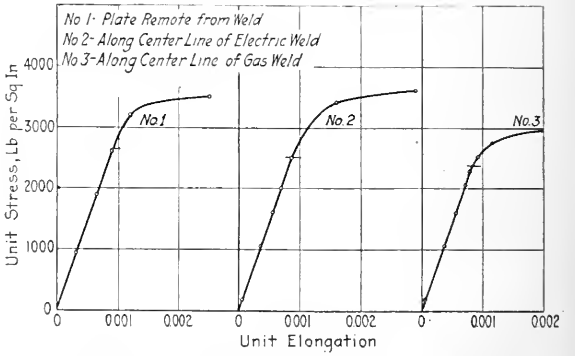


Fig. 18 Stress-Strain Diagram for Special Specimens Cut Parallel to Weld Joints

Liege Engineer Graduates to Hold International Congress

The Association of Graduate Engineers of the Liege School has scheduled an International Scientific Congress for June 11 to 16, on the occasion of the seventy-fifth anniversary of the Liege School. Graduate engineers of recognized schools and scientists of Belgium and the Allied Nations are invited to attend.

The Congress will include seven sections; mining, metallurgy, mechanical engineering, electricity, chemical industries, civil engineering and geology. A list of questions drafted to give an idea of some of the questions to be discussed has been published by the committee, and for the mechanical engineering section they cover turbines, reciprocating engines, jet apparatus, machine tools, transportation equipment, hoisting and handling machinery, special metallurgical apparatus, special mining machinery, applied hydraulics and thermo-dynamics, and combustion. Copies of these questions may be obtained by engineers expecting to be in Liege at that time, by application to the Editor of Mechanical Engineering.

The tentative program includes the unveiling of a War Memorial and the formal opening, a reception and banquet on Sunday, June 11, a reception by the University of Liege Monday morning, opening of the Assembly and meeting of Sections in the afternoon, a reception at the City Hall by the municipal authorities and a concert and ball at the Royal Conservatory of Music in the evening. Beside the meetings a reception at the Governor's Pallace is scheduled on Tuesday, formal closing of the Assembly on Wednesday and visits to the Exposition, to industrial works and points of interest until the closing of the Exposition on Saturday. Further information may be had by addressing O. Lepersonne, Secretaire-General de L'a. I. Lg., 16 Quai des Etats-Unis, Liege, Belgium.

Cotton-Ginning Machinery

BY SOLOMON E. GILLESPIE,[1] DALLAS, TEXAS

Of the two classes of cotton grown in the United States—sea island or long-staple, and upland or green-seed—the former does not adhere to the seed and the lint can be pulled off clean by running it through rollers set close together, leaving the seed behind. Upland cotton, on the other hand, adheres to the seed, and the present paper is devoted to a description of the apparatus developed since Eli Whitney's epoch-making invention in 1792 for mechanically handling the raw seed cotton, removing the lint therefrom, and forming it into shape suitable for delivery to the baling press.

The cotton-ginning process comprises (a) elevating the cotton from the wagons in which it is brought to the ginnery to (b) a cleaner where the dirt, sand, leaf trash and other foreign substances are extracted; (c) elevating the cleaned cotton to (d) feeders which deliver it uniformly to (e) the gins where the lint is removed from the seed by the teeth of circular saws mounted at close intervals on a rotating shaft, from which teeth it is (f) cleaned off pneumatically and (g) carried to a condenser, where it is formed into a "bat" and delivered to a press box for packing, wrapping and pressing. The latest developments of the various devices employed in these steps are described and illustrated in the paper, and the author has included much valuable information for designers in the way of dimensions, relative proportions, speeds of operation, etc.

LONG before the dawn of history the cotton plant was cultivated in various parts of the world, and the earliest records of spinning its fleecy bolls are of such antiquity that it is difficult to obtain satisfactory evidence of its beginning. The name "cotton" itself is of Oriental origin, being derived from the Arabic "koton" or "gootn."

Before taking up the ginning of cotton it is well to consider its principal characteristics. There are two general classes or distinctive kinds of cotton grown in the United States, "sea island" and "upland." Sea island cotton does not adhere to the seed, and the lint can easily be pulled off clean, leaving the seed perfectly smooth. The staple varies from $1^1/_2$ in. to $2^1/_4$ in. in length, and is of a light creamy silk color. While strong, it is finer than other kinds and being but about 0.00063 in. in diameter, has a more beautiful luster.

Upland cotton adheres to the seed, and appears to grow out of them more like wool from a sheep's back. The seed, after being divested of lint as well as possible, still have a woolly appearance, and in a great many varieties a greenish color, and hence upland cotton often referred to as "green-seed" cotton. The stable varies in length from $^5/_8$ in. to $1^1/_4$ in., and its color ranges from white to a creamy tint. The staple is inferior in strength to the sea island type and coarser, being 0.00076 in. in diameter. The fibers are soft, elastic, moist and pliable, but the natural twist is rather inferior in character to that of sea island cotton, being irregular.

Good commercial cotton must possess certain well-defined external and internal characteristics. The external qualities, which are apparent to the touch or visible to the naked eye, are:

a Length of fiber
b Fineness or smallness of diameter
c Evenness and smoothness
d Elasticity
e Tensile strength
f Color

The internal characteristics, which are discernable by a microscope, are:

a Hollowness, or tubular construction
b Natural twist, due to the collapsed tube
c Corrugated edges
d Moisture

These characteristics are necessary to constitute a good mature cotton fiber, are essential in effecting the close union of the filaments, and make cotton superior to any other fiber, vegetable or animal. And since the cotton fiber has such a delicate structure and great value, it is necessary that the machinery used in its ginning and cleaning be of such character that the least damage will be done to the staple in the process.

The first method to be employed in separating cotton lint from the seed was that of hand picking. The next method, originated in India about 300 B. C., made use of rollers, which when running close together would pull the lint through and leave the seed behind. The roller gin is now used principally for ginning sea island or long-staple cotton and has gone through a long process of development and improvement.

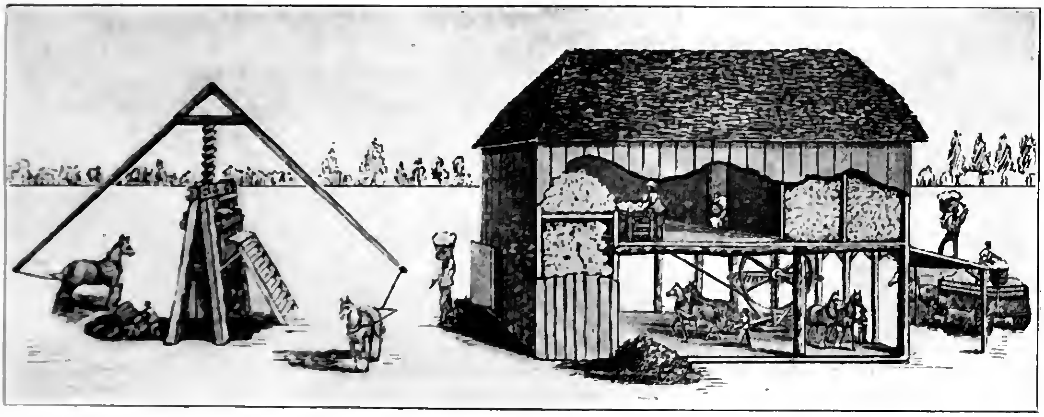


FIG. 1 EARLY TYPE OF GINNERY

In the United States the great problem that presented itself in the early days of the industry was that of removing the seed from the upland or green-seed cotton. The roller gin in its crudely developed state at that time would handle the sea island cotton to a certain extent, but was not adaptable to and suitable for the upland cotton.

In 1792 Eli Whitney, of Massachusetts, went by boat to Savannah, Georgia, and there developed the first cotton gin, for which a patent was granted him two years later. The original Whitney gin was a hand-power and hand-fed gin, consisting of a horizontal wooden cylinder about $7^1/_2$ in. in diameter and 2 ft. long, into which wire teeth were driven in rows spaced apart to admit the seed cotton but with the teeth in each row so close together as not to admit seed. The teeth were all inclined the same way, making an angle of 55 deg. to 60 deg. with a tangent at the point of entry. The

---

For presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922 of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. All papers are subject to revision.

[1] Mechanical and Industrial Engineer. Mem. Am.Soc.M.E.

cylinder had suitable bearings at each end and a hand crank, and above and in front of the cylinder was a hopper to receive the seed cotton, while directly over it was a breastwork or stripping grate consisting of a timber lined with a metal strip having a series of slots through which the rows of teeth could pass, taking the lint cotton but obstructing the seed. The lint was removed from the teeth by means of a cleaner or brush consisting of four sticks with bristles and so constructed that it formed a tangential cylindrical co-acting surface of bristles rotating in an opposite direction to that of the teeth and much faster. It was driven by an endless belt and idler. The gin was not continuous in action as are the gins of today, but had to have its seed dumped from time to time as they accumulated.

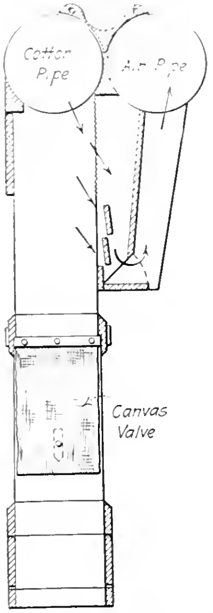


Fig. 2 Pneumatic Elevating System for Large Ginnery

Two years later—May 12, 1796—a patent was issued to H. Ogden Holmes of Augusta, Georgia, on a hand-fed and hand-operated gin similar to Whitney's, except that it was continuous in operation, being so constructed that the seed would shed out as fast as they were delinted. This was also the first gin to use metal disks or saws, which were mounted on a square shaft with the ends turned down for bearings and the saws separated by space blocks. The brush contained more than four bristle-filled sticks, and was driven in reverse direction to that of the saws and four or five times as fast. This gin would shed the seed continuously as fast as delinted, and the roll of cotton in the roll box would revolve just as it does in the saw gin of today.

A little later, larger power-driven gins were employed, Fig. 1, the transmission consisting usually of a large 8-ft. wooden bevel gear mounted on a vertical axis with an extended beam or arm to which a horse or mule was hitched, and a horizontal shaft with a wooden pinion worked in conjunction with the large bevel gear, on which shaft a 12-ft. band wheel was mounted and from which the gin was driven at from 200 to 300 r.p m. by means of a belt. In this system the gin was hand-fed from a platform above. The lint was discharged into a sack suspended beneath a hole in the floor back of the gin, sacking being the first system to be used in handling cotton in the market. Later, however, a lint room was built to receive the lint cotton, which was then carried out of doors, in baskets and put into a crude wooden press. This press was of very heavy mill construction, consisting of a single heavy box with discharge doors at the bottom and four large wooden corner struts or tension supports. An elevated platform was built of sufficient height to easily permit the placing of cotton in the press box from above, just below the overhead sills. The press screw was of wood and 15 in. in diameter with levers fixed to the top end and inclined downward to receive a rope to which a horse or mule was attached. Some presses had roofs over them, while others were left out in the open.

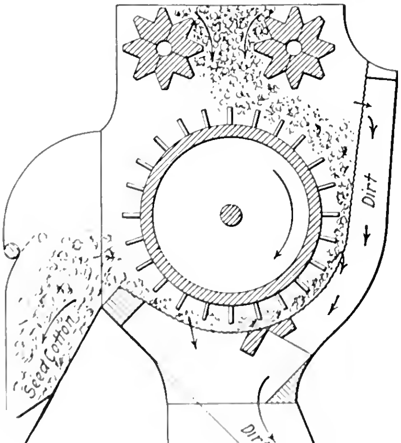


Fig. 3 Feeder for Ginning Roll Box

The ginning system was later improved by the addition of a mechanical feeder over the gin and a single lint condenser back of it, and also by the employment of the steam engine for motive power. As the demand for larger output grew the ginneries were increased to two and three stands and the presses made more modern by the use of a 5 in. steel screw. In some cases the presses were equipped with large steam cylinders 30 in. to 36 in. in diameter, which operated much more rapidly than the screw press. These small ginneries were commonly known as plantation gins and were a part of the equipment of each large plantation. As the cotton industry grew, however, and the large plantations were superseded by small ones, custom gins came into use, doing away with the plantation gin and compelling inventors to seek better methods of caring for larger capacities at the gins. At first belt carriers were installed back of each battery of gins, which received the lint from each of the single condensers and delivered it to the press box. This crude system however, was later replaced by a single lint flue receiving the lint cotton direct from the various gin stands—which were in batteries of from two to six stands—and delivering it to a single large lint condenser or bat former, which then delivered it to the press. The lint flues were first constructed of wood, but later sheet iron was used, the diameter being about 18 in. at the smaller end and increasing as gins were added.

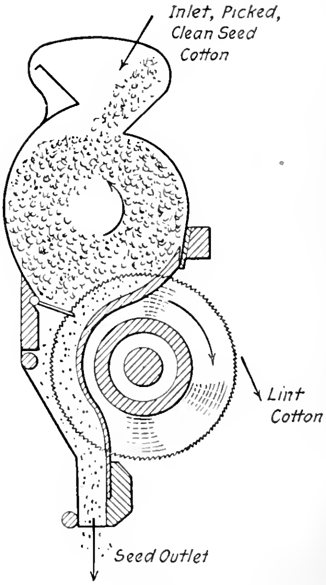


Fig. 4 Plain Gin

To care further for the large output of cotton at the custom ginneries, the revolving double-box press was developed. In this press one box acted as a receiving chamber from the condenser and was provided with a tramper or packer which packed 500 lb. of lint cotton in it, after which it was revolved around, bringing

the other (empty) box onto the receiving side while the one filled with cotton was pressed into a bale.

The standard cotton-bale boxes for presses are 27 in. by 54 in. by 10 ft.; the cotton is pressed from the latter dimension down to 36 in. and then six ties are put around it. Before being pressed, jute bagging is placed at the top and bottom of the cotton for wrappers. Upon releasing the pressure on the bale it usually expands from 40 to 42 in. making a finished bale 27 in. by 54 in. by 40 to 42 in. with a density of 12 lb. per cu. ft. A maximum pressure of 10,000 lb. is required in packing a bale of cotton in the receiving chamber and 70,000 lb. to press a standard bale.

Mechanical elevating systems were also developed for use in the large ginneries. The earlier designs were belt carriers, consisting of slats of wood nailed or riveted to two narrow belts, which would drag the seed cotton along from the point where it was fed on by hand to the point of delivery in the feeders. This process however, required too much human labor, and one comprising a suction fan with vacuum box and belt distributor was next devised.

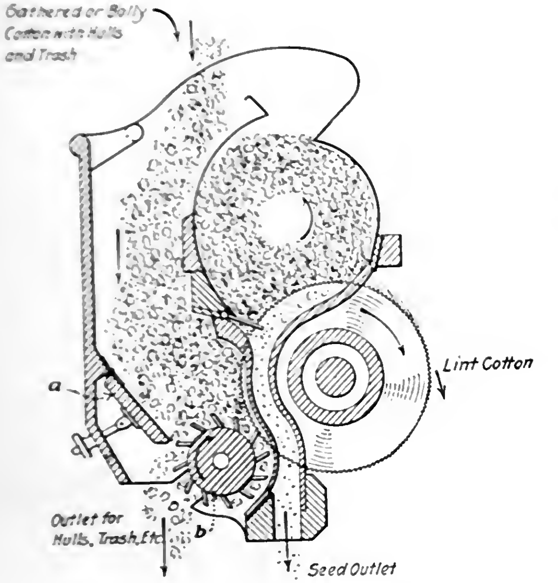


Fig. 5 Huller Gin

In this system the cotton was sucked from the wagon through a pipe to the vacuum box in which there was a wire screen to separate the cotton from the air, the cotton then falling on the spiked belt distributor below, by means of which it was delivered to each gin feeder. The screen area in these vacuum boxes was 1 sq. ft. of $^1/_4$-in. mesh screen wire to 14 to 20 saws. The pneumatic elevating system, Fig. 2, was also invented and consisted of a vacuum chamber or elevator chute over each feeder and gin. This chute consisted of a chamber 12 in. by 53 to 60 in. by 6 ft. high with an air and cotton pipe at the top, a screen box attached on the upper back side and a heavy 12 to 16-oz. canvas valve near the center. This valve was so constructed that when the suction was applied it would close and prevent leakage of air through the valve causing suction in the telescope pipe in the wagon. This would deliver cotton into the several elevator chutes and then periodically the air would be cut off by means of a valve trip, thus releasing the air suction, and the canvas valves would drop the cotton into the gin feeder. The screen in the pneumatic elevator to separate the cotton from the air is usually light No. 21 gage, $^1/_4$-in. mesh wire, and the screen area is about one square foot to 10 saws. The fans used in these two elevating systems are of the steel-plate centrifugal type, varying in size from a 30-in. fan for a two-gin installation to a 45 to 50-in. fan for six gins. The peripheral speed of the suction fan-blast wheels varies from 11,000 ft. per min. to 13,000 ft. per min., which maintains a vacuum of 14 to 16 in. of water.

Seed-Cotton Cleaners

There are many kinds of machines in use for cleaning seed cotton, but the general principle employed in them all consists of agitating the cotton on a wire screen of $^1/_4$ to $^1/_3$-in. mesh, permitting the dirt, sand, leaf trash and other foreign substances to escape.

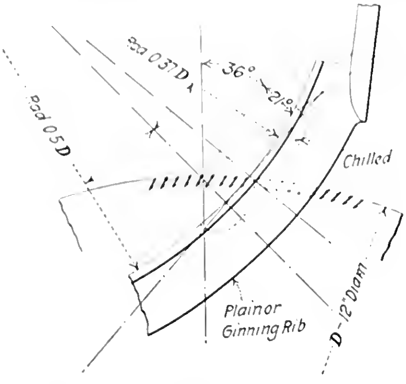


Fig. 6 Detail of Rib and Saw, Plain Gin

It is customary in some sections of the country, where climatic and other conditions interfere with the opening of the cotton boll, to provide a boll-breaking attachment to a cleaner. In some sections, where labor is scarce, the seed cotton is not carefully picked from the open bolls but is grabbed; that is, cotton, pod and all are pulled off in a mass. In such cases the cleaning is an important item, because if not carefully handled the cotton will be damaged in the process. Some cleaning machines therefore have a cylinder of saws to separate the seed cotton from the pod or broken bolls; but this process is best accomplished in the huller gin which will be considered later.

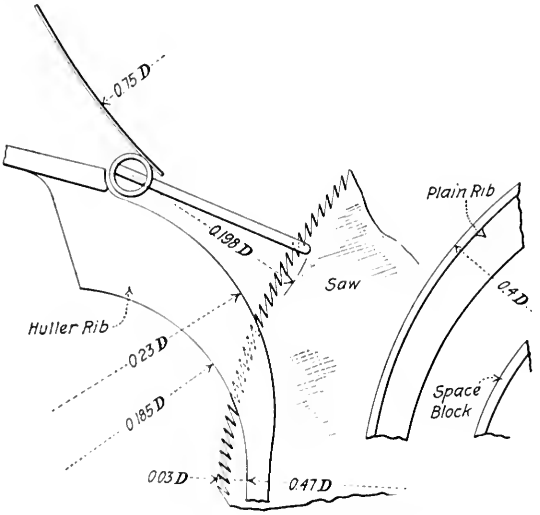


Fig. 7 Detail of Rib and Saw, Huller Gin

Feeders

The feeder receives the cotton from the pneumatic elevator or belt distributor above it, and delivers it in a uniform, even amount to the ginning roll box. There are two general types of feeders, The horizontal slatted-belt type that receives the cotton from the belt distributor or pneumatic elevator on a very slow-moving slatted belt and moves it horizontally up to a spiked drum or picker roller 9 in. to 11 in. in diameter, rotates 180 to 200 r.p.m. and is provided with a series of No. 8 spikes projecting 1 in. from the surface. These spikes lift the cotton over and throw it down

a chute into the ginning-roll box. Another general type, Fig. 3 receives the cotton from the elevator chutes or belt distributor on to two fluted rollers 5 in. to 6 in. in diameter rotating toward each other at $^1/_2$ to 1 r.p.m., slowly feeding the cotton down where it is taken off by a picker roller similar to the one previously described, and is then whipped around a $^1/_3$-in. mesh No. 16 gage wire screen that partly surrounds the picker roller at a distance of about $^1/_2$ in. therefrom, threshing the light leaf trash and sand out of it before delivering it to the ginning roll box for the next process. The latest improved feeders are effective cleaning machines.

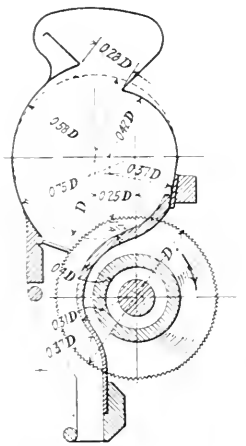


Fig. 8 Proportions of Plain Gin Roll Box

The Seed-Cotton Gin

The gin stand is the principal machine in the system as it performs the main work of separating the seed from the lint. There are two general types of saw gins, (*a*) the plain gin, Fig. 4, that gins only clean seed cotton that is substantially free from bolls and trash and is the original type used; and (*b*) the huller gin, Fig. 5, that separates the seed cotton from the bolls, burrs, leaf trash, dirt and other foreign substances in the front lower roll box, and then carries the seed cotton into the upper roll box where it separates the lint from the seed, thus performing a double ginning operation. The main working parts in both types of gins are the saws cylinder, roll box and a means of removing the lint from the saw teeth after it is separated from the seed.

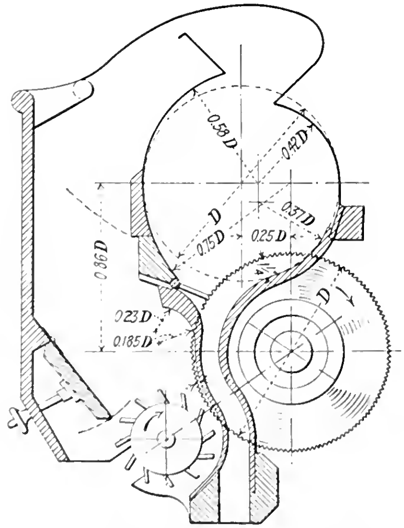


Fig. 9 Proportions of Huller Gin Roll Box

The Plain Gin

The standard saw cylinder is made up of a series of 70 to 80 steel circular saws 10 to 12 in. in diameter and 0.035 in. thick, mounted on a 2$^3/_{16}$ in. to 2$^7/_{16}$ in. mandrel and separated by wood or iron space blocks 0.6835 in. to 0.7396 in. thick and 4$^3/_4$ in. for 10 in. and 6 in. in diameter for 12-in. saws. The 12-in. diameter saw is considered best practice. The saw teeth all incline in the direction of rotation. There are seven teeth per inch, which are punched out and then filed smooth. This punching, however, crystalizes the saw steel to a certain extent and often results in defective teeth, with rough edges which are not noticeable to the naked eye but are very distinctly seen with a microscope. Some means should be devised for milling or grinding the teeth instead of punching to insure a perfect smooth tooth free from fracture and crystallization. The usual practice in the design of the tooth is to make both the front and back edges straight lines. In some cases, however, the front edges have been made straight and the back edges convex, resulting in what is known as "hog-back" teeth. The inclination of the teeth edges, Figs. 6 and 7, with a radial line through the point are 36 deg. for the front edge and 57 deg. for the back edge, the two edges making an angle of 21 deg. with each other at the point; this, however, may vary to suit certain working conditions later referred to. The saws rotate with a tooth travel of 1000 to 1250 ft. per min. for brush gins and 1400 to 1900 ft. per min. for air-blast or pneumatic gins.

The roll box, Fig. 8, consists of a series of ribs between the saws with a half-rib at each end, a back hollow above the ribs, an inlet opening or feed inlet at the top, a cover on the front side with a seed grate attached, and a shield or cover for the exposed portion of the saws below the roll box. In the development of the gin it was found by experiment that the process of ginning worked best by placing the roll box above the saws, thus permitting the roll of cotton to rest upon them, Fig. 4; the saw teeth in taking hold of the cotton fibers would cause the whole mass of cotton to revolve in reverse direction, and usually at about a fifth of their velocity, depending upon the quantity of cotton in the roll box and the hardness of the roll.

The cotton roll is theoretically round, Fig. 8, and the same diameter as that of the saws; but due to the following necessary working conditions its perfect roundness is distorted.

a The saws are caused to project up into the roll box from 1$^1/_{16}$ in. to 1$^5/_{16}$ in., 1$^3/_{16}$ in., being considered the best practice. The cotton roll merely rests upon the saws, and the saw teeth, Fig. 4 only project into it. The cotton roll itself when rotating, is hollow, due to centrifugal force, and the cavity in the center is from 25 to 50 per cent of its diameter. It is best practice for the roll of cotton in the roll box to be as soft as possible, that is, with as large a cavity as possible, because this prevents the cotton fibers from wedging into the throats of the saw teeth, cutting and knapping the fibers, and also permits the fibers caught by the saw teeth to disentangle from the mass of the roll without breaking off; this precaution is especially necessary when the saw teeth are traveling at a high velocity.

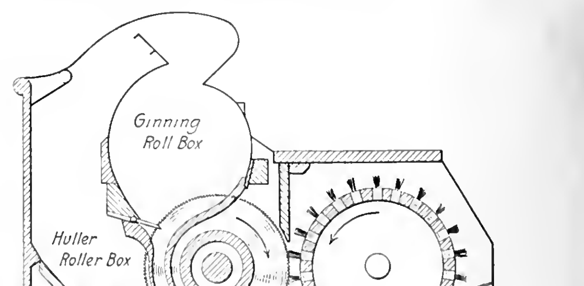


Fig. 10 Brush for Removal of Lint from Saw Teeth of Huller Gin

b The rib is tangent to the theoretical roll at its lower side; but the curve of the rib cuts up into the theoretical roll with a radius of 37 per cent of the saw diameter *D*, and at the upper edge of the

rib, from $1^1/_2$ to 2 in. above the point where the saw teeth pass through, there is an offset dropping the working line back tangent to the theoretical roll, to permit the cotton fibers that were pulled between the ribs and not carried away by the saw teeth, Fig. 4, to free themselves from the ribs. The ribs are usually made of cast iron and at the points where the saw teeth pass between them they are chilled, for an inch or so each way, Fig. 6, thus making a hard working surface that exhibits very little wear. The space between the ribs at the point where the teeth pass through is 0.125 in. wide and increases in width in each direction therefrom. The wearing surface of the rib as well as the edges are ground smooth and polished. The lower end of the rib is extended downward beyond the circle of the saw and attached to a rail or bar and the upper end extended just above the offset to attach likewise to a bar or rail, while the inner surface is ground to the curvature of the theoretical roll.

c The back hollow begins at the upper end of the rib, tangent to the theoretical roll, and curves inward and upward with a radius of 42 per cent of the saw diameter *D* to give the roll a proper density at the ginning point below and also pack it just before reaching the inlet opening at the top. This opening is 28 per cent of the saw diameter *D*, and is for the purpose of admitting cotton into the roll box at the top when operating as a plain gin.

d The front roll curves are the reverse of those of the rib and back hollow. The front is tangent to the theoretical roll at the intersection of the horizontal center line with it, and curves outward therefrom toward the top, to allow freedom for the admission of cotton, with a radius of 58 per cent of the saw diameter *D*. It also curves out from the center line toward the bottom with a radius of 75 per cent of the saw diameter *D*, to allow the roll to loosen so the ginned and cleaned seed will drop out. Near the bottom of this curve of the front there is a seed grate consisting of a pivoted rod with No. 8 fingers projecting out between the saws and extending $^1/_4$ in. inside of the saw-tooth curve. By raising the fingers or grates they press up against the bottom of the cotton roll and retard the shedding of the seed, and by lowering them the seed are shed free; if lowered too much, however, the seed are released before the lint is entirely removed, Fig. 4, the ginning being thus regulated. The seed are shed out in the course of their travel from the seed grate to the point where the saw teeth pass between the ribs, the seed that are free from lint dropping out of the roll on to the ribs below and escaping to the seed conveyor below. The center of the roll box is not directly above the center of the saws because it would cause the ribs below to be too flat and not permit the seed to slide down out of the way, therefore the center of the roll box is 25 per cent of the diameter *D* in front of the vertical center line. The exposed portion of the saws below the roll box is covered with a shield to prevent injury to the operator; some roll boxes, however, have fronts that extend down and cover the exposed saws.

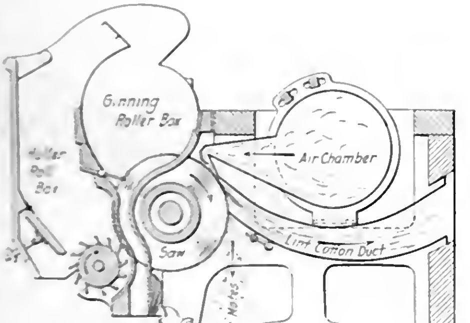


Fig. 11 Air-Blast or Pneumatic Gin

The saw teeth in traveling under the cotton roll take hold of some of the fiber and carry it between the ribs, leaving the seed in the roll box to be shed out as above explained. Each saw tooth that is loaded with lint cotton, amounting to from 0.000005411 lb. to 0.000004466 lb. per tooth for brush gins and from 0.000004025 lb. to 0.00000375 lb. per tooth for air-blast or pneumatic gins, being 100 to 160 fibers per tooth based on 29,000,000 fibers per pound, must be unloaded or cleaned before it returns to the roll box again. The removal of the lint from the saw teeth is accomplished by means of a brush, Fig. 10, consisting of a series of $^3/_4$ by 1-in. sticks, usually 22 in number, in which bristles are inserted usually projecting 1 in. from the stick. These sticks are mounted on a series of drum heads on a shaft $1^{15}/_{16}$ to $2^3/_{16}$ in. in diameter. The outside diameter of the brush cylinder is usually 15 in. Each brush has four wings 1 in. by 6 in. on each end head. In the operation of the brush gin the brush is set up to the saw cylinder so that the tips of the bristles overlap the saw teeth just $^1/_{16}$ in., and then caused to rotate in the reverse direction to that of the saws and at a peripheral speed of 6300 to 6900 ft. per min., or approximately six times as fast as the saw-tooth travel. When the bristles are new they have a wiping effect on the saw teeth, but after considerable use the tips wear off to such extent that they do not touch the saw teeth, and it is only the air blast generated by the brush that removes the lint. At the rear of the brush there is a board or sheet-metal cut-off, similar to that of a fan. And just above and between the saw cylinder and the brush there is a parting board that directs the air current on to the saw teeth, removing the lint and at the same time deflecting the motes out of the general current by centrifugal force with the assistance of the mote board, while the lint is blown into the lint flue below. The mote board is just below and between the saw cylinder and the brush, and is adjustable so that in the regulation thereof the motes just pass out while all of the lint cotton is caught in the lint flue. The usual air current or pressure produced on the saw teeth by the brush varies from 5 to 6.5 in. of water, and in its travel to the lint-flue main body it expands until the pressure in the flue is $^3/_8$ to $^1/_2$ in. of water.

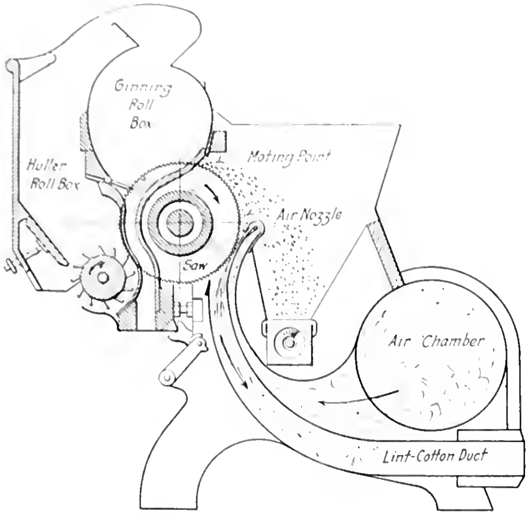


Fig. 12 Another Type of Pneumatic Gin

The discovery that the air blast generated by the brushes had such an important part in removing the lint from the raw teeth led to the discovery of the pneumatic gin. Figs. 11 and 12, show two different types of this gin. One (Fig. 11) discharges the motes below, while the other, (Fig. 12) discharges them over the top of the air lip. In the early air attachments the discharge-nozzle opening was $^7/_{16}$ in to $^1/_2$ in. wide and extended 1 in. beyond each end saw; after continued development, however, these openings were reduced to $^1/_4$ in. to $^5/_{16}$ in. The air blown from the lip

opening continues to hug the sheet that leads to the lint-flue opening, and this sheet is brought up to within $^1/_{32}$ in. to $^3/_{32}$ in. of touching the saw teeth. The lint opening is just wide enough to receive all the air discharged from the air nozzle, and in addition thereto a small amount of the outside air is injected by the dynamic action of the air current. There is thus a slight current from the outside leading into the lint flue to insure that there will not be a loss of lint fibers on the outside, which would be the case if the reverse action took place. The air pressure at the nozzle outlet is usually from 8 in. to 12 in. of water. The various pressures for other points in and around the air nozzle for the two types of gins are as shown in Figs. 13 and 14. The pressure in the lint flue at the rear of the gins varies from 0.7 in. to 1.0 in. in the rear of the gins to 0.5 in. to 0.65 in. in the lint-flue uptake to the condenser.

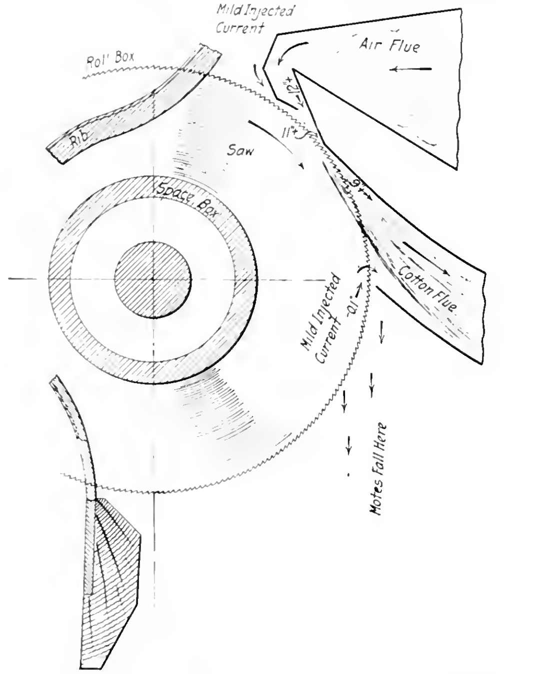


Fig. 13 Air Pressure at Various Points in Pneumatic Gin Shown in Fig. 11

The Huller Gin

The operation of the huller gin is very similar to that of the plain gin, in that the saw cylinders and the method of removing of the lint therefrom are the same. The roll-box construction is also the same, except that there is an additional huller roll-box in front of the ginning roll-box, Figs. 5 and 9, for separating the seed cotton from the burrs, sticks, trash, etc., and the cotton is delivered into the huller roll-box first, Fig. 5, and from there is carried up into the ginning roll-box by the saws; hence the feed to the ginning roll-box is from below instead of from the top, as is the case with the plain gin. The huller roll-box, Fig. 5, consists of a chamber in which the cotton is fed, and this chamber has a hinged removable front cover *a* with an inclined sheet or board for regulating the refuse discharge, and a huller picker roller *b* $2^1/_2$ to $4^1/_4$ in. in diameter with 10 to 16 longitudinal rows of No. 8 spikes set at an angle of 30 deg. to radius of point where they enter roller. These spikes are alternated and in circular rows of 5 to 8 spikes between each pair of saws, and project out $^3/_4$ in. to 1 in. from the roller, which rotates at from 300 to 700 r.p.m. There is also a set of huller ribs, Fig. 7, to prevent the hulls and trash from being carried into the upper or ginning roll box, thus performing a double ginning process. The huller ribs partly surround the huller picker roller, Fig. 9, and the outer or working surface of the rib is $^1/_4$ to $^3/_8$ in. from the tips of the saw teeth; just below the seed grate the rib curves out and is fixed to a rib rail or bar.

In the operation of the huller gin the cotton, Fig. 5, is fed into the huller roll box, the spiked picker roller rotating in the reverse direction to that of the saws, spikes inclining backward. The cotton is thus thrown on to the saw teeth and carried up into the ginning roll, leaving the trash, a part of which is shed out; but as the quantity increases, the box front is swung out by hand, discharging the foreign substances. When there is a large amount of trash the picker roller is pulled out from the ribs and the inclined board moved back, thus permitting the trash to shed out in front of and behind the roller; but if there is only a small quantity, the huller roller should be set up close to it, to prevent the dropping of locks of cotton. The huller ribs are spaced sufficiently apart at the point where the teeth pass between to permit the seed cotton to pass through into the ginning roll box. The lint is removed from the saw teeth by means of a brush or current of air as has been described for plain gins, and the operation of the ginning roll box in shedding the seed is the same. The lint cotton is removed from the saw teeth and passed into the lint flue which has inlets from the various gins set in battery. The size of the lint flue varies according to the number and size of gins, the general practice being to have about three square inches per saw.

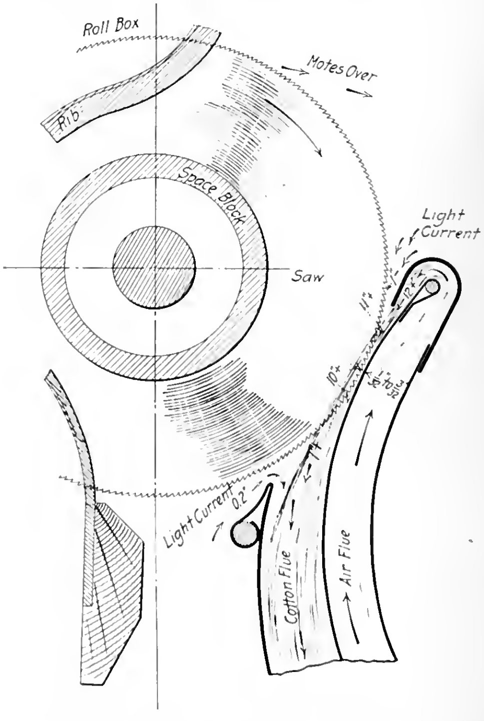


Fig. 14 Air Pressure at Various Points in Pneumatic Gin Shown in Fig. 12

The Condenser

The lint flue delivers the cotton into the condenser which consists of a large horizontal drum covered with 8-mesh No. 21 wire screen. The drum is usually 54 in. long, the same as the cotton bale, and its diameter is usually 30, 40, 50, 60, or 72 in. respectively, for 100, 175, 250, 325 or 400 saws. The screen drum, Fig. 15, is mounted in a housing that spirally circumscribes it with air outlets at the ends and two doffing rollers at the discharge side, the lower one having flaps of thin $^3/_{32}$-in. light cloth-backed rubber. The rollers receive the lint cotton from the drum and deliver it on the lint slide and then into the receiving chamber of the press box. The portion of the screen drum exposed to the cotton air current is about 75 per cent, and there is 1 sq. ft. of screen provided for every 5 to 6 saws; but when the drum rotates it travels at a rate of speed of 50 to 80 ft. per min. for the smallest up to the

(*Continued on page 242*)

Reduction of Fuel Wastes in the Steel Industry

By F. G. CUTLER,[1] ENSLEY, ALA.

The paper sets forth the economy of utilizing blast-furnace gas, at one time considered to be of little material value, in reducing the wastes of the steel industry. It is shown how the quantity of gas to be expected in the production of one ton of pig iron may be computed, and the uses to which this gas may be put are analyzed quantitatively. A heat balance, based on the production of one ton of pig iron is presented, showing the sources of heat and the requirements for blast-furnace and steel-mill operation. It shows that the total heat from the by-products of a ton of pig iron is more than sufficient to finish a ton of steel. The heating requirements are not met by the tar and by-product gas, although the average power requirements are more than met by the blast-furnace gas and coke breeze. It therefore becomes desirable to reduce the heating requirements for the production of steel by using more efficient heating furnaces, and to conserve all possible heat by charging hot steel into the soaking pit and reheating furnaces, in order to reduce the quantity of fuel required for supplementary heating.

In order to show the relative proportion of the energy in the shape of heat or power required for the manufacture of steel that is utilized from the fuel by-products of the manufacturing process, the following figures have been prepared showing the quantity of heat derived from the by-products of the manufacture of pig iron.

In the production of one ton of pig iron, from under 1800 to over 3000 lb. of coke are used, this variation being due to difference in metallic content of the charge, condition of the furnace lining, quality of coke, etc. The heat energy of this coke is utilized in the reduction of the ore to pig iron and changing the impurities to a slag, a part is lost in radiation, and approximately half is delivered at the top of the furnace in the shape of gas for use under boilers for the production of steam, or in gas engines for the production of power. The gas has also been used in soaking pits, in by-product oven heating, ladle drying, etc., and other uses have been proposed, but by far the greatest quantity has been used under boilers.

It has been only within the last few years that blast-furnace gas has been considered to have any material value. In the past there has been no recognized method of determining whether or not a blast-furnace plant has been guilty of wasteful practice, or if guilty, what the extent of this waste might be, and it is the intention of this paper to propose a standard method of comparison of total combustion efficiency, both with the idea of determining, for any particular plant, the relative efficiency, from day to day or month to month, as well as for the comparison of one blast-furnace plant with another, for the information of the management and the engineers in determining the necessity for improvement in equipment or personnel.

Heat Available from the Blast Furnace

In proposing this standard comparison reference is made to Fig. 1 which is taken from Mr. Brassert's paper on Modern Blast Furnace Methods, published in the year book of the American Iron and Steel Institute in 1914. This chart shows the effect of variation in coke rate upon the heat value of blast-furnace gas at 62 deg. fahr. As blast-furnace gas leaves the top of the furnace it usually has a temperature of from under 300 to over 600 deg. fahr., generally averaging about 400 deg. fahr. At this latter temperature, the sensible heat of the gas is equivalent to about 8 B.t.u. per cubic foot of gas at 62 deg. The B.t.u. per cubic foot of blast-furnace gas according to Brassert is $62.5 + 0.016R$, where R = lb. of dry coke per ton of pig iron; and including sensible heat of the gas at 400 deg. fahr. would be equal to $70.5 + 0.016R$. The cubic feet of gas per ton of pig iron (as shown by Brassert) is equal to $71.4R$, so that in the top gas from a furnace at 400 deg. fahr. the B.t.u. per ton of iron is $1.142R^2 + 5033.7R$. Brassert also gives the cubic feet of air per pound of coke equal to $51.4R$, so that both gas production and the blast requirement bear a direct ratio to the coke consumption of the furnace per ton of iron. The figures given in Mr. Brassert's paper, so far as the author has been able to discover, are applicable to all blast furnaces using coke as fuel

Heat Required for the Stoves

The blast is heated in stoves under pressure, and the heat required per cubic foot of blast is proportional to the rise in blast temperature in the stove, and inversely proportional to the efficiency of the stove, which is usually considered to average 60 per cent. After the necessary gas is used to heat the blast, the remainder can be measured in the shape of power. Any increase in stove or boiler efficiency or reduction in leakage of gas, etc., is reflected in increased surplus power, and as we are largely interested in the surplus power, after the blast furnace requirements are satisfied, any error in the assumptions relative to the efficiency of the stoves is of minor importance, particularly as the stoves use the smaller fraction of the total. The blast supplied from the blowing engines is heated by compression to about 150 deg. fahr., varying somewhat with blast pressure, etc., and is usually heated in the stoves to from 1150 to 1350 deg. fahr. In the following calculations it has been assumed that 0.02 B.t.u. are required per cubic foot of blast per deg. fahr., that the blast is heated in the stoves to 1250 deg. fahr., that the average overall stove efficiency (i.e., ratio of heat given to the blast to the heat in the gas) is 60 per cent and that 55 cubic feet of blast are heated per pound of coke charged.

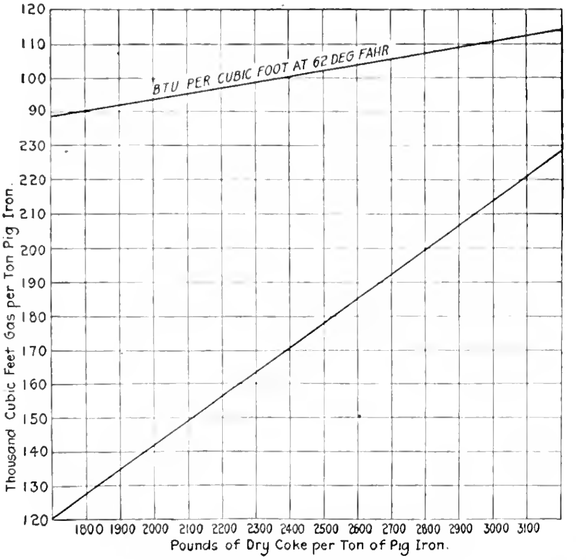


Fig. 1 Effect of Coke Rate on Production of Blast-furnace Gas

The heat required in the gas for heating the blast for one ton of pig iron to a temperature of 1250 deg. fahr. can therefore be expressed by the following formula where H = B.t.u. per lb. of coke burned in the blast furnace.

$$H = \frac{(1250 - 150) \times 0.02 \times 55R}{0.60} = 2020R$$

The heat in gas per ton product after the blast is heated is, therefore, $1.142R^2 + 3013.7R$. For other top temperatures and blast temperatures the constants will change slightly.

---

[1] Chief of Bureau of Steam Engineering, Tenn. Coal, Iron & R.R. Co.

Abstract of paper to be presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. Copies of the complete paper may be had upon application. All papers are subject to revision.

Heat Required for Gas-Fired Boilers

In order not to enter into the discussion of the relative merits of steam vs. gas engine, surplus uncooled gas, after the stoves are heated, will be assumed to be used under boilers. In one boiler horsepower-hour there are 33,305 B.t.u., and assuming that the "standard" efficiency of blast-furnace-gas-fired boilers is 66.6 per cent, in one boiler horsepower-hour $\frac{33{,}305}{0.666} = 50{,}000$ B.t.u. would be required in the gas, so that the boiler hp-hr. per ton would be $\frac{\text{Surplus B.t.u. per ton iron}}{50{,}000 \text{ B.t.u.}}$. As the blast furnace product is usually expressed in tons per day the average boiler horsepower per hour generated from blast furnace gas under the above conditions can be expressed by the formula:

Average boiler horsepower per hour per ton of pig iron per day

$$= \frac{1.142R^2 + 3013.7R}{50{,}000 \times 24}$$

In assuming the standard efficiency of 66.6 per cent for boilers and 60 per cent for stoves, it should not be understood that these are the maximum efficiencies that can be attained, but rather that they are taken as a standard for comparison and represent average practice that can be maintained in a fairly modern plant which is correctly designed, and which is operated by reasonably intelligent men.

Using the above, Fig. 2 has been prepared. This chart also shows the per cent of top gas required for heating the blast to an average of 1250 deg. fahr. with the stoves of 60 per cent total efficiency. This chart can be used by the blast furnace superintendent or engineer to determine the horsepower that should have been generated from gas for any period. From the actual results as shown by a meter on the boiler feed line, after deducting an allowance for steam generated by coal firing (usually small) or for gas used by gas engines, it will be possible to determine whether the total efficiency, including stoves and boilers, is above or below the standard.

The following table shows the boiler horsepower-hours per ton of pig iron for several coke rates as calculated from the above formula.

Pound of Coke per Ton	Boiler-Horsepower-Hours per Ton Product	Boiler-Horsepower-Hours per Ton per Day
2000	211	8.8
2200	242	10.1
2400	276	11.5
2600	310	12.9
2800	318	14.5
3000	386	16.1

To furnish the blast to the furnace with either high-pressure condensing, turbo-blowers or reciprocating steam engines requires about 70 boiler hp-hr. per ton of coke burned in the blast furnaces, and to operate the various furnace auxiliaries, such as pumps, air compressors, steam bells, mud guns, hoists, etc., requires from 15 to 25 boiler hp. per ton of product, so that after the furnace requirements have been met, there is available for the generation of power from 100 to 250 boiler hp-hr. per ton of pig iron, depending on the coke burned in the furnace.

At 2 kw. per boiler hp-hr., this means that from 200 to 500 kw-hr. per ton of pig iron is possible with steam equipment from the surplus gas from the blast furnaces.

Heat Required for Manufacture of Steel from Pig Iron

The manufacture of steel from pig iron in the open hearth requires heat for melting scrap and fluxing the impurities, and power for the various operations incident to this process. The quantities of heat and power required vary materially with different plants on account of difference in equipment, practice, etc., but for the purpose of this paper it will be assumed that a ton of ingots requires one ton of pig iron plus enough scrap to offset the losses and this work requires from 5,000,000 to 9,000,000 B.t.u. and an expenditure of from 20 to 30 kw-hr. per ton. This ton of ingots will make about 0.85 ton of blooms, and the heating in soaking pits will require from 1,500,000 to 3,500,000 B.t.u. per ton of steel depending upon the temperature of the steel arriving at the pits, rate of operation etc., and the rolling of the ingots into blooms will require from 40 to 60 kw-hr. per ton. From the blooming or slabbing mill the material, usually reheated at an expenditure of from 2,500,000 to 6,000,000 B.t.u. per ton, is furnished to finishing mills, the power required, depending on the reduction of section, temperature of rolling, etc., varying from 35 to over 300 kw-hr. per ton.

Utilization of Industrial Wastes

Waste heat from open hearth and heating furnaces and kilns is utilized for the production of steam, and otherwise waste steam is utilized in low or mixed pressure turbines for the production of power, but as these subjects have been discussed many times, and are not peculiar to the steel industry, they will not be discussed except to say that while these economies are many times worth while in existing plants, very few new installations as designed include waste-heat boilers with furnaces, or low-pressure turbines as integral parts of new power plants.

Surplus by-product gas, after the ovens are heated, is sold for use as domestic fuel, etc., replacing natural gas, water gas, etc., and is used in the steel plant for melting steel in the open hearth, and for various heating operations in the steel industry. In former years this material was considered as having only nominal value and it was but rarely that any attempt was made to utilize it efficiently.

With the advance in fuel prices, shortage of natural gas, etc., and also largely due to special heating requirements connected with the manufacture of artillery and ammunition during the war, a number of combustion systems were developed that by more or less accurately regulating the proportion of air to gas have greatly increased the combustion efficiency of heating furnaces, and the control of combustion has been found of great importance in the maintenance of economy.

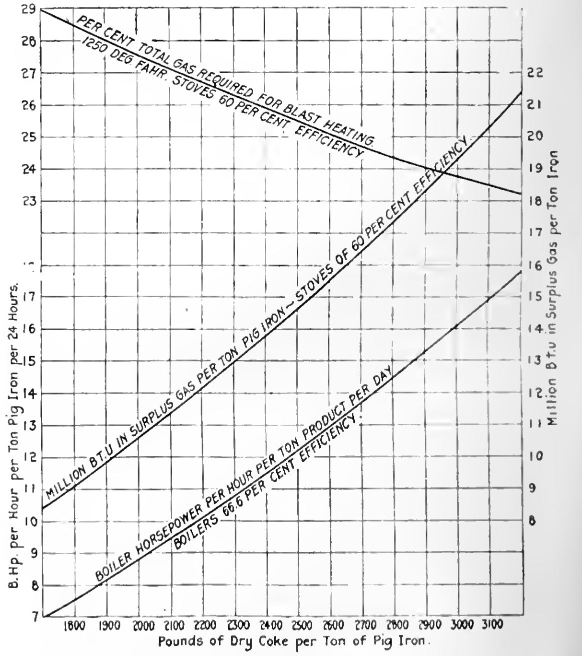


Fig. 2 Effect of Coke on Production of Power from Surplus Blast-furnace Gas

Dust coke breeze, from the coke plant (i.e., the material through a $1/8$-in. screen), is used to cover molten pig iron in transit from the furnaces and in making bottoms of soaking pits and heating furnaces. A great deal of this material which was thrown away or more or less inefficiently burned on hand-fired grates or, by mixing with slack, on mechanical stokers, is now more efficiently burned by itself, on traveling-grate forced-blast stokers.

Tar, either before or after the creosote oils have been removed, has been found to be a very good fuel for open-hearth furnaces,

(Continued on page 242)

Hydroelectric Installation on the Kern River

Two Turbo-Generators Arranged for Dual Operation at Either 50 or 60 Cycles—Unique Equipment for Efficient Use of Water Supply

By ELY C. HUTCHINSON,[1] SAN FRANCISCO

As the Kern River No. 3 Plant of the Southern California Edison Company marks the most important forward step in hydroelectric practice in recent years, a brief review will be given of the reasons leading to its development.

The plant is required to supply 60 cycle current for pumping plants to irrigate the growing crops in the San Joaquin Valley during the summer season, when the demand in Southern California is comparatively low. With the approach of winter, the pumping load, and with it the demand on the 60 cycle system decreases, while at the same time, the demand on the 50 cycle in Southern California increases. To meet this condition the plant must be connected into the general transmission system supplying the Southern California territory. This dual requirement is further complicated by a widely varying seasonal flow of the river with no opportunity for storage.

The power house is a reinforced concrete building 88½ft. wide and 130 ft. long, situated on the bank of Kern River. Tail water from the turbines is returned directly to the stream. The generator equipment consists of two 17,500 kva. General Electric Company vertical units, operating 3-phase at 11,000 volts for 60-cycle and 10,000 volts for 50-cycle current. They are provided with Reist spring type, water-cooled thrust bearings for supporting the entire rotating element inclusive of the hydraulic turbine runner and shaft. As is explained later, the turbines are designed so that an uplifting force is produced within the casing, thus reducing the load on the thrust-bearings.

Fig. 1 Exterior of Power House

The hydraulic turbine and their auxiliaries are of particular interest, as they are operating under the highest head ever attempted with turbine construction, and contain many novel features essential to success under the conditions. The operating requirements may be summarized as follows:

Effective head—780 ft. to 820 ft.

Water quantity—variable, from full supply for two units to less than sufficient for one under full load. No storage.

Generating frequency—either 50 or 60 cycles. Both units can be operated at 60 cycles, both at 50 cycles, or either unit can be operated at 60 cycles and the other at 50 cycles.

Speed—for 60 cycles, 600 r.p.m. For 50 cycles, 500 r.p.m.

The operating guarantees were:

Capacity—22,500 hp. per unit for either 50 or 60 cycle operation. (They are however operated almost continuously at 25,000.)

Efficiency—90 per cent maximum, either at 50 or 60 cycles.

Maximum speed rise—full load rejection, 60 cycle, 21 per cent, 50 cycle, 29 per cent.

Maximum pressure rise—full load rejection, 50 and 60 cycle, 20 per cent.

The turbines were designed and built by the Pelton Water Wheel Company's San Francisco Works. They are of the vertical type as shown in Fig. 2.

The casings are of cast steel, made in halves and bolted to a cast-steel speed-ring made in one piece. The casing covers are made of cast iron. The upper cover is constructed to support the turbine bearing, which is of the external babbitt-lined type. Leakage from the inside of the turbine casing is prevented by a stuffing box of unusual design.

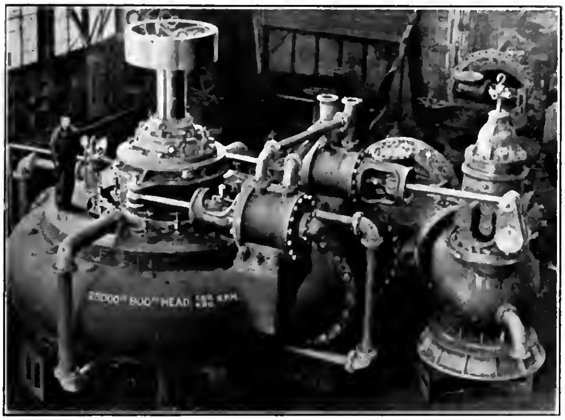


Fig. 2 Turbine in Place but Generator Not Connected

Owing to the high internal pressure and high rotating speed of the shaft, it was necessary to make special provisions for cooling the stuffing box. This was accomplished by fitting a water-jacketed, renewable wearing-sleeve over the shaft, and arranging to pack the stuffing box only loosely with specially designed metallic packing-rings. Any possible water seepage is drained off to tail water by means of an automatic ejector device.

Two interchangeable bronze runners are provided for each unit, one for 50 and the other for 60-cycle operation. These runners may be changed and the unit put back on the line in twenty hours by means of an interesting set of devices, for which patent application has been made. The procedure is as follows:

The runners fit on a tapered extension of the main shaft, which is hollow. A special portable hydraulic jack, which connects rigidly to the shaft, is used to force the runners on or off. The draft tube has two removable cast iron sections, each permanently provided with 4 roller-bearing car-wheels. These sections are lowered to rails set into the floor, after which they are rolled out or the way to give free access to the runner. All parts are raised of lowered by the power house crane with the hoisting cable passing through the hollow shaft.

One of the draft-tube sections acts as a carriage for the runner, which is thus wheeled to an open hatchway. Here the change is made from 50 to 60 cycle, or vice versa, with the station crane,

---

[1] Engineer, Pelton Water Wheel Co.

Abstract of a paper presented at a meeting on March 23, 1922, of the San Francisco Section of The American Society of Mechanical Engineers.

The new runner, on its carriage, is then wheeled to position below the turbine casing and hoisted into place. The change of runners is made without disturbing the gate-rigging or the guide-vanes, which are carried in grease-lubricated bronze bearings at both ends.

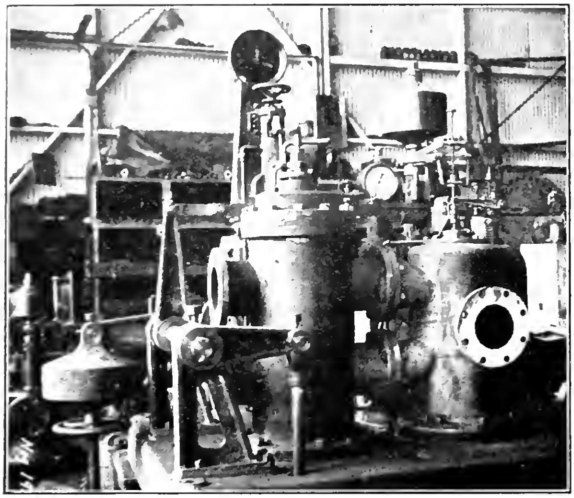


Fig. 3 Shop Assembly of Governor

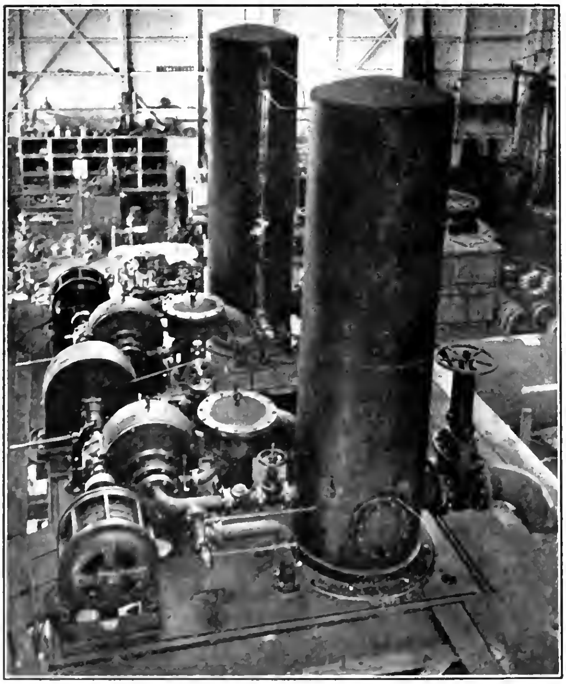


Fig. 4 Shows Assembling of Pumping Equipment, etc., for Oil-Pressure System Note Between the Two Motors the Impulse Wheel Which Takes Over the Pumping Load in Case of Momentary Failure of the Motors

On account of the high-operating head, the design of the water-seal rings between the rotating runner and the turbine casing called for careful study. It was finally decided that all seal-rings should be made removable and renewable, whether on the runner or in the casing covers. Straight face concentric clearance rings of rolled steel are attached to the runners, and bronze matching rings were placed on the casing covers. The control of pressures on the upper and lower faces of the runner and also the resultant hydraulic uplift for relief of the thrust-bearing load is automatic.

Further, when operating turbines under heads as high as used at Kern River No. 3 plant it is absolutely necessary that a thoroughly reliable and efficient brake be installed as a part of the equipment. It takes very little water at such high heads to develop sufficient power to keep the turbine rotating at full speed without load. Then if the guide vanes become worn and possibly slightly bent through closing on some obstruction, it is conceivable that enough leakage would occur actually to prevent closing down with the governor, were no brake available.

The brakes on the turbines of this plant are of the post type lined with a specially made wire-inserted asbestos-stitched fabric. They are hand operated from the main floor. From full speed of 600 r.p.m. the brakes will bring the rotating element to a full stop without undue effort in less than three minutes and in an emergency can be operated much more rapidly.

The governors are of the Pelton vertical-spindle belt-driven floating lever, actuator type taking oil pressure from a central system and delivering it to the servomotors, which are mounted rigidly on the turbine casing. The actuators operate on the open sump system, with enclosed centrifugal elements and dash-pot compensation. The shop assembly of the governor is shown in Fig. 3.

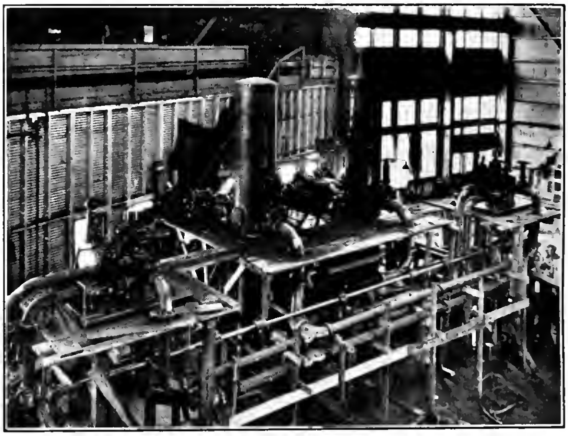


Fig. 5 Complete Shop Assembly of Governor and Oil Pressure System

A mechanical synchroscope and gate-opening indicator makes it possible to synchronize the valve positions in both governor actuator and hand control so that there will be no surging movement of the turbine-gate mechanism when switching from board to governor operation, or vice versa.

The pressure oil system is in duplicate, each side being of sufficient capacity to operate both main turbines at one time. The arrangement as shown in Fig. 4, includes two oil pumps of the Pelton rotary two-stage or series type. Shop assembly of governor and oil-pressure system is shown in Fig. 5.

Normally electric motors are used for operating the pumps. The arrangement is such, however, that if, for any reason the electric motor fails, the nozzle of a water motor automatically opens and the pump continues in service. The pump is thus made to operate continuously. This does not have any bad effect upon the oil however, for, when the pressure in the accumulating tanks reaches a predetermined maximum the pumps are automatically unloaded.

The equipment of the turbine and governors for the most efficient use of the available water supply is unique. About 300 sec. ft. of water is required to supply each turbine unit at full load. The stream flow varies with the season and at times is not sufficient for fully supplying one unit. From this minimum the quantity increases gradually to 600 sec. ft. or more. As there is

no storage available special apparatus was desired for automatically making use of the water supply to best advantage.

For periods when the water is more than sufficient for one unit but not enough for two, a cross connection is made between the turbine and one of the governors takes master control of its turbine, which delivers 60 cycle current on a fluctuating load to the Mt. Whitney system. The remaining turbine is then set in block load delivering its power into the 50 cycle system. By means of the cross connection between the units the master governor automatically sets the load limit on the block load unit so its guide vanes at once move to consume any water rejected by the master machine on load decrease or vice versa. Thus a constant flow equal to the maximum available water supply is made to do useful work instead of being allowed to run to waste over the spillway and the master unit always has available a water supply margin sufficient to take care of load fluctuations which always occur on a governing unit. The cross connection between the turbines makes it possible to use this margin quantity on the block load unit until needed for governing since a call for more water in the master unit will immediately act to decrease the consumption of the block load carrier by an equivalent amount. An adjustment is provided in the cross connection to correct for the variation of turbine gate discharge between the two units and to insure smooth operation in the water transfer. In addition to this cross-connection suitable means are provided to take care of seasonal variations in the supply of water.

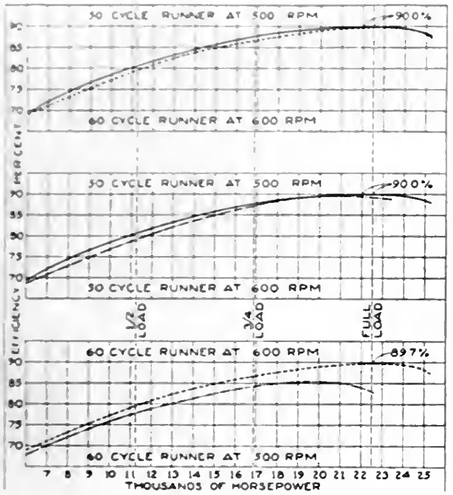


Fig. 6 Efficiency Curves of Turbines at Two Speeds and Two Frequencies

The units were very carefully tested for efficiency and to determine speed regulation, pressure rise and general conformance to the contract requirement.

Among other things these tests have shown that while there is very little difference in the efficiency of the 50-cycle runner operating at 500 r.p.m. or 600 r.p.m., there is a decided decrease of maximum output when the runner is not operating at its designed speed as illustrated in Fig. 3.

The loss in kilowatt-hours from this alone will make a change of runners advisable if sufficient water for the maximum capacity of the proper runner for as short a time as three weeks may be expected. On the other hand, if the 60-cycle demand is not likely to last that long it will not pay to make the change. This may be easily calculated by balancing the total additional kilowatt-hours produced against the output lost during a twenty-hour shut-down to change runners at the start and a second twenty-hour interval to change back again at the end of the run.

The curves show efficiencies of the 60-cycle, 600 r.p.m. runner operating at both normal speed and at 500 r.p.m. for 50-cycle generation. A marked difference in results is obtained. This is accounted for by the distortion in entrance and discharge angles as well as the increased distance between the ends of the guide vanes and the entrance of the runner.

The water is taken from the river by means of a concrete diversion dam of ogee form. After passing through an inclined grizzly, and two motor-operated head gates, it is carried by concrete flume for about one half mile to a double-compartment, reinforced-concrete sand-settling basin 400 ft. long by 60 ft. wide by 20 ft. deep. One compartment may be sluiced of sediment while the other is in use.

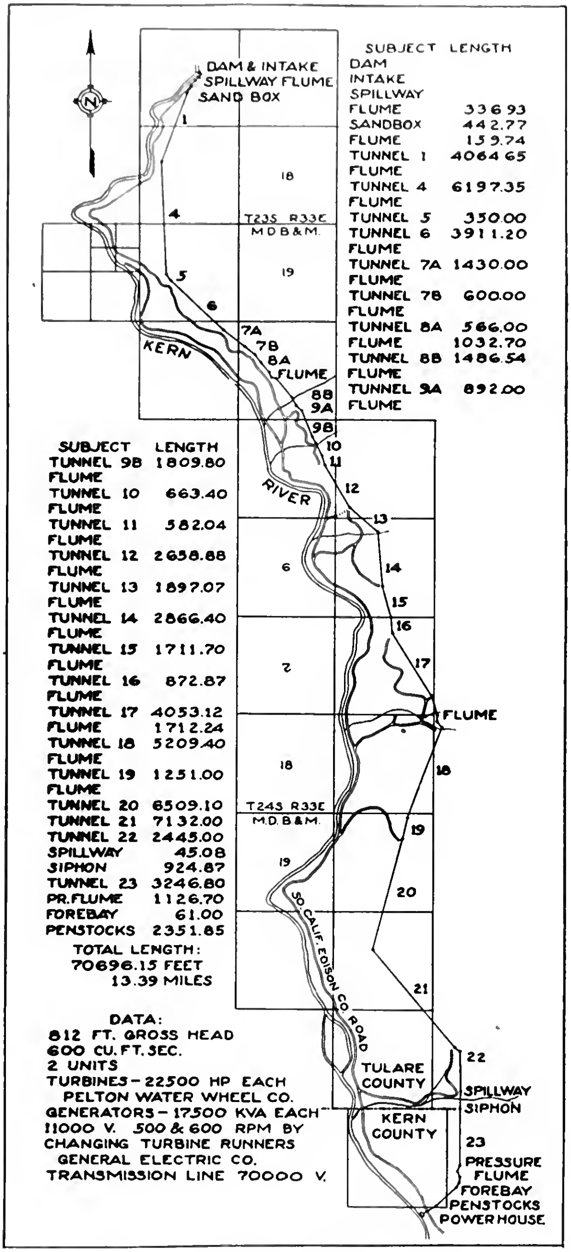


Fig. 7 Plan of Power-Water Supply System

From the sand-box to the surge-chamber, a distance of about 11$^1/_2$ miles, the conduit is mainly in tunnel, alternating with short stretches of concrete flume. The surge chamber is of reinforced concrete. A steel pipe 2520 ft. long, 84 in. in diameter at the surge-chamber, tapering to 60 in. at the power house, leads to each of the two turbines.

REDUCTION OF FUEL WASTES IN THE STEEL INDUSTRY

(*Continued from page 238*)

either by itself or in conjunction with by-product gas, and has been used for steam production either as an auxiliary fuel on blast-furnace boilers or by itself, and its use has been proposed to heat by-product ovens, thus releasing additional gas otherwise required for heating the ovens.

Heat Balance

Table 1 gives an example of the approximate heat balance of one ton of pig iron as used in the steel plant, using average figures, and based on an average coke consumption in the blast furnace of 2500 lb. of coke per ton of product.

TABLE I HEAT BALANCE FOR MANUFACTURE OF ONE TON OF PIG IRON

From the coke plant delivering one ton of coke there result the following fuel by-products for consumption in the steel plant after the heat and power requirements of the by-product plant have been met:

12 gal. tar at 162,500 B.t.u. per gal., B.t.u.	1,950,000	
30 lb. of coke breeze at 12,000 B.t.u. per lb., B.t.u.	360,000	
10,000 cu. ft. gas at 500 B.t.u. per cu. ft. (net value), B.t.u.	5,000,000	
Total per net ton coke		7,310,000
Heat available per ton pig iron	B.t.u.	B.t.u.
In tar from by-product plant	2,435,000	
In coke breeze from by-product plant	450,000	
In surplus gas	6,250,000	
Surplus from by-product plant		9,135,000
In blast furnace gas		19,635,000
Required for blast heating	5,000,000	
Required for blowing equipment	4,400,000	
Required for blast-furnace operation	1,000,000	
Required for total blast furnaces		10,400,000
Surplus from blast furnace plant		9,235,000
Total heat energy from by-products		18,370,000
Heat required for steel plant *Open hearth (pig iron to ingots)*		
Melting (approx.)	7,000,000	
Power, 25 kw. at 25,000 B.t.u. per kw-hr.	625,000	
Total heat consumption		7,625,000
Roughing Mill		
Heating (approx.)	2,000,000	
Power, 50 kw-hr.	1,250,000	
Total		3,250,000
Finishing Mill		
Heating (approx.)	4,000,000	
Power, 100 kw-hr.	2,500,000	
Total for finishing		6,500,000
Total heating requirements	13,000,000	
Total power requirements	4,375,000	
Total		17,375,000

Necessity of Heat Conservation

From Table 1 it will be seen that the total heat from the by-products of a ton of pig iron is more than sufficient to finish the average ton of steel, but upon inspection of the table it will be found that the heating requirements have not been met from tar and by-product gas, while the average power requirements are more than met from blast-furnace gas and coke breeze.

It therefore becomes very desirable to reduce the heating requirements for production of steel by using more efficient heating furnaces, and to conserve all possible heat by charging hot steel into the soaking pit and reheating furnaces, in order to reduce the quantity of fuel required for supplementary heating.

The production of gas at the by-product plant is practically uniform, while the consumption at the steel plant is variable and as a result the gas pressure at the steel plant (usually some distance away from the by-product plant) is variable. As gas holders of sufficient capacity to absorb the fluctuations have not been found advisable it becomes necessary to schedule the use of gas by consuming departments in order partially to equalize the consumption. In many cases it is advisable to use by-product gas under boilers (although it is more valuable for other purposes) in order to prevent or reduce its waste, as it is easier to change from gas to coal on boilers than to fire up producers.

One of the most important problems of the steel plant manager and engineer is so to regulate the production and consumption of the various fuels occurring as a by-product of steel-plant manufacture that the consumption of raw coal in producers or under boilers that would otherwise be sent to the by-product plant is a minimum, for the reason that the by-products from the coal, coked in the by-product plant, usually exceed any possible return as fuel.

COTTON-GINNING MACHINERY

(*Continued from page 236*)

largest size condenser. This is equivalent to a screen exposure when running, of from 2 sq. ft. down to 1 sq. ft. per saw per minute. The peripheral speed of the doffing rollers should be the same as that of the screen drum. From the condenser the lint cotton is delivered by the doffing rollers to the lint slide, thence into the press box.

The Cotton-Ginning Process

The seed cotton is brought to the cotton-gin plant in quantities of 1600 lb. when clean-picked cotton and of 2000 lb. to 2200 lb. when gathered or grabbed cotton. When ginned there will be a finished bale weighing about 500 lb., and 1050 lb. of cotton seed; the remainder is refuse, as trash, hulls, dirt and other foreign substances. The seed cotton is usually hauled in wagons, from which it is sucked off through a telescope by means of air-suction steel-plate centrifugal, fans operating at a blast-wheel peripheral speed of 11,000 to 13,000 ft. per min., and producing a vacuum of 14 to 16 in. of water. In the course of its travel the cotton is carried through a cleaner where it is agitated on a screen to remove the foreign substances; thence it passes to the elevating system where the air is separated from it, and is dropped into the gin feeders, where further cleaning is performed. The cotton is next delivered to the gin in such quantity as will not gorge the roll box but will be sufficient to insure a nice, moderately soft, pliable ginning roll. If the cotton is clean-picked it can be delivered direct to the ginning roll in a plain gin; but if gathered or grabbed it will contain hulls, etc., and should be delivered to a huller roll box.

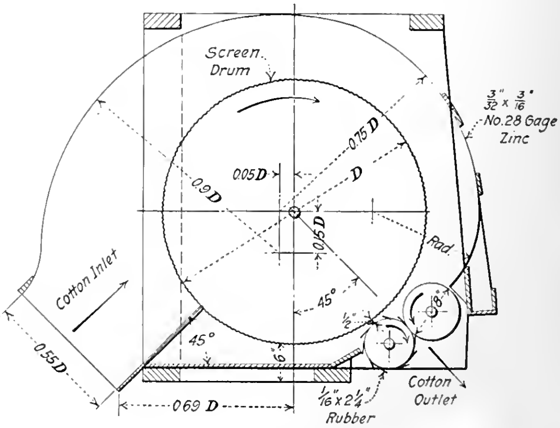


Fig. 15 Condenser

The seed fall from the roll box down into seed conveyor, from which they are delivered to the customer's seed box or into a seed storage house. The hulls, trash and foreign substances are conveyed outside of the gin house to the boiler room for fuel—that is, that part that is combustible—or hauled off to be used later as fertilizer. The motes are also conveyed out and in some instances used for low-grade fiber stock. The lint cotton passes from the gin to the lint flue and then to the condenser, where it is separated from the air and formed into a bat. It is then delivered into the press box for packing, wrapping and pressing, ready for the market, and after marketing is compressed and rewrapped before being export.

Textile Machinery to be Discussed at A.S.M.E Meeting

At the Atlanta Spring Meeting, May 8-11, of The American Society of Mechanical Engineers, the Textile Division will hold two joint sessions with the Machine Shop Division at which six papers on textile machinery will be presented. In addition to Mr. Gillespie's paper, printed above, the papers will deal with weaving, spinning, and carding machinery.

The Moody Ejector Turbine

Particulars of a Turbine for Low-Head Installations Which Delivers the Rated Horsepower at Maximum Efficiency When the Head is a Maximum, and also Maintains the Output When Head is Reduced at Flood Periods

By S. LOGAN KERR,[1] PHILADELPHIA, PA.

ONE of the greatest difficulties met in the operation of low-head hydroelectric power plants is the reduction of capacity during flood periods. It is usually impossible, owing to the nature of the surrounding country and the enormous quantity of water required, to provide storage reservoirs to such an extent that all excess water flowing during these flood periods can be entrained and used when the stream flow is below normal. Some regulation, of course, is effected in a few instances, but for the most part there is sufficient only to carry the plant over the daily peak.

Where the storage is thus limited, owing to the character of the country surrounding the plant, the flow of water during the flood season is much greater than is required by the turbines. This excess is therefore wasted over the dam, and in addition causes the tail water to rise in level.

Since the turbine operates upon the difference in level of the head and tail waters, should these levels vary the same amount, then this difference or head would be constant. Usually this is not the case, for with a given rise in level of the water going over the dam, the rise in the level of the tail water is greater, thus decreasing the net head. This effect is illustrated in Fig. 1. The head at low water is evidently much greater than at high water as reference to this sketch will show. The line intermediate between the two extremes shows the effect when the level of the head water is increased by a small amount. It is evident even in this case that the net head is decreased.

Since the horsepower of the turbine varies as the three-halves power of the head acting upon it, the output of the station is decreased in the same ratio, but as the operation is of necessity at constant speed, the efficiency may be less as well, depending upon the characteristics of the wheel, causing a still further decrease in capacity. Thus the resultant loss in power may be very great, depending upon the rate of off-flow of the tail water, which in turn is dependent upon the character of the stream bed below the dam.

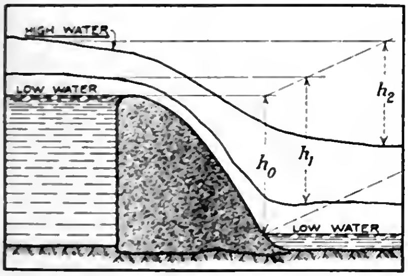


Fig. 1 Sketch Showing Decrease in Effective Head During Periods of High Water

As was stated above, in low-head plants where the quantity of water required to generate a given amount of power is large, the storage facilities are usually small. Therefore the turbine should be designed to give maximum efficiency at rated output when the head is a maximum, for at this time water is scarce and economical operation is imperative.

Due to their inherent characteristics, the high- or relatively high-speed wheels used in low-head work give as a rule a rather narrow operating range at maximum efficiency, and a small overload capacity beyond this point of maximum efficiency. To design a turbine, then, that would deliver the required output under a reduced head would be inadvisable, for this same turbine would not operate at best efficiency when delivering rated horsepower under the higher normal head resulting from low water.

This is illustrated in Fig. 2 where the turbine is designed to deliver 100 per cent of rating at 75 per cent of normal head. When this same turbine is operated under 100 per cent head, its capacity is increased to 140 per cent of rating; but as only 100 per cent is required, it is evident that the efficiency will be several per cent less than the maximum. This method of meeting the problem would be wasteful from the standpoint of economy of operation at maximum-head conditions.

Another method would be to install a number of additional units that could be placed in operation when the capacity of the plant was cut down at high water. Such a plant would require a much greater expenditure of money in the first cost, which could render a return on the investment for a short period only each year. This, then, is a possible solution, but the resultant fixed charges upon the plant would be so great, in many cases, as to make the cost of power prohibitive.

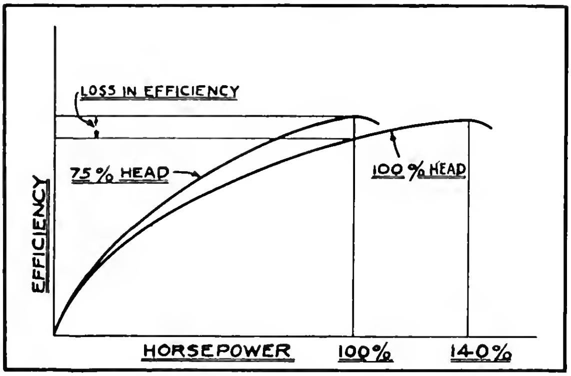


Fig. 2 Sketch Showing Disadvantage of Designing Turbine for Maximum Efficiency at the Minimum Head Conditions

There remains this problem: to design a turbine that will operate as economically as possible at times when the available supply of water is small, and yet develop normal rated power when the overabundance of water decreases the effective head.

The Moody Ejector Turbine

A turbine designed to meet these requirements has been developed by Mr. Lewis F. Moody. The apparatus consists of a turbine of the normal type designed to operate at maximum efficiency under the average head prevailing at times of low water, but at the top of the draft tube, just below the runner, an annular opening is made in the wall of the tube, the amount of this opening being controlled by a cylinder gate.

When the turbine is operating normally, this gate is closed and the contour of the draft tube is unchanged, as shown in Fig. 3. When the head falls off due to the rise of the tail water, this gate is opened slightly, allowing a jet of water at high velocity to enter the draft tube without first passing through the runner. This case is shown in Fig. 4. The action of the jet, expressed simply, is to "pull" more water through the runner and hence to increase the horsepower output of the turbine.

The jet actually creates an additional suction head that compensates for the loss in the difference in level between the head and tail water. So that the turbine is in reality operating under a

---

[1] Research Assistant I. P. Morris Dept., Wm. Cramp & Sons' Ship & Engine Building Co.

Extracts from a thesis submitted to the University of Pennsylvania for the degree of Bachelor of Science in Mechanical Engineering by the author in June, 1921. Awarded A.S.M.E. Junior Prize for the best paper during the year 1921. All papers are subject to revision.

head made up of two parts: first, the effective head measured as the difference in levels of the head and tail water (less, of course, the frictional head in the water passages); and second, the "suction head" produced by the action of the jet of water admitted below the runner. For this reason the device has been called an "ejector turbine."

Tests Made on the Turbine

The apparatus described above was set up and tested in the I. P. Morris Experimental Laboratory of the William Cramp & Sons Ship & Engine Building Company in Philadelphia. The turbine was equipped with guide vanes placed in the ejector. The function of these vanes, which will be called ejector vanes hereafter in order to avoid confusing them with the guide vanes and speed ring vanes of the turbine proper, is to give the water entering the ejector an initial whirl, so that there will be a minimum amount of interference with the water coming off the runner.

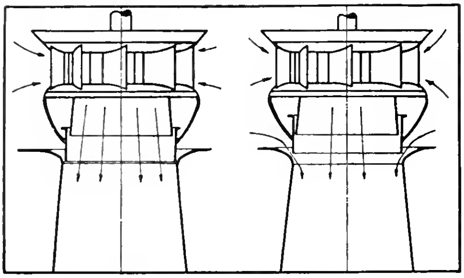


Fig.3 Fig.4

Figs. 3 and 4 Sketches Respectively Showing the Ejector Closed and Open

In the first series of tests (A1 to A6) model runner No. 55 was used. This runner (16 in. in diameter at the throat) is of the mixed-flow type and has a specific speed of 84.4 at best ϕ. The symbol ϕ represents the coefficient of peripheral velocity or the ratio of the linear velocity of a point on the runner to the theoretical spouting velocity of the water under the operating head. This ratio may be based on any one of several diameters, but in this article, the ϕ based on the diameter at the throat of the runner is meant. The values of specific speed (N_s) are all given in the English foot-pound system.

The first test (A1) was made at the maximum opening of the ejector (3.155 in.). The measurement of these openings was made by taking the average of a series of readings scaled off at various points around the ejector. A series of ϕ-Efficiency and ϕ-Horsepower curves under 1 ft. head and 1 ft. throat diameter was drawn for each test and the performance curves calculated from these. Description of the necessary calculations and of the method employed in testing are given in appendices to the complete paper.

A series of tests was made, each with a decreasing opening of the ejector until a point of 0.824 in. was reached. The next test (A6) was made with the ejector gate entirely closed.

However, this test did not give as good efficiency as was previously secured with the same runner and draft tube in another test. Upon investigation, it was found that the cylinder gate of the ejector did not seat properly upon the lower ring and that a small opening was left on one side of the turbine, thus admitting a small amount of water on about one-third of the periphery of the ejector. It is of interest to note that for any given gate opening of the turbine, although the efficiency was reduced about five per cent from that previously obtained, yet there resulted a slight increase in horsepower with even this small ejector opening.

In plotting performance curves of the values in test No. A6 the test efficiencies were stepped up to correspond with those obtained in previous tests. This is permissible, for in tests Nos. B6 and C2 made with runner No. 65, the ejector was calked tight to eliminate this difficulty and to correspond to the more perfect construction that would be found in large units built for commercial purposes. The results in these tests gave efficiencies that checked very closely with those obtained when the same runner was tested without the ejector installed.

Another series of tests was made using runner No. 65 in place of runner No. 55. This runner (16.25 in. in diameter at the throat) is of the "diagonal-flow" type and has a specific speed of approximately 100. This series of tests (B1 to B6) was run with varying openings of the ejector, but the angle of the ejector vanes was changed to conform with the variation in the theoretical value of the whirling component of the water leaving the runner with the increase in specific speed.

When this series had been run, it was thought advisable to test runner No. 65 with the ejector vanes removed in order to study the effect of the ejector water without this initial whirl.

Investigation of the Influence of Ejector upon the Flow in Draft Tube

It was desired as well to see the effect that the water injected into the draft tube through the ejector would have upon the normal flow of water coming off the runner. In order to measure the velocity of water in the draft tube it is necessary to know the direction that it takes, since the flow is not the same as in a pipe line or canal, but moves with a whirling motion and follows a path similar to a helix in form. The steepness of this helix depends upon a great number of conditions, principal among which are the type of runner, the speed, and the load under which the turbine is operating.

An instrument was developed by the writer with the coöperation of the staff in charge of experimental work of the I. P. Morris Department especially for this test to measure the velocity and direction of flow in the draft tube. The apparatus, because of its form and the use for which it was designed, has been called a "pitot velometer."

The pitot velometer consists of a double pitot tube similar to the "Pitometer" with symmetrical openings 180 deg. apart. The head was arranged so the maximum dimension would pass through a hole the size of the outside diameter of standard $^3/_8$-in. pipe. The whole head, rod, and end connections are free to rotate and move in and out from the center line of the draft tube. A pointer is fixed on the outer end of the instrument, and a dial hung on a ball bearing and weighted to keep the zero of the scale vertical showed the position of the center line of the openings in the head.

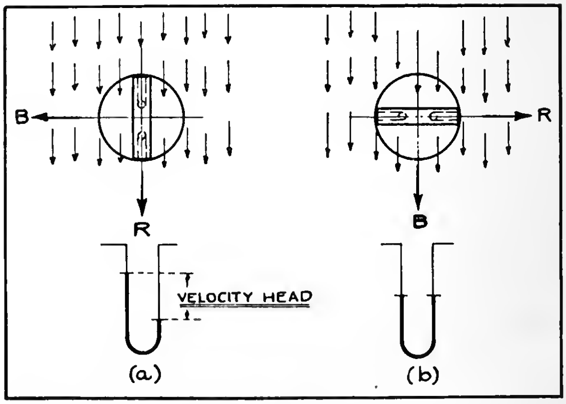


Fig. 5 Positions of Pitot Velometer (a) when Reading Velocity and (b) when Reading Deviation from Vertical
(R indicates red pointer; B, black pointer.)

These two opeinings were attached to the legs of a differential gage filled with mercury and when the head was turned to a position so that the two openings were in a line with the flow of the water, the velocity head was indicated on the gage. When the rod was rotated through 90 deg., the center line through the openings was perpendicular to the flow, and the two legs of the gage stood at the same level. It was found that the apparatus was very much more sensitive in this position than with the openings in line with the flow, and that the angle of deviation from the vertical could be more accurately read.

For this reason two pointers were attached to the rod; one painted black was set at right angles to the line through the center

of the openings, and the other painted red set parallel with this line.

In taking a reading, the rod was set at the desired point on the diameter of the draft tube and rotated until the two legs of the differential gage stood equal, this position is shown in Fig. 5 (*b*). The reading of the deviation was recorded as shown by the black pointer. The red pointer was then brought to this point, automatically placing the openings in line with the flow and the velocity read by the difference in levels of the mercury columns. This

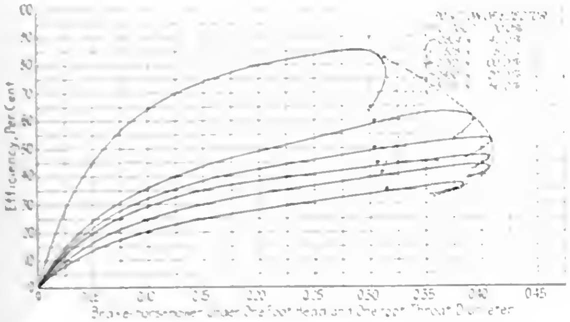


Fig. 6 Curves Showing Operation at Normal ϕ with Varying Ejector Openings and Ejector Vanes in Place; Runner No. 55

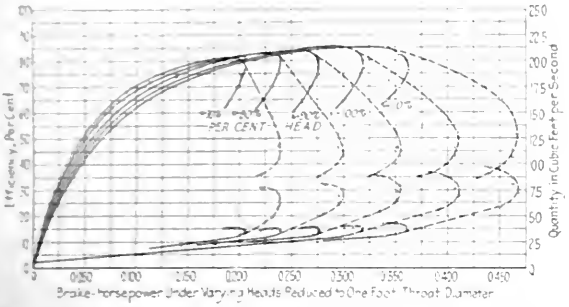


Fig. 7 Curves of Horsepower, Efficiency and Quantity for Runner No. 55 Under Varying Heads

Normal Operation Indicated by Solid Lines and Operation with Ejector by Broken Lines

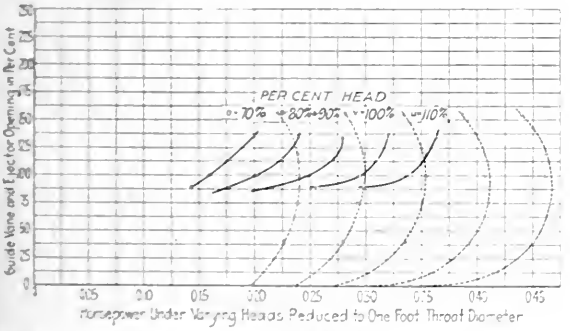


Fig. 8 Curves of Horsepower for Varying Heads for Different Gate (solid lines) and Ejector (broken) Openings, Runner No. 55

position is shown in Fig. 5 (*a*). The scale of the dial was graduated in degrees and half-degrees. It was possible to measure the deviation of this velocity from the vertical accurately to within a single degree.

The scale of the mercury gage was graduated to read zero when the two legs were equal; below this line the scale was laid off in inches of mercury. Above the zero line the scale was so arranged to give the velocity directly in feet per second. The pitot velometer was located approximately 24 inches below the horizontal center line of the turbine.

The diameter of the draft tube at the point where the instrument was installed was $19\frac{3}{4}$ in., but as the flow was investigated on one side only of the tube, the horizontal motion of the head was one-half of the diameter or $9\frac{7}{8}$ in.

Readings were taken at each even inch from the vertical center line up to and including a point at a radius of 9 in., thus making a total of ten readings for one complete traverse.

It was thought best, due to the time required (seven to ten

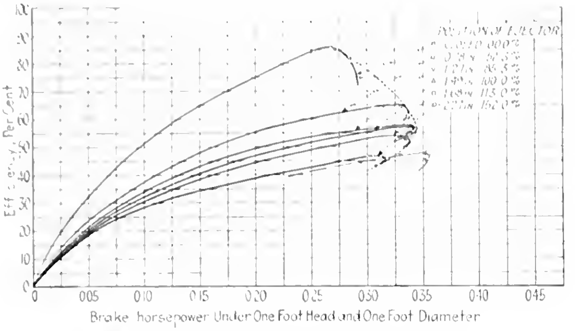


Fig. 9 Curves Showing Operation at Normal ϕ with Varying Ejector Openings and Ejector Vanes in Place; Runner No. 65; One Curve with Vanes Removed

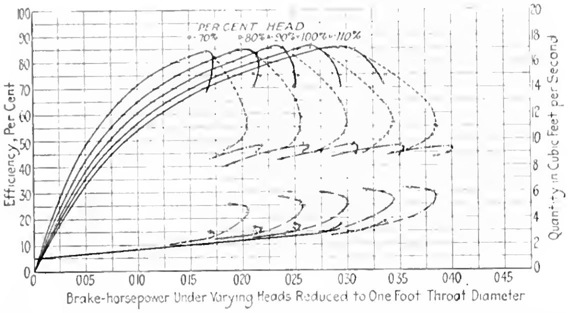


Fig. 10 Curves of Horsepower, Efficiency and Quantity for Runner No. 65 Under Varying Heads

Normal Operation Indicated by Solid Lines and Operation with Ejector by Broken Lines

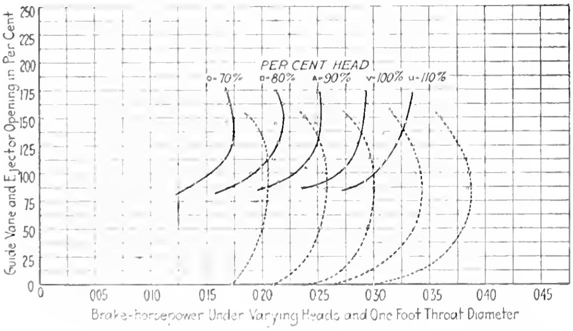


Fig. 11 Curves of Horsepower for Varying Heads for Different Gate (solid lines) and Ejector (broken lines) Openings, Runner No. 65

minutes) for one complete traverse of the draft tube, with ten readings each of velocity and angle of deviation from the vertical, to take traverses only at points within the possible operating range of the turbine, or of a turbine of this type installed in a power plant.

Since the limits of maximum and minimum ϕ for this range could easily be determined, three traverses were made for each gate opening at points within these limits. A large number of traverses were made, two examples of which are shown in Figs. 14 and 15.

Two tests were made, the first (C1) was run with the ejector

open about one and one-half inches, the second (C2) was made with the ejector closed and caulked, to have, as a basis of comparison, the flow of water coming from the runner uninfluenced by the ejector water.

Results of Tests

In order to show the increase in horsepower obtained by use of the ejector over that normally delivered by the turbine, a series of performance curves was drawn with efficiencies as ordinates and horsepower under 1 ft. head reduced to 1 ft. throat diameter as abscissae. These curves were drawn for each of the tests in the first and second series. The envelope of these curves was then drawn in and is taken as the performance of the turbine and ejector combined.

It may be seen from Figs. 6 and 9 that a considerable increase over the rated output is obtained by the use of the ejector. This increase is 36.7 per cent based on rating of 0.300 hp. under 1 ft. head and 1 ft. throat diameter for runner No. 55 and 30.0 per cent for runner No. 65 equipped with vanes in the ejector. Based on the maximum power obtainable these values are 34.5 per cent for runner No. 55 and 17.0 per cent for runner No. 65.

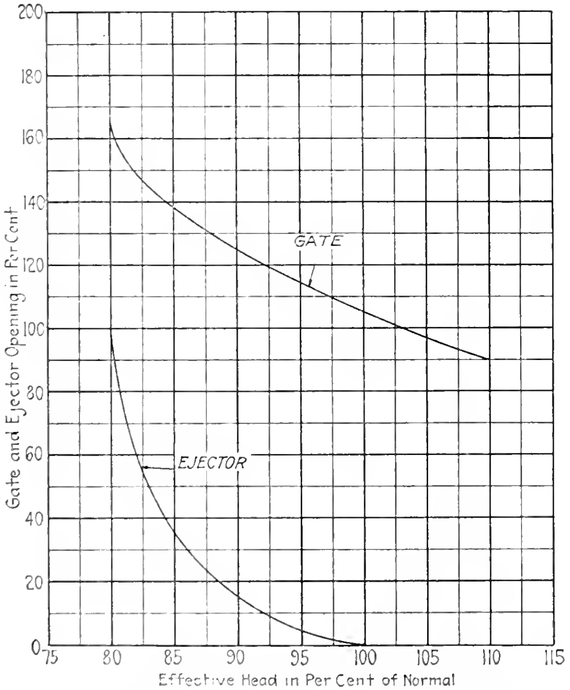


Fig. 12 Constant-Horsepower Curves, Runner No. 55

A second set of curves (Figs. 7 and 10) was plotted showing the performance of the turbine and ejector under varying heads, each curve consisting of two parts, the normal performance curve and the envelope of the several ejector performance curves. Curves are plotted for 70, 80, 90, 100 and 110 per cent of normal head, the latter being taken as 1 ft. to have a standard for a basis of comparison. Along with these curves have also been plotted curves of horsepower against quantity.

Guide vane and ejector openings have also been plotted against horsepower and appear as Figs. 8 and 11. In all of these results there has been no allowance made for the increased frictional losses in the water passages leading up to the turbine, since the model tested was of the open-flume type. Therefore the losses resulting from the increase in quantity flowing must be calculated for each individual case where the ejector is to be applied. It should be noted that the results include some of the losses, namely, the losses within the turbine and the losses in the draft tube, but not the losses that would occur in the penstock or the casing. It is probable that these will not be excessively large, since low-head installations have relatively short penstocks which are usually integral with the dam.

It may be noted that with runner No. 55, normal rated horsepower can be maintained under 80 per cent head and under 83 per cent head with runner No. 65, when both are equipped with guide vanes in the ejector.

From the curves of horsepower, gate and ejector opening, another series of curves was obtained (Figs. 12 and 13). These might be called very appropriately "Constant-Horsepower Curves." The ordinates are per cent ejector or gate opening and the abscissae are per cent normal head. If, therefore, the per cent of normal head under which the turbine is operating is known, by finding the points where the gate and ejector opening curves cross this line, the proper setting of the turbine and ejector gates that will maintain rated capacity may be read. These curves are plotted for each of the two main series of tests.

In Fig. 10 (curves of horsepower and efficiency under varying heads for runner No. 65) a set of small curves, one for each 10 per cent of normal head from 70 to 110 per cent are drawn for comparison with the other performance curves. These are the results of test No. C1 (runner No. 65 with ejector vanes removed), and it may be seen that there is a slight numerical increase in horsepower over that obtained with the vanes in place, but judging from the position of these curves with relation to the others and to the shape of the envelope of the curves of varying ejector openings, it is reasonable to suppose that the maximum increase obtainable with the ejector vanes removed is much greater than the actual numerical difference would indicate. It would seem that the turbine was operating on the drowned part of the envelope.

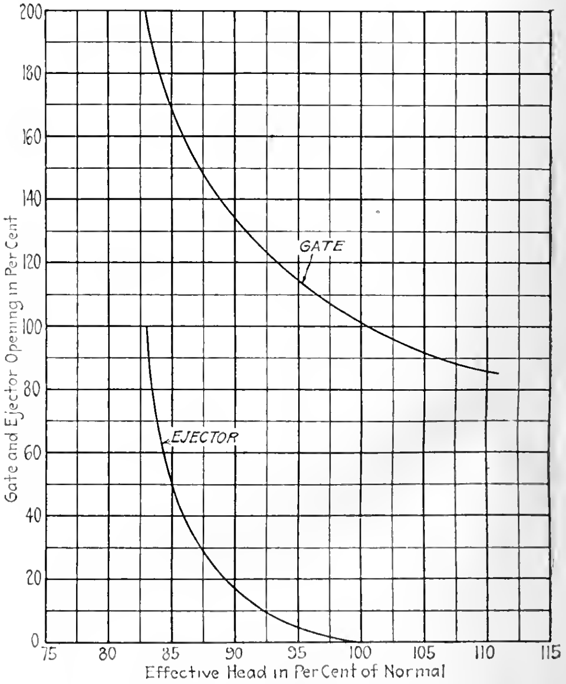


Fig. 13 Constant-Horsepower Curves, Runner No. 65

The explanation of this is probably that the increase in area of the opening with the vanes removed was greater than that required to secure maximum horsepower, and had the effect of drowning the turbine. If the opening had been smaller, the actual maximum horsepower obtainable with the vanes removed would have been secured.

In all the foregoing tests the turbine was equipped with the Moody spreading draft tube, and it is reasonable to suppose that the results are considerably better than could have been obtained with a straight or curved tube of another form. This statement is borne out by recent tests comparing the performance of various draft tubes.

Conclusions Regarding Flow in the Draft Tube

When the turbine is operating at normal ϕ, the whirling component of the water coming off the runner is in the direction of rotation of the turbine. In all readings of the deviation of this velocity from the vertical, this direction is taken as positive.

From curves of traverses made both with and without the ejector open, it has been found that if the turbine is overgated this whirl may become negative, due to the excess of water passing through the runner. At overload the runner is not moving in the same relation to the water as at normal operation, and the whirl under these conditions may become negative at all but very large values of ϕ. When the turbine is operating at high values of ϕ, the whirl is positive, or nearly so, even though the turbine is overgated.

From comparisons of traverses made with and without the ejector open, the following general conclusions may be drawn (see Figs. 14 and 15):

1 The characteristic form of the curve of the angle of deviation from the vertical was not influenced by the water from the ejector.

2 The velocity of the water at the outer portion of the draft tube was increased by the action of the ejector water over values obtained without the ejector open.

3 The ejector had little or no effect upon the flow of water coming from the runner up to and including a point about $6\frac{1}{2}$ in. from the center line of the draft tube, or in other words, the inner two-thirds of the draft tube was not affected by the ejector.

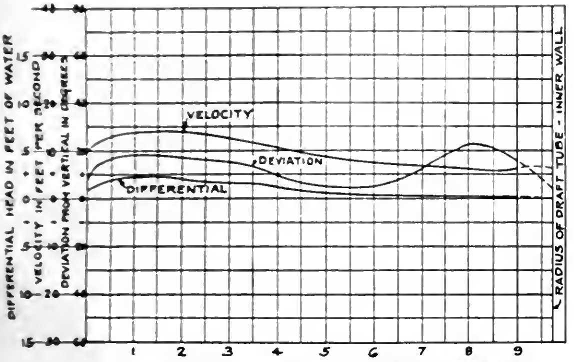


Fig. 14 Flow in Draft Tube, Ejector Closed; Gate Opening 40 Per Cent; $\phi = 1.262$; Runner No. 65

4 The action of the runner influenced the direction of the flow of water issuing from the ejector, and not vice versa.

By referring to the curves plotted from results of these traverses, it may be seen that the angle of whirl is very nearly the same regardless of whether the ejector is open or not, but that the velocity of the water in the outer third of the draft tube is increased considerably over that with the ejector closed.

Summary

As was stated in the introduction, the need for the ejector type of turbine is felt only in low-head installations where the reduction in head due to flood periods reduces the capacity of the plant to an appreciable extent.

It is obvious that instead of wasting the excess water that would ordinarily pass over the dam during these periods, the ejector uses this same water to counteract the reduction of the effective head and to maintain the rated output of the plant.

While it is imperative that the turbine operate at maximum efficiency when the head is a maximum and water is scarce, it is also true that economical operation is secondary to the maintenance of rated output when there is so great an overabundance of water that the capacity is reduced.

The Moody ejector turbine meets these requirements, for under design conditions it operates as a normal turbine delivering rated horsepower at maximum efficiency; but when the head is reduced at flood periods, the cylinder gate on the ejector is opened and the output is maintained.

This turbine also finds its application, where stream flow and storage conditions permit, in carrying peak loads. At this time the ejector would have the effect as illustrated in the curves of horsepower and efficiency under constant head (Figs. 6 and 9). The maximum possible horsepower that can be obtained is that indicated by the envelope of the several ejector curves. The turbines would therefore be designed to deliver rated power for the average load and rely upon the ejector to carry the peaks. The application of the ejector to these conditions could only be effected where the peak loads could be accurately estimated in advance.

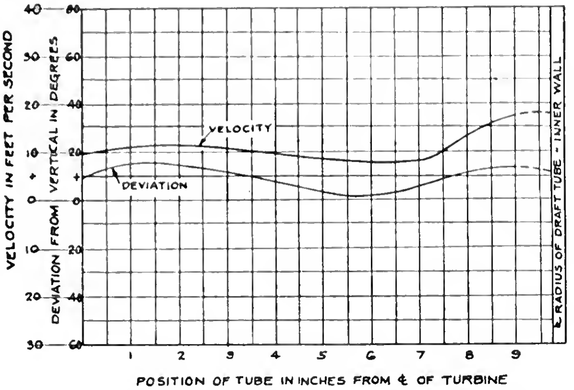


Fig. 15 Flow in Draft Tube, Ejector Open 1.54 in.; Gate Opening 40 Per Cent; $\phi = 1.306$; Runner No. 65

In conclusion, the Moody ejector turbine finds its principal application in low-head installations where the effective head is reduced by flood conditions and great fluctuations occur in the stream flow between high and low water.

Public Conference on Business Training of the Engineer

The United States Commissioner of Education is calling a second public conference on commercial engineering on behalf of a committee on commercial engineering appointed by him to investigate business training of engineers and engineering training for students of business.

The conference will be held May 1 and 2 at the Carnegie Institute of Technology in Pittsburgh. President Arthur Hamerschlag of this institution is a member of the committee which is composed of prominent deans of schools of engineering, and of commerce in our larger universities, and of engineers and business men who are nationally known for their interest in the reduction of the costs of production, distribution, transportation, etc., through better training in schools and colleges of the personnel of industry and commerce.

The conference will be open to the public. Invitations to appoint delegates to the Pittsburgh Conference, however, will be sent by the Commissioner of Education to commercial and trade organizations, engineering and scientific societies, educational institutions and other groups as well as to prominent individuals.

Owing to the timeliness of the subject, the conference in Pittsburgh will even have greater national significance than the first public conference on this question, which was held in Washington two and one-half years ago under the direction of this committee on commercial engineering of which Dr. Glen Levin Swiggett of the Bureau of Education is chairman.

Outstanding topics at the Pittsburgh Conference will deal with the new problems that have recently arisen in modern industries, the solution of which demands a more scientific approach to include job analyses and personnel specifications and a translation of these for use in our engineering and commerce schools; and with the training of the engineer for a better understanding of problems of community development.

Test Code for Hydraulic Power Plants and Their Equipment

Preliminary Draft of the Sixth in the Series of Nineteen Test Codes Being Formulated by the A.S.M.E. Committee on Power Test Codes

By action of the Council of The American Society of Mechanical Engineers at its meeting in December, 1917 a Joint Committee organized for the purpose of revising the A.S.M.E. Test Code on Water Wheels was approved. Since that time a Committee of twelve and recently thirteen specialists in Hydraulics have worked diligently at this revision. These men represented respectively the American Society of Civil Engineers, the American Institute of Electrical Engineers, the National Electric Light Association, and The American Society of Mechanical Engineers.

In December, 1918, when the enlarged Committee on Power Test Codes was organized and eighteen Individual Committees appointed, by mutual consent, the Committee on Hydraulic Power Plants became No. 18 of this group. The representatives of the four Societies on this Individual Committee are as follows: *A.S.C.E.:* Nathaniel A. Carle, Benjamin F. Groat,[1] and Clemens Herschel; *A.I.E.E.:* Harold W. Buck, Henry S. Putnam, and Philip Torchio; *N.E.L.A.:* Charles M. Allen, Markham Cheever, and J. A. Walls; *A.S.M.E.:* John L. Harper, Raymond D. Johnson, Chester W. Larner, and William F. Uhl. Mr. Uhl is Chairman of the Committee and he will be glad to receive suggestions for corrections and additions to this draft of its Code. These should be addressed to him care of The American Society of Mechanical Engineers.

Introduction

1 Tests of hydraulic power plants relate either to the entire plant, extending from head water to tail water, or to any elementary part or parts of the plant desired. For the purpose of such tests the plant may be divided into six distinct parts, and these may be grouped into three divisions as follows:

Head-Water Division:

(*a*) That lying upstream from the forebay
(*b*) That lying between the forebay and the entrance to the wheel flume or wheel case

Turbine Division:

(*c*) The wheel case and speed ring
(*d*) The runner and guides or nozzles
(*e*)[1] The draft tube. For the purposes of this code the draft tube subdivision shall be considered to be that portion of the hydraulic system extending from the turbine runner to the point of maximum elevation (beyond and exclusive of local surface of disturbances) of the tail water and shall not necessarily terminate at the end of the physical draft tube.

Tail-Water Division:

(*f*) The tail-race.

2 Some of the individual parts noted may be absent from certain classes of hydraulic plants, but all parts of every plant may be logically included in the main divisions given. Figures 1, 2 and 3 illustrate typical conditions.

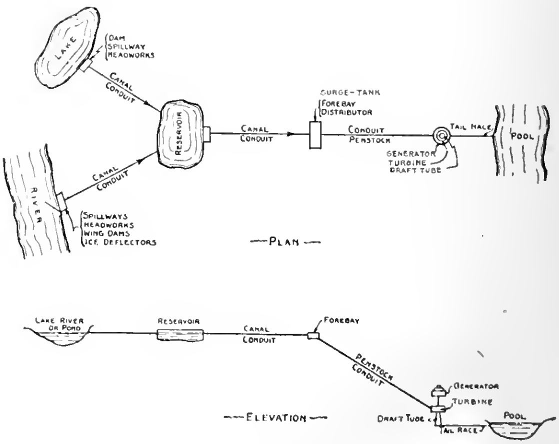


Fig. 1

3 The tests may be either *laboratory* or *field* tests, and as such may cover any part or parts of the plant. They may also be combined *laboratory and field* tests, including tests of a turbine model used as a representative substitute of the existing turbine, being con-

---

[1] In signing the report of the Committee Mr. B. F. Groat has made the following reservations.

Par. 1, 2 and 3. I do not agree to the methods of treating the draft tube subdivision in this proposed statement of the code. There is an accepted definite hydraulic theory which may be practically applied to the physical end of a draft tube to determine accurately the full amount of energy being discharged by the draft tube, and any code for testing should set this forth clearly and should limit the amount of energy passing the physical end to reasonable proportions, or, otherwise state, as one of the results of the test, the amount of excess energy discharged in a unit of time which should be entered in the record as a loss of efficiency. This loss of efficiency may be chargeable to the turbine, to the method of its operation, or to the draft tube or other imperfection, or to a combination of these imperfections. It is the province of the test to determine how much this loss in efficiency is. If the loss is within reasonable limits it is passable. If not, it is the province of experts to say how the losses should be divided among the offending elements of the plant.

I cannot agree to the addition of the velocity-head in the tail race to the tail race level because this credits as useful work what otherwise would be a loss. This amount of loss should appear in every report of a test and appear as a loss, whether it be charged against the turbine, the draft tube, or other part of the plant. To add this velocity head to the tail race level completely buries it from the view.

Par. 1*e*. In my opinion the over all efficiency of a hydraulic power plant should be measured beyond the point of a maximum elevation of the tail water in the tail race or tail pond so as to obtain the elevation of the water surface therein uninfluenced locally by disturbances emanating unduly, from the plant. When the plant is properly designed the point of maximum elevation in the tail race, or tail pond, will lie substantially in the surface of the surrounding water and there will be no "point of maximum elevation of the tail water." When the test is of the turbine the loss ought to be measured at the physical end of the draft tube and the allowable loss limited as suggested above.

Par. 5*e*. A positive statement should be made that current meters in disturbed water do not adhere to their still water ratings. This is one of the most certainly established facts of engineering. It should also be stated that the current meter offers one of the most accurate methods of measuring water when care is taken to correct the record by means of ratings in turbulent water. Cup meters are prone to over-register while screw meters are prone to under-register. Surely one of the important offices of the code is to warn the testing engineer of the possible source of error in his instruments and methods.

While I do not want in any way to inject my personal methods into the code unduly, I feel that it may be permissible for me to explain that I have treated a mass of flowing water as a mass of disturbances, these disturbances forming an *aggregate* which may be measured by its effects of one kind or another, say upon the current meter. I have shown by experiment that a certain proportion of transverse motion in turbulent water has, with respect to the longitudinal motion, fixed effect in accelerating a cup meter of given type, and a fixed counter effect in retarding a screw meter of given type, with reference to their still-water ratings no matter whether the transverse disturbances are large or small, frequent or infrequent. That the divergence between the records of the two types of meter is an accurate means of determining the relative amount of turbulence in the water, and an accurate means of correcting the divergent records so as to determine the true velocity.

Par. 18*b* (2). I agree to the definition of "effective head" as in 18*b* only when there are definite and reasonable limitations to the amounts of the losses which are credited to the plant, or part thereof, by a blind application of this definition. If, for example, the division of the plant is a conduit, then the energy leaving should be as large as possible. If it is a turbine, the energy should be as small as possible when leaving. No code for testing hydraulic plants should fail to make clearly expressed distinctions and reasonable allowable limitations in the two cases. A code of testing should supply correct rules for detecting and determining the true losses in the various portions of the plant. It should also state the reasonable limitations to the various losses so that there will be some showing up of excessive losses. Losses at the end of a draft tube should be limited to the head due to 4 feet per second, or some other reasonable amount. Losses in a conduit should be limited by specifications as to hydraulic slope per foot of length of conduit.

Par. 18*b* (2). I do not agree that in the case of an open flume turbine the velocity of the water coming into the turbine flume should not be considered in determining the effective head. I disagree on grounds similar to those stated above relative to the determination of tail water level. This is a deceptive piece of antiquated engineering that should not be allowed in the code, especially if the combined efficiency of the flume and turbine are to be determined. The velocity-head within the flume should be charged as effective head. Every part of the hydraulic energy that comes to a plant should be charged against that plant in a full statement of the conditions. Nothing is gained by deceiving ourselves into the belief that our works are more efficient than they are.

structed in all respects homologous thereto, and the results being corrected for dissimilar conditions. A laboratory test is one made on apparatus not installed in its final position. A field test is one made on apparatus installed in its permanent location in the plant.

OBJECT

The object of a test made under this Code is primarily the determination of the energy losses in any part or parts of the plant for the purpose of determining the degree of fulfillment of the performance guarantees between builders and users; or for determining how a greater portion of the potential water power available can be converted into useful work; or how combined operation of units or plants may be most effectively conducted.

See Code on "General Instructions."

MEASUREMENTS, WATER

5 On account of the difficulty in making accurate water measurements, every practicable means of checking the quantities measured should be utilized and if feasible more than one method should be employed for comparison with the results of the specified method. The standard method of water measurement is by volume or bulk. By comparison with this method the rating of any other method may be determined.

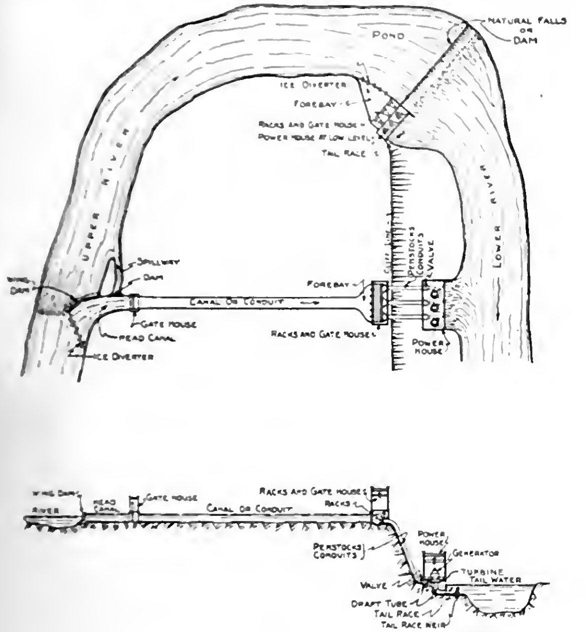


FIG. 2

MEASURING WATER IN CLOSED CONDUITS

5a *Venturi Meter.* The venturi meter is adapted for use in conduits in which the flow is not unduly disturbed by bends, sudden changes of section or obstructions near the upstream end of the meter. A commercial meter may be installed as part of the original plant or later by removing a portion of the conduit. If the conduit is large enough to work in, a temporary meter may be constructed of wood or other suitable material inside the conduit.

5b *Pitot Tubes.* Pitot tubes may be employed in conduits where conditions are substantially as described under Par. 5a, but pitot tubes are more sensitive to the disturbing effects of bends, sudden changes of section and obstructions than the venturi meter.

5c *Salt Solution.* The salt solution method may be advantageously employed in conduits where the conditions of flow are too disturbed or the conduits are too short to permit the use of the venturi meter or pitot tubes.

MEASURING WATER IN OPEN CONDUITS

5d *Weir.* This method is adapted for use in open conduits wherever the plant is so arranged as to permit the construction of a weir of proper length with a suitable channel of approach, and provided further that the use of the weir does not change the head on the turbine in excess of the limits provided in Par. 11.

5e[1] *Current Meter.* Current meters may be used in open conduits which are free from serious disturbances such as cross currents and eddies. They are adapted to many cases where the use of the weir is impossible.

5f *Salt Solution.* This method is applicable to practically all conditions of flow in open conduits. It is especially advantageous in cases where the flow is disturbed and may be used under conditions which would not permit the use of current meters or a weir.

MEASURING WATER—SPECIAL METHODS

5g *Special Methods.* The following methods or means employed for water measurement may sometimes be used, but they are subject to limitations and are available only under special conditions. Some of them have not yet been checked sufficiently by accepted methods to permit their use alone.

(1) Traveling screen
(2) Volumetric or bulk
(3) Color method
(4) Brine velocity

MEASUREMENTS, HEAD

6 Head measurements consist of the determination of:

(*a*) Gross Head
(*b*) Net Head

6a *Gross head.* The determination of the gross head consists of measurements of difference of elevation between two water surfaces.

Preparations for measuring the gross head require

(1) Establishing bench marks from which the elevation of the water surfaces may be determined by differential leveling.

(2) Providing gage boards and setting them by differential leveling. From these the elevation of the water surfaces may be obtained by direct reading.

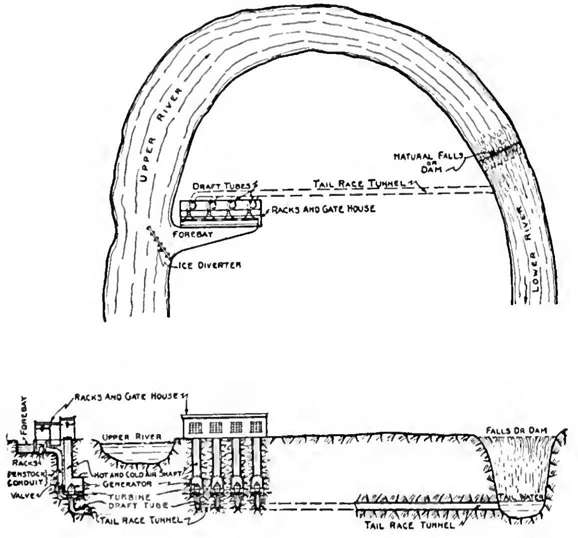


FIG. 3

(3) Providing stilling boxes and hook gages at points of desired measurements, and referring them to the bench marks.

6b *Net Head.* The determination of the *net head* consists of measurements establishing the difference in elevation of the points between which the net head is to be determined and measurement of areas of the conduits at these two points, by means of which the velocity head can be computed. The preparations required for determining the net head acting on a turbine are as follows:

(1) *Open-Flume Turbines.* Provide board, rod or float gages in the open turbine flume, and if practicable near the center of the setting, and similar gages in the tail race, all gages being located at points reasonably free from local disturbances. Gages are to be placed so as to be uninfluenced by velocity effects. If this is impracticable when the gages are set in the open channel, they should be placed in properly arranged stilling boxes. When stilling boxes are used, the communication between the box and channel should consist of one or more piezometer openings in a plane surface parallel to the flow, thereby avoiding velocity effects. When board gages are used at the side of the channel, they should be flush with the wall surface.

(2) *Encased Turbines.* Measure the area of the casing intake, provide piezometers at this point and connect them to separate gages. If spring gages are used, the elevation of the center of the dial is to be determined, and such gages are to be piped so that the air can be absolutely removed from the pipe leading to it. The piezometer orifices should be approximately $^1/_8$ to $^1/_4$ inch in diameter. Provide also a gage of either the board, rod or float type and locate it in the tail race at a point reasonably free from local disturbances, and otherwise following the directions given above for the open-flume turbines.

---

[1] See footnote, page 248.

Measurements, Speeds

7 There are two methods of speed determination.

7a *The Speed of Revolution* of a shaft is determined by means of a hand revolution counter and a watch, or a recording revolution counter. For accurate work and in all cases for low speeds a stop watch and revolution counter must be used.

7b A *Recording Speed Indicator* is used to obtain the average speed during a test run covering a considerable time interval in place of a series of readings at regular intervals or to determine the variation of speed for governor tests.

Measurements, Power

8 There are two methods available for measuring the power, viz., the *dynamometer method* and the *electric method*.

In addition to the power so measured, there may be other quantities of power to be included with the power supplied by the turbine shaft, such as the power for the governor pumps when driven by the turbine shaft.

8a *Dynamometer Method.* The dynamometer method is suitable where the turbine drives equipment which cannot be used to measure power or in the case of hydroelectric plants where the generator efficiency is unknown or known for only one speed where knowledge of the variable speed characteristics is desirable.

8b *The Electric Method* is applicable to hydroelectric plants, the power of the turbine being computed from the electric output. The power delivered to the generator shaft is determined by adding to the power output at the generator terminals all other power furnished by the shaft, such as generator losses that are absorbing power directly from the shaft, or power for operating exciters which are driven by the shaft; all of these items to be measured or calculated in accordance with the lastest A.I.E.E. Standardization Rules.

The power determined above is equal to the power delivered to the generator by the turbine shaft when connected direct to the generator shaft, but must be increased by the losses of any intermediate transmitting device, such as a gear or belt drive.

In cases where the turbine supplies the power for extra ventilation for the generator, it may or may not be necessary to treat the power for ventilation independently as part of the output of the turbine. Such amounts of power must be handled consistently with the specifications relating to the generator tests and generator efficiency.

Reduced or negative windage, if any, due to extra ventilation should be considered in determining the generator losses.

Instruments and Apparatus

9 The apparatus and instruments required for the various measurements noted are herewith summarized for convenience of reference. Directions for the use and calibration of these instruments and appliances are given in Par. 101 to 197 of the Code on "Instruments and Apparatus."

9a *Measuring Water*
  (1) Venturi meter
  (2) Salt solution
  (3) Pitot tube
  (4) Weir
  (5) Current meter
  (6) Special methods.

9b *Measuring Head*
  (1) Direct measurements
  (2) Float gage
  (3) Hook gage
  (4) Stilling box
  (5) Pressure gage
  (6) Board gage
  (7) Piezometer.

9c *Measuring Speed*
  (1) Hand revolution counter
  (2) Continuous revolution counter
  (3) Electric speed indicator.

9d *Measuring Power*
  (1) Dynamometer
  (2) Electric load.

Operating Conditions

10 Determine what the test operating conditions should be to conform to the object in view and see that they prevail throughout the trial. As the head on a water-power plant is rarely constant throughout an extended period of time, the working head during the test may be different from the head for which the turbine was designed or under which guarantees were made. In such cases it is necessary, especially in acceptance tests, to correct by computation the results for this deviation of head.

11 Acceptance tests should be made, if possible, under the head and at the speed specified in the contract. The net head shall not differ from the specified head by more than 10 per cent unless the speed of the turbine shall be adjusted to correspond to the head under which the test is made. If the speed is changed in proportion to the square root of the head, the horsepower output will change in proportion to the three-halves power of the head, and the turbine efficiency may be assumed to remain the same for a range of head variation of 15 per cent.

12 Fluctuation of load during any single run of an acceptance test must not exceed 5 per cent above or below the prescribed load. The head under which a test run is made shall not vary more than 2 per cent from the head for which the proper speed has been fixed at the beginning of the run. If these limitations cannot be complied with by the use of the commercial load, an artificial load must be provided.

13 Apparatus installed for purposes of test must be arranged so as not to affect the performance of the turbine or other parts of the equipment under test. If this cannot be done, a special experiment must be made to determine the effect of removing and replacing the apparatus in question and a proper allowance made therefore.

14 The unit under acceptance test must be in normal operating condition throughout the test, and must have been operated under load for an aggregate time of at least three days prior to the test if so required by either party. A careful inspection should be made of the turbine before and after the test to determine that the water passages are free from obstructions and all parts in normal operating condition.

Duration

15 The duration of an efficiency test depends mainly upon the method of water measurement employed. Sufficient time must be allowed to obtain a requisite number of observations to insure a reliable average.

Records

16 A sufficient number of blank tables should be prepared for every observer, and the readings taken by the individual observers should be entered in a table or log of data and results immediately after making the test. All readings should be taken against time and also by signal where there is some special reason for signal readings. Instrument calibrations and correction curves should be prepared in advance of the test, and measures taken to enable results to be computed as quickly as possible during the course of the test or before the work of testing shall be considered to have been completed. If this rule is carried out, errors will generally be detected in time to correct the readings in question at once.

17 In order to avoid the possible necessity of throwing out an entire series of observations due to some one or more errors, it is advisable that the computations and the plotting of results be completed as soon after the observations are taken as possible. If this is done before leaving the test room and particularly before removing the test apparatus, the observations in question can be repeated without much difficulty.

Calculations of Results

18 The method of calculating the leading data and results are given below under the following headings:

(*a*) Rate of flow
(*b*) Head
(*c*) Power
(*d*) Efficiency.

18a *Rate of flow.* This is obtained either by the velocity-area method, which involves the determination of the mean velocity of the water, and with the cross-sectional area of the conduit known, the rate of flow equals the product of the two factors; or by the direct-discharge methods, which require the determination of the weight or volume of water flowing in a given time.

18b *Head.*

(1) Gross or Total Hydrostatic Head. This is obtained by taking the difference in elevation between the head water surface and tail water surface of a hydraulic power plant when the plant is not in operation.

(2)[1] Net or Effective Head. The effective head acting on a plant or division of a plant is the pressure head (if a closed conduit) or elevation of the water surface (if an open conduit) at the entrance section, plus the velocity head at this point, less the sum of the pressure head or elevation of the water surface and velocity head at the discharge section of the plant or division of the plant in question when the plant is in operation.

---

[1] See footnote, page 248.

In the case of an open-flume turbine the velocity of the water coming into the turbine flume is not considered as being effective and the effective head on the turbine in that case is the difference in elevation between head water in the flume near the center of the turbine and the tail race at the end of the draft tube sub-division, less the velocity head at the latter point.

In the case of an encased turbine the velocity of the water entering the casing is considered to be effective and the effective head on the turbine in that case is the pressure head plus velocity head at the casing intake plus the difference in elevation between the point of measurement and the end of the draft tube sub-division, less the velocity head at the latter point.

In the case of an impulse wheel or turbine without a draft tube the effective head on the wheel or turbine shall be considered to be the pressure head at the nozzle plus the velocity head at this point plus the elevation of this point above the tail water.

18c *Power*

(1) *Potential Energy.* The total potential energy of any hydraulic plant or any part thereof is that latent in the available rate of flow of water due to the difference of elevation (Par. 18b) between the upper and lower ends of the plant or part thereof.

The rate of work in horsepower (theoretical horsepower) is expressed as follows:

$$\text{T.hp.} = \frac{Q \times W \times H}{550}$$

where Q = cu. ft. per sec.
W = weight per cu. ft.
H = gross head as defined in Par. 18b.

(2) *Water Horsepower.* The available water horsepower is found by the following formula:

$$\text{W.hp.} = \frac{Q \times W \times \text{effective head}}{550}$$

where Q = cu. ft. per sec.
W = weight per cu. ft.

(3) *Brake Horsepower.* The brake horsepower is the power delivered by the turbine shaft. Power measuring methods are summarized in Par. 9d.

In the case of direct-connected hydroelectric units, the delivery of power (b.hp.) from the turbine is considered to be at a point on the turbine shaft beyond which the turbine manufacturer furnishes no bearings, or beyond which he has connected no power-consuming devices.

As an illustration of this, take the case of a single vertical direct-connected three-guide-bearing unit with thrust bearing mounted on top of the generator. If the turbine manufacturer furnishes only the lower guide-bearing, the power is to be assumed as delivered between the turbine guide bearing and the lower generator bearing. If the turbine manufacturer furnishes two bearings beyond the runner, then the power is assumed to be delivered beyond the second bearing.

18d *Efficiency.* The efficiency of a hydraulic plant or any subdivision of the plant is the ratio of the energy made useful, to that which is available. For some parts of the plant the efficiency may be expressed directly in terms of ratio of heads, the losses which occur when there is no leakage being losses of head. For parts of the plant including the turbine it must be expressed as a ratio of powers. Where there is leakage, a correction must be made for the power corresponding to the loss thus sustained.

The various efficiencies are defined as follows:

(1) *Plant Efficiency.* The plant efficiency is the relation expressed as a ratio of "brake horsepower" developed by the turbine to "theoretical horsepower" of the water, or

$$\text{Plant Efficiency (expressed as a percentage)} = \frac{\text{B.hp.}}{\text{T.hp.}} \times 100.$$

(2) *Turbine Efficiency.* The turbine efficiency is found by the following formula:

$$\text{Turbine Efficiency (expressed as a percentage)} = \frac{\text{B.hp.}}{\text{W.hp.}} \times 100.$$

(3) *Part-Plant Efficiency.* The efficiency of any part of the plant not including the turbine, is the ratio of the W.hp. at the point of discharge to the W.hp. at the entrance. If there are no leakage losses between these two points, the efficiency may be expressed as a direct ratio between the effective heads at the two points.

The efficiency of any part of the plant including the turbine is the ratio of the b.hp. delivered by the turbine shaft to the available W.hp. entering that part of the plant for which the efficiency is desired.

DATA AND RESULTS

19 The data and results of the test are to be reported in accordance with the appended forms, the first of which, Table 1, gives the general data covering the leading features and dimensions of the entire plant; and the second, Table 2, a summary of the principal quantities and leading results.

TABLE 1 GENERAL DATA CONCERNING PLANT

HEAD-WATER EQUIPMENT

(a) *Reservoir*

(1) Name..........
(2) Distance from power plant..........mi.
(3) Area at surface of full reservoir..........acres
(4) Area at each foot of depth..........acres
(5) Draft..........ft.
(6) Capacity..........cu. ft.
(7) Outlet area..........sq. ft.

(b) *Pond*

(8) Surface area of full pond..........sq. ft.
(9) Elevation of surface of full pond..........ft.
(10) Draft..........ft.
(11) Capacity..........cu. ft.
(12) Spillway length..........ft.
(13) Elevation of crest of spillway..........ft.

(c) *Closed Conduits*

(14) Area of intake..........sq. ft.
(15) Area of conduits..........sq. ft.
(16) Length..........ft.

TAIL-WATER EQUIPMENT

(d) *Open Conduits*

(17) Area of intake..........sq. ft.
(18) Area of conduit with full discharge..........sq. ft.
Area of conduit with part discharge..........sq. ft.
(19) Wetted perimeter..........ft.
(20) Length..........ft.
(21) Depth with full discharge..........ft.
(22) Slope..........ft. per 100

(e) *Forebay*

(23) Area with full pond..........sq. ft.
(24) Net rack area..........sq. ft.
(25) Net area of intakes..........sq. ft.
(26) Submergence of top of intake with full pond..........ft.
(27) Elevation of crest with full pond..........ft.
(28) Spillway length..........ft.
(29) Elevation of crest of spillway..........ft.

(f) *Penstocks*

(30) Inlet area..........sq. ft.
(31) Net area of penstock (average area if of variable diameter) sq. ft.
(32) Length..........ft.
(33) Area at turbine connection..........sq. ft.

(g) *Standpipe*

(34) Distance from turbine..........ft.
(35) Type (open, tank, differential, etc.)..........
(36) Net area at penstock connection..........sq. ft.
(37) Net area at tank..........sq. ft.
(38) Net area at throttle if any..........sq. ft.
(39) Elevation at connection to penstock..........ft.
(40) Elevation of top..........ft.
(41) Elevation of overflow..........ft.
(42) Overflow area with 1 ft. discharge depth..........sq. ft.

TURBINE EQUIPMENT

(h) *Open-Flume Settings*

(43) Net rack area per unit..........sq. ft.
(44) Intake area..........sq. ft.
(45) Dimensions of flume..........
(46) Submergence of turbine..........ft.
(47) Type of turbine..........

(i) *Encased Settings*

(48) Type of casing (cylindrical, spiral, etc.)..........
(49) Area of inlet..........sq. ft.
(50) Diameter of casing..........ft.
(51) Length of casing..........ft.
(52) Area of spiral at several points..........sq. ft.
(53) Type of turbine..........

(j) *Turbine Runners*

(54) Reaction or impulse..........
(55) Kind of buckets..........
(56) Material of runner or disk..........
(57) Inlet depth of buckets..........in.
(58) Total discharge area of buckets..........sq. in.
(59) Nominal diameter of runner..........in.
(60) Maximum discharge diameter..........in.

(k) *Turbine*

(61) Type (Whether horizontal or vertical, reaction or impulse, open-flume or encased, cylindrical or spiral casing, needle or deflecting nozzle, swivel or cylinder gate, single or multiple runner, outside or inside gate mechanism, etc.)..........
(62) Rated capacity under.....ft. head..........b.hp.
(63) R.p.m. at rated capacity..........r.p.m.
(64) Maximum gate opening..........in.
(65) Maximum net nozzle area..........sq. in.

(l) *Draft Tube*

(66) Area at runner discharge..........sq. ft.
(67) Area at outlet..........sq. ft.
(68) Maximum gross draft head..........ft.
(69) Minimum gross draft head..........ft
(Distance from center of shaft or bottom of runner to lowest and highest tailwater, for horizontal or vertical turbines, respectively.)
(70) Length of draft tube (on center line)..........ft.
(71) Area of tube at several points..........sq. ft.

Tail-Water Equipment

(m) *Tail Race*
- (72) Cross-sectional area at draft tube........................sq.ft.
- (73) Depth ....ft.
- (74) Wetted perimeter ....ft.
- (75) Surface slope .. ..ft. per 100

Load

(n) *Mechanical*
- (76) Kind (industrial, brake, dynamometer, etc.) .....
- (77) Capacity.......................................

(o) *Electrical*
- (78) Kind (industrial, water rheostat, etc.).......
- (79) A.c., or d.c. generator........................
- (80) Capacity (A.I.E.E. rating)....kw. or....kva ....
- (81) Frequency...............................cycles
- (82) Phase..
- (83) Voltage.......................................volts
- (84) Efficiency of generator at various outputs and various power factors, if a.c.........................per cent
- (85) Exciter capacity......................................kw.
- (86) Exciter voltage.................................. volt.

Auxiliary Equipment

(p) *Governor*
- (87) Capacity...ft-lb.
- (88) Type (oil-pressure, water-pressure or mechanical).............
- (89) Governing system (unit or central) ....
- (90) Pressure system (open or closed)...........................
- (91) Working pressure..lb.
- (92) Closing time (full stroke)........ ....sec.
- (93) Opening time (full stroke).............................sec.
- (94) Difference in speed between no load and full load.....per cent
- (95) Capacity of oil pump..........................gal. per min.
- (96) Volume of pressure tank ....cu. ft.
- (97) Volume of receiving tank.............................cu. ft.
- (98) Diameter and length of pipe:
  - (a) Between pressure tank and regulating valve......in.....ft.
  - (b) Between regulating valve and cylinder...........in.....ft.
  - (c) Between regulating valve and receiving tank.....in.....ft.
  - (d) Between pump and pressure tank...............in.....ft.
  - (e) Between pump and receiving tank.............in.....ft.
- (99) Flywheel effect
  - (a) Of turbine rotating parts (Wr^2)....................ft²-lb.
  - (b) Generator rotating parts...........................ft²-lb.
  - (c) Separate flywheel...............................ft²-lb.
  - (d) Gears, pulleys, etc.............................ft²-lb.
- (100) Synchronizing device.................................
- (101) Load limiting device.................................

(q) *Pressure Regulator*
- (102) Discharge capacity.............................cu. ft. per sec.
- (103) Type (governor-operated or automatic)......................

TABLE 2 PRINCIPAL DATA AND LEADING RESULTS

- (1) Date of test ....
- (2) Test of hydraulic plant located at ....
  - To determine.................
  - Test conducted by...............
- (3) Type of turbines and class of service ....
  - (a) Name of builder....
- (4) Type of generators, if any ....
  - (a) Name of builder......
- (5) Rated power of turbines ....b.hp.
- (6) Rated flow of water, each ....cu. ft. per sec.

General Data

- (7) Method employed for measuring water...........
- (8) Method employed for measuring power............
- (9) Duration of period covering water measurement........hr.
- (10) Duration of period covering power measurement.........hr.

	Plant test at full gate	Turbine test at gate
(11) Volume of water flowing. cu. ft. per sec.		
(12) Leakage of water flowing. cu. ft. per sec.		
(13) Net volume of water utilized...................cu. ft. per sec.		
(a) Weight of water utilized per sec. . lb.		
(14) Gross head, average..................ft.		
(15) Effective head, average..............ft.		
(16) Revolutions per min., average ....r.p.m.		
(17) Theoretical horsepower of water ...t.hp.		
(18) Water horsepower................w.hp.		
(19) Brake horsepower developed by brake test. ....b.hp.		
(20) Electrical output of generator . .. e.hp.		
(21) Brake horsepower by calculation from generator test..................b.hp.		

Efficiency

(22) Plant efficiency................per cent		
(23) Turbine-setting efficiency.......per cent		
(24) Efficiency as rated or guaranteed by builders....................per cent		

Research Results

(25) Water flowing per sec.		
(a) full capacity..............cu. ft.		
(b) 75 per cent capacity........cu. ft.		
(c) 50 per cent capacity........cu. ft.		
(d) 25 per cent capacity........cu. ft.		
(26) Head lost (gross head—effective head)		
(a) Full capacity....... ...ft.		
(b) 75 per cent capacity.. ...ft.		
(c) 50 per cent capacity. ...ft.		
(d) 25 per cent capacity...........ft.		
(27) Brake horsepower developed		
(a) Full capacity......... .....b.hp.		
(b) 75 per cent capacity... ....b.hp.		
(c) 50 per cent capacity........b.hp.		
(d) 25 per cent capacity........b.hp.		
(28) Efficiency at turbine coupling		
(a) Full capacity...........per cent		
(b) 75 per cent capacity ....per cent		
(c) 50 per cent capacity ....per cent		
(d) 25 per cent capacity ....per cent		
(29) Efficiency at switchboard of generator		
(a) Full capacity...........per cent		
(b) 75 per cent capacity ....per cent		
(c) 50 per cent capacity ...per cent		
(d) 25 per cent capacity ....per cent		

(30) Turbine results at various gate openings

	Water, (c.f.s.)	Brake hp.	Efficiency, per cent
(a) Full gate			
(b) 0.9 gate			
(c) 0.8 gate			
(d) 0.7 gate			
(e) 0.6 gate			
(f) 0.5 gate			

Sections of Code on Instruments and Apparatus Referring to This Test Code

Power Measuring Apparatus

101 There are two types of apparatus used to measure the power output of a hydraulic turbine, *viz.*, dynamometers and electric generators, that are direct connected to the turbine shaft. The latter apparatus is preferred to dynamometers on turbines that are used to drive electric generators.

Dynamometers

102 Dynamometers are of two general types; *viz.*, *absorption dynamometers* which absorb the power by mechanical or fluid friction and dissipate it as heat, and *transmission* dynamometers, which transmit or pass along the power they measure, wasting only a small part in friction.

103 The absorption dynamometers are represented by the following:

Prony brake, which is limited to small amounts of power.

Aldendynamometer, which is an improved form of Prony brake and is of much greater capacity.

Froude or ***Water Brake***, which is suitable for higher speeds than the other two.

Electric Generators

104 Whenever an electric generator is used for measuring the power output of the turbine the electrical output of the generator divided by its efficiency represents this power. The generator output is measured during the test of the turbine. The efficiency should be obtained from the manufacturer of the generator or by a separate test.

105 It is preferred that the generator efficiency be determined by the manufacturer before leaving the factory under the load, voltage and speed conditions duplicating those obtained during the test of the turbine, if the manufacturer's data are dependable. Otherwise, the generator efficiency should be determined for the loads, voltages and speeds to be obtained when testing the turbine, by the separate-loss method, the electrical measurements being made in accordance with The Standards of the American Institute of Electrical Engineers, 1921 Revision, Sections 4334–4342. In determining the generator efficiency by the separate-loss method it is calculated by dividing the generator output by the sum of the output and the various generator losses.

106 When practicable the generator, if of the alternating current type, is to be separately excited during both generator and turbine power tests, and the excitation loss is not to be included in computing generator efficiency, and is therefore, also to be omitted in computing power output at the turbine coupling. If the main generator is excited from a direct connected exciter or from an exciter belted from the shaft of the unit, the power of which is to be measured, then to the output of the main generator, computed without reference to excitation, there is to be added the output of the exciter divided by its efficiency; and in the case of the belted exciter, the belt losses

are to be added. It is preferable, for simplicity, that when possible the current for excitation shall be obtained from a separately driven exciter.

107 The losses in a constant-potential synchronous generator are of two classes; namely, those which remain substantially constant at all loads and those which vary with the load. The former include core losses, windage and friction. The latter include I^2R losses in the armature winding. The simple method of determining the losses and hence the efficiency is only approximate, since the losses which are assumed to be constant do actually vary to some extent with the load, and also because the actual I^2R loss in the armature windings is sometimes appreciably greater than the calculated I^2R loss. The difference between the approximate losses and the actual losses is termed "stray load losses." These latter are due to distortion in electric or magnetic fluxes from their no-load distributions or values brought about by the load current. They are usually only approximately measurable, but are of sufficient magnitude to require consideration when determining generator efficiency by the separate-loss method.

108 When determined by the separate-loss method, the generator efficiency, in the case of polyphase alternators separately excited, is to be taken as

E = [(kw. output at terminals)] divided by [(kw. output) plus (friction and windage) plus (I^2R loss in armature) plus (stray load losses)] all losses being expressed in kilowatts.

Kw. Output

109 The kw. output of the generator should be measured by a polyphase wattmeter and the necessary instrument transformers at the generator terminals.

Friction and Windage

110 The value of generator windage and friction should be directly measured by driving the generator alone by an independent motor, the output of which shall be determined by multiplying the motor input by its efficiency.[3] The generator shall not be connected to a load or have its field excited. The output of the driving motor will represent the generator loss due to bearing friction, collector ring friction and windage. With units having direct-connected exciters, the windage and friction may be measured by driving the generator by the exciter run as a motor. When the windage and friction cannot be directly measured, it is to be taken either from shop tests of generators of similar design, or from a retardation test made after installation. When possible, more than one method should be used in order to obtain a check. In making a retardation test, the turbine shaft and runner, or the turbine runner, are to be disconnected when practicable from the generator shaft, to enable the windage and friction of the generator alone to be measured. When the turbine shaft or runner cannot be disconnected, the generator windage and friction are to be computed by deducting from the total windage and friction that of the turbine, which for this purpose may be found with sufficient accuracy from the formula:

$$W = KBD^4N^3$$

where W = turbine windage and friction in kilowatts.
K = an empirical coefficient which may be taken as 0.000115, as determined from available test data.
B = height of turbine distributor in feet.
D = entrance diameter of runner in feet at center line of distributor.
N = revolutions per second.

I^2R Loss in Armature

111 The I^2R loss in the armature can be calculated for each load from the armature current and electrical resistance of the armature. This requires the measurement of the resistance by a Wheatstone bridge at various loads. These measurements can be made immediately after the stray load tests (see paragraph 112) for each load, before the resistance has had time to change because of cooling of the generator.

Stray Load Losses

112 The stray load losses which include iron losses and eddy-current losses in the copper, due to fluxes varying with load and also to saturation, shall be determined by driving the generator on short circuit and at the current corresponding with the generator load under consideration. An independent motor, or the exciter if direct connected, should be used to drive the generator, it being necessary to determine the efficiency of the motor as prescribed in the section on Friction and Windage, paragraph 110. The output of the motor driving the generator alone when reduced by the sum of the windage and friction and I^2R losses of the generator equals the stray load loss for the generator at the load corresponding with the generator current.

113 If, under special conditions of an installation, other losses exist, these are to be added to the stray load losses determined above.

Salt Solution Method

114 This method consists of introducing salt at a known rate into a body of flowing water, determining the quantity of salt in the water at a point far enough downstream to insure a thorough mixture with the water to be measured, and calculating from these data the quantity of water flowing between these points per unit of time.

115 The practical details require careful consideration, but when the necessary conditions are properly fulfilled this method of measuring flowing water, especially large quantities, is practical and accurate.

116 Two important requirements are (1) that the salt must be added at a fairly constant rate, and (2) that thorough mixture takes place before the samples are drawn off for analysis.

117 The salt solution method of measuring the flow of water may be conveniently divided into that part of the work which is principally mechanical and that which is principally chemical. The mechanical division embraces the work necessary to prepare the equipment for the introduction of the salt and for taking samples, the preparation of the salt solution to be introduced into the water, its actual introduction into the stream, and the taking of the samples. The chemical division embraces the preparation of the special dilution and the titration of the samples.

118 Common salt, NaCl (a quality known to the trade as "coarse-fine"), is usually employed. The salt is dissolved in water to form a brine before being introduced into the water to be measured.

119 It is desirable to have the initial brine supply highly concentrated but not quite saturated. A solution consisting of 16 lb. of salt per cu. ft. of water is satisfactory. (Specific gravity of about 1.18.)

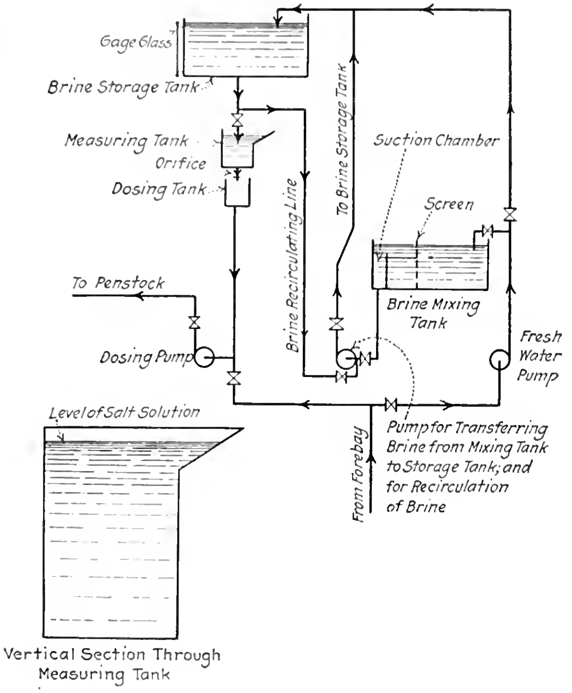


Fig. 101

The apparatus required is as follows:

1 A brine-mixing tank
1-a A brine storage tank
2 A measuring tank with orifice or nozzle
2-a A dosing tank
3 Equipment for introducing the salt solution into the flowing water
4 Equipment for taking samples

120 The brine-mixing tank should be divided into two compartments with screens between them, so that foreign matter which may enter the brine with the salt can be screened out before it enters the storage tank. All tanks should be located so that there will be no danger of the salt or the brine being carried into the water to be measured other than through the measuring tank. A pump will usually be required to supply the water to the mixing tank. The brine storage tank should be elevated above the mixing and measuring tanks.

121 A pump, in many cases the same pump referred to above, will be required in order to pump the brine from the mixing tank to the storage tank. An arrangement of piping is necessary to permit a circulation of the salt solution between the two tanks to insure a brine of equal strength. It is advisable to have the storage tank of sufficient size to hold brine for a number of measurements. A satisfactory arrangement is shown in Fig. 101.

122 One way of getting a fairly constant rate of discharge is to use a measuring tank having an orifice or discharge nozzle. With this the level of the solution in the tank is kept constant throughout a measurement to

---

[3] This necessitates getting from the motor manufacturer data showing the efficiency of the motor at the speeds and loads actually obtained or determining the efficiency by means of a Prony brake test of the motor. During such a brake test the power output and the speed of the motor should be varied while the following data are taken:

If D. C. Motor	*If A. C. Motor*
Brake Horsepower	Brake Horsepower
R.P.M.	R.P.M.
Terminal Voltage	Terminal Voltage
Field Current	Electrical input by wattmeter
Armature Current	

Performance curves should be drawn that will permit of determining the efficiency of the motor when used under any combination of the variables just mentioned.

insure a constant rate of discharge. A projection, having an inclined bottom, on the upper part of one side of the tank, as shown in Fig. 101, accentuates any variation in the level of the solution in the tank.

123 One of the following two means of introducing the solution from the discharge orifice or nozzle into the stream of water to be measured may be necessary.

124 (1) Where the distance between the point of introducing the salt solution and the point where the samples are to be taken is great and if the water is more or less turbulent, the solution may be introduced without much effort to attain uniform distribution, especially if the flow is concentrated in a closed pressure conduit.

125 (2) Where the distance is short, every effort must be made to introduce the solution uniformly over the whole area of the canal or conduit in which the water flows, and some regard must be taken of the unequal velocities in the stream. Sometimes the solution is introduced through a series of pipes having numerous small orifices, the pipes and orifices being distributed to suit the flow. To insure sufficient discharge and also to insure a thorough mixture, a pump should be installed between the dosing tank and the point of introduction into the conduit. The pump suction in addition to drawing brine from the dosing tank obtains its main supply from the conduit or canal in which the water to be measured flows and from a point upstream from the point of introduction. The pump suction head must be reasonably uniform and the level of the dosing tank must be maintained by means of a throttle valve. The horizontal cross-section of the dosing tank should be small, in order to exaggerate changes of level resulting from fluctuations in the rate at which brine is supplied.

126 The introduction of the salt solution into the distributing system under high pressure is favorable to a uniform mixture and the solution shall be introduced under sufficient pressure to produce a uniform mixture as shown by the samples taken after mixing. Wherever possible, the brine should be added to the water on the inlet side of the turbine and the final sample of water should be taken on the discharge side of the turbine to insure thorough mixing of the brine and the water.

127 While the salt solution is being introduced, samples should be taken continuously as follows:

(*a*) Sample of salt solution
(*b*) Sample of natural stream water
(*c*) Sample of dosed stream water after the salt solution has become thoroughly mixed with the water in the stream.

128 A sample of the salt solution should be taken continuously from a point as near the dosing pump as possible.

129 The sample of natural stream water should be taken continuously well above the point where the salt solution is introduced and during the period when it is being introduced.

130 The dosed stream sample should be taken far enough downstream and after sufficient lapse of time to insure a thorough mixture and stable conditions. The samples should be continuous over a period of not less than 5 minutes and should be secured by pumping or by means of bottles arranged to fill slowly.

131 Where the sampling station covers a large cross-section samples must be taken from points distributed well over the entire area, until it is found by trial that the distribution is so uniform that samples from a few points are sufficient. Samples should be taken from not less than 6 points and preferably more.

132 It is necessary to make a preliminary investigation to determine the proper place for taking samples of dosed stream water, and the necessary time interval between the time of beginning dosing and taking the samples.

133 The salt solution should be added to the stream of water to be measured at such a rate as to increase its salt content by at least 0.003 lb. per cu. ft. and under no circumstances should the initial salt content exceed 25 per cent of the salt content of the dosed water.

134 The waters of natural streams usually contain an initial quantity of salt in solution, which must be considered in making a correct gaging.

135 The relative salt content of the various samples should be determined by titration against a standard silver nitrate solution by an experienced chemist.

136 *Calculation of Results.* The number of cubic feet per second of water dosed with a salt solution is equal to the ratio of (the weight of the salt introduced per second) to (the weight of a cubic foot of the water multiplied by the weight of salt added per pound of water in a sample of the dosed water).

Let Q = discharge in cu. ft. per second of stream to be measured.
q = cu. ft. per sec. of salt solution introduced.
C = concentration of salt solution in pounds per cu. ft.
C_1 = concentration of salt in the natural stream water in pounds per cu. ft.
C_2 = concentration of salt in the dosed stream water samples in pounds per cu. ft.

Then the following equation may be derived:

$$(Q + q)\ (C_2 - C_1) = q(C - C_1)$$

$$Q = \frac{(C - C_1)q}{C_2 - C_1} - q$$

137 Since concentrations are proportional to the volume of standard silver nitrate solution required to titrate unit volume, we have:

$$Q = \frac{(V - V_1)q}{V_2 - V_1} - q$$

in which,

V = volume of silver nitrate solution necessary to titrate unit volume of concentrated salt solution
V_1 = volume of silver nitrate solution necessary to titrate unit volume of normal stream water
V_2 = volume of silver nitrate solution necessary to titrate unit volume of dosed stream water.

If V is large compared to V_1 and $\frac{(V - V_1)q}{V_2 - V_1}$ is large compared to q, the equation reduces to

$$Q = \frac{qV}{V_2 - V_1}$$

138 A detailed discussion of the sources of error in the measurement of water by chemical gaging and the derivation of the formula given above, together with correction factors to be applied for more precise application of the method, is given in a paper by B. F. Groat in Trans. American Society of Civil Engineers, Vol. 80.

Pitot Tube

139 The measurement of flow of water by means of pitot tubes cannot be regarded as an extremely accurate method on account of the difficulty of duplicating the conditions under which the tube is calibrated with the conditions under which it is used. A tube properly calibrated in straight-line flow or in still water will give accurate determinations when used at the same velocities in a pipe in which the flow is free from whirls or eddies, but strictly speaking such conditions are never attained even in long straight pipes. Furthermore, the degree of disturbance cannot be observed or determined. The best that can be done is to calibrate the tube for straight-line flow and to use it only under conditions where reasonably straight and smooth flow may be expected to occur. The resulting error, although undeterminable, will then be small. (The magnitude of the error will be given in a later issue.)

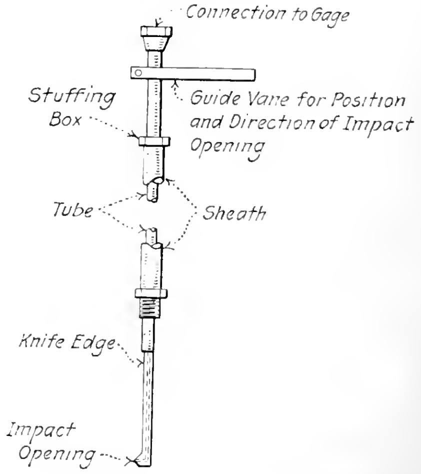


Fig. 102 Single Opening Pitot Tube

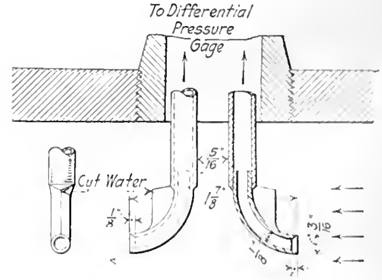


Fig. 103 The Pitometer

140 The pitot tube is suitable for use only where the conditions of flow, as indicated by the readings, are reasonably steady. Steady readings are indicative of steady flow. The question of symmetrical distribution of flow in the pipe is not as important as steady flow. Well designed bends of long radius in the pipe will affect the distribution of velocity across the diameter of the pipe for a considerable distance beyond the bend, but this is not necessarily objectionable. It is desirable to have a run of straight pipe, at least 15 pipe diameters long, following short bends, valves and poorly designed intakes, and immediately preceding the pitot tube to minimize the disturbances to flow which may result from such features. The greater the length of the straight pipe ahead of the pitot tube the greater is the probability that parallel stream flow will exist, which will increase the accuracy of the velocity measurement. The uniformity of the readings obtained at the various points on repeated trials is the most reliable criterion by which to judge the character of the indications.

141 The single-opening pitot tube, Fig. 102, in connection with a "wall piezometer," i.e., not less than two pairs of diametrically opposed holes, that transmit only the pressure head of the water, affords the combination of the simplest and most easily constructed instrument. The piezometer holes shall not exceed $^1/_4$ in. diameter, their edges at the inside wall of the conduit shall be sharp and the holes shall be normal to the internal surface of the wall.

142 The "Pitometer," Fig. 103, is a commercial adaptation of the Pitot principle. This instrument, as also all other tubes which are symmetrical, has the advantage of being reversible.

143 Different forms of pitot tubes may be used, provided they are properly calibrated. If calibration is impossible the form of the tube shown in Fig. 102 is to be used. The formula for use with this tube is $v = c \times \sqrt{2gh}$ where $c = 0.98$ and h is the difference in head between the readings of the pressure gage connected to the pitot tube and the one connected to the piezometer, expressed in feet of water. The coefficient for the Pitometer is furnished by the maker.

144 For measurement of water flowing in conduits under pressure, using pitot tubes, at least two tubes should be arranged to traverse two relatively perpendicular diameters. In the case of very large conduits, or those having unsymmetrical shape or flow, pitot tubes should be arranged to traverse the intermediate diameters completely or partially, giving traverses at 45 degree intervals. The piezometers for the various diameters should be connected so that they may be separately read. The conditions of measurement, including velocity distribution, length of straight run of penstock, and condition of piezometer orifices, should be such that no piezometer shall vary in its readings from the average of all the piezometers by more than 10 per cent of the average velocity head. The piezometer orifices should be flush with the inside surface of the penstock wall, and the wall should be smooth and parallel with the center line of the penstock in the vicinity of the orifices. The orifices should be $^1/_8$ inch to $^1/_4$ inch in diameter. The piezometer openings should be spaced around the wall of the conduit at equal angles at a section approximately one foot upstream from the pitot tube section to avoid the effect of the pitot tube supporting structure, the conduit being of uniform cross-section between the piezometer and the points of the pitot tubes.

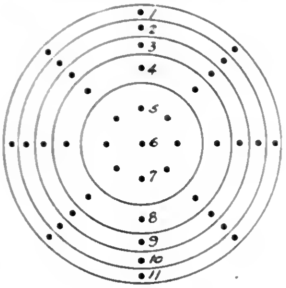


Fig. 104

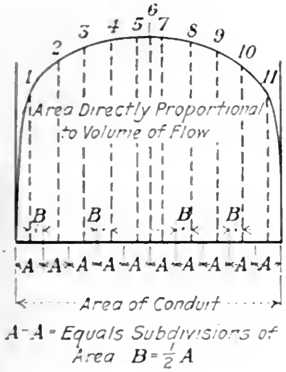


Fig. 105

145 The differential pressures obtained with the pitot tube should be measured as prescribed in paragraphs 191 to 194 of the section on Head-Measuring and Pressure-Measuring Apparatus.

146 Long tubes must be supported to prevent vibration, the support being designed so as to affect the readings as little as possible. In measuring the flow in open channels with pitot tubes, the observations and computations are similar to those used for current-meter measurements, which are described in a separate section.

147 For determining the flow in closed conduits under pressure the area of the conduit is divided into a number of equal concentric areas, the number depending upon the size of the conduit and the degree of accuracy required for the measurement. See Fig. 104. The tube stations are figured to come on the half area point of all the areas, with an extra station in the center of the pipe.

148 A diagram (see Fig. 105) is then constructed having an abscissa representing the conduit area, with vertical lines on the centers of the equal areas. By plotting velocities as ordinates on this diagram, and drawing a curve through the plotted points, the circumscribed area is proportional to the cubic-foot-seconds flowing through the conduit.

Venturi Meter

149 Figure 106 shows a Venturi tube in a horizontal position, with approximate dimensions as generally constructed, although it may be set at any desired angle. For testing hydraulic turbines the velocity through the throat is not to be more than 50 feet per second.

150 Two piezometer tubes are shown in Fig. 106, one at the throat and one at the upstream end of the meter tube. The difference between the indication at the upstream end of the meter tube and that at the throat is used in determining the discharge through the meter tube. The throat velocity with low rates of flow should be great enough so that the difference of pressure heads shown by the piezometers will cause a measurable indication, but should not be so great as to cause the throat pressure to drop below atmospheric, lest there be trouble with air leaking into the tubes.

151 The differential pressures between the inlet and the throat of the Venturi tube should be measured as prescribed in paragraphs 191 to 194 of the section on Head-Measuring and Pressure-Measuring Apparatus.

152 The upstream cone should have a summit angle, which is the angle between wall of the cone and the pipe wall extended, of about 21 degrees. The downstream cone should have a summit angle of not more than 5 degrees. All corners of the main water channels should be rounded. The pressure connections should be made to four or more standard piezometer holes equally spaced around the pipe and staggered with respect to the vertical. Except where standard throats with ring pressure chambers are used the pressure connections are to be connected to read individually or collectively, the object being to obtain the average pressure and avoid dependence on a single piezometer hole, subject to possible local disturbances. The meter tubes are generally made of cast iron but may be made of other materials such as plate steel, concrete or timber. The throat should be of metal accurately bored to size and smoothly finished. It is sometimes desirable to build a Venturi meter of wood, plate steel, or concrete into an existing conduit or in a tail race.

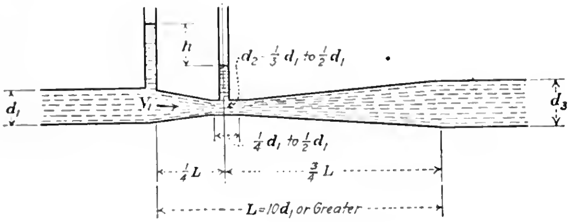


Fig. 6 Venturi Meter

153 The value of C, the "coefficient" of the meter tube, built as above described, is to be taken as 0.99.

154 The formula for calculating the Venturi meter tube discharge is:

$$Q = C \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \sqrt{2gh}$$

where Q = cu. ft. per sec.

$C = 0.99$, the coefficient of the meter tube.

a_1 = area of the upstream end of the meter tube in sq. ft.

a_2 = area of the throat in sq. ft.

h = differential pressure between upstream and throat piezometers, expressed in feet of water.

155 More accurate results are obtained with Venturi tubes installed so that there are runs of straight pipe on the upstream and downstream sides of at least 8 and 3 pipe diameters, respectively, instead of being installed inside of an existing conduit, which may be of non-circular cross section or of varying cross section.

Weir

156 The weir is a suitable means of measuring the flow of water in open channels when the obstruction of the channel and change of water levels, due to the interposition of the weir, are not objectionable. Many experiments have been made with weirs of different forms, resulting in a number of different formulas for weir discharge. All of these formulas are empirical and require the use of coefficients derived experimentally; consequently the accuracy of the results depends upon the accuracy of the experiments and the use of the formulas and coefficients under conditions identical with those under which the original experiments were made. Weirs carefully used under favorable circumstances are accurate within 1 per cent. Indiscriminate use of weir formulas and coefficients under unsuitable conditions has resulted in much confusion in regard to the accuracy of this method of water measurement.

157 The sharp crested rectangular weir without end contractions, known as the *suppressed weir*, in which the sides of the channel form the ends of the weir, is the basis of the formula and coefficients herein specified.

158 The formula to be used is:

$$Q = C\,L\,h^{3/2}$$

where Q = quantity in cu. ft. per sec.
L = length of weir in ft.
h = difference in level of surface of water upstream (a distance prescribed farther on in this section) and the crest of the weir in feet.

159 The following table gives the values of C for various heads (h) above the crest and heights of crest (P) above the bottom of the channel of approach. See Fig. 107.

160 VALUES OF C FOR VARIOUS HEADS AND HEIGHTS OF CREST P.
P = HEIGHT OF CREST ABOVE BOTTOM OF CHANNEL OF APPROACH

HEAD, h	HEIGHT OF CREST P. (ABOVE BOTTOM OF CHANNEL OF APPROACH), (FT.)										
(ft.)	4	5	6	7	8	9	10	12	14	16	20
1.0	3.376	3.356	3.344	3.335	3.329	3.325	3.322	3.317	3.314	3.311	3.308
1.2	3.391	3.366	3.350	3.339	3.332	3.326	3.322	3.316	3.311	3.308	3.305
1.4	3.409	3.378	3.359	3.346	3.336	3.330	3.324	3.316	3.311	3.307	3.303
1.6	3.429	3.392	3.370	3.354	3.343	3.334	3.328	3.319	3.312	3.308	3.302
1.8	3.450	3.408	3.382	3.363	3.350	3.340	3.333	3.322	3.315	3.309	3.303
2.0	...	3.425	3.394	3.373	3.358	3.347	3.338	3.325	3.317	3.311	3.304

161 (To facilitate computations, all corrections for velocity of approach have been included within the coefficients as given. These are therefore to be used in the formula stated above, the observed head being used without modification.)

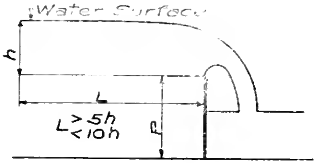


FIG. 107

162 The weir shall, if possible, be located on the tailrace side of the turbine, if used for turbine testing, and care shall be taken that smooth flow, free from eddies, surface disturbances or the presence of considerable quantities of air in suspension, exists in the channel of approach. To insure this condition the weir shall not be located too close to the end of the draft tube, and stilling racks (see Head-Measuring Apparatus) shall be used when required.

163 The channel of approach shall be straight, and of uniform cross-section. Where used, stilling racks shall be arranged to give approximately uniform velocity across the channel of approach. The uniformity of velocity shall be verified by current meter or otherwise.

164 One method of determining the head on the weir or the elevation of the surface of the flowing water, is by direct observation upon it as it flows. The head on the weir may also be observed by hook gages placed in stilling boxes communicating with orifices approximately 1 inch in diameter in the sides of the channel of approach, approximately 1 foot below the level of the crest, the head being observed independently at both sides of the channel. The head (h) on the weir shall be measured at a distance of not less than five nor more than ten times the thickness of the stream going over the weir upstream from the weir. The weir shall be sharp-crested, with smooth vertical crest wall, complete crest contraction, and free overfall. A metal crest free from rust, with sharp right angled corner on the upstream edge, a crest width of $^1/_8$ inch and beveled to an angle of 45 degrees on the downstream face, shall be used. The crest shall be carefully leveled.

165 Complete aeration of the nappe shall be secured and observations of the crest conditions and form of nappe shall be made during the test, to avoid defective conditions such as adhering nappe, disturbed or turbulent flow, or surging. Aeration of the nappe usually requires the construction of air passages leading to the space beneath the nappe. The sidewalls of the channel should be smooth and parallel and should extend downstream beyond the overfall above the level of the crest. Weirs of a length exceeding approximately twenty times the head (excepting in cases where the velocity of approach is extremely low); or weirs of moderate crest length having high velocities of approach; or those in which the velocity of approach is irregularly distributed, or in which the len[illegible]g channel is subject to the action of the wind, shall either be subdivided into a number of sections or the head shall be observed not only at both sides but also at intermediate points across the channel of approach.

166 The head on a weir must be carefully measured. A small percentage error in head measurement causes approximately $1^1/_2$ times that error in calculated discharge. Considerable errors in the measured head may be made by careless methods of referring the crest level to the head gage scale, and by assuming that a non-level crest is level without knowing the average level. The mean level of the water surface must be measured, not the crests of the small waves or surges existing in all flowing water.

CURRENT METER

167 Ordinarily, the current meter is provided with a mechanism which completes an electric circuit at each revolution, or at a given number of revolutions of the current meter wheel. By means of wires connecting the meter to batteries and buzzer or other indicating device, the observer is enabled to determine the rate at which the wheel revolves. Some current meters are arranged with mechanical recording devices. Current meters may be suspended from a cable or attached to a rod. In the former case they are generally provided with electrical recording devices and these are better suited for large streams where observations are taken from a boat or cable station or other more or less insecure positions. Meters attached to rods are better suited for work in small streams or canals where observations are taken from a bridge.

168 The measurement of flow of water by means of a current meter cannot be regarded as an extremely accurate method on account of the difficulty of duplicating the conditions under which the instrument is calibrated with the conditions under which it is used. A meter properly calibrated in straight line flow or in still water will give accurate determinations when used at the same velocities in a stream in which the flow is free from whirls or eddies, but strictly speaking such conditions are never attained in streams. Furthermore, the degree of disturbance cannot be observed or determined. The best that can be done is to calibrate the meter for straight line flow and to use it only under conditions where reasonably straight and smooth flow may be expected to occur.

169 The meter should be calibrated before using on a test and also after using. If the current meter is to be used suspended from a cable or attached to a rod, it must be calibrated similarly.

170 The hydraulic section on which the measurements are to be taken is selected primarily with regard to flowage conditions. The bottom and sides should be smooth and the section uniform for a sufficient distance both up and down stream to insure a smooth flow and avoid turbulence. Accurate soundings should be taken at close enough intervals to insure an accurate determination of cross-sections. When soundings are made in a current, corrections should be made for the deflection of the sounding cable. Where meters suspended from flexible cables are to be used, it is desirable to take the soundings with cables giving the same deflections as the meter cables, insuring the determination of the cross-section in the same plane as the meter readings. All soundings should be plotted for the same mean stage. The hydraulic section should then be laid out to some convenient scale and divided into sections or panels.

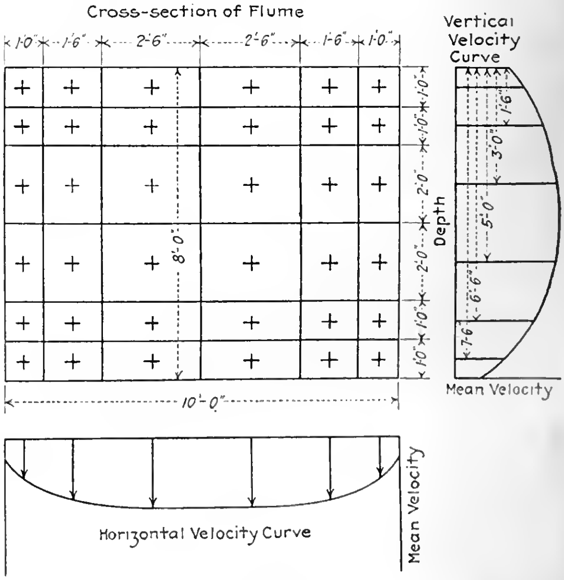


FIG. 108

INDIVIDUAL UNIT TESTS

171 After the cross-section is accurately determined, it should be laid off in vertical sections and enough point stations located on the center line of each section to enable a consistent vertical curve to be plotted. The point method should be used, holding the meter at each predetermined point a sufficient time to allow the varying velocities of a cycle at that point to register. Under uniform velocity conditions the duration of time at each point should be not less than one minute. The top station should be just under the water surface and the lower station as near the bottom as the meter will operate. The depth of water should be accurately recorded during the test. After the vertical velocities are plotted and the areas planimetered in order to get the mean velocity, a horizontal velocity curve should be plotted from the mean vertical values.

172 By continuing the curves to the sides and bottom of the section, the entire area is considered in the determination of the quantity. See Fig. 108.

COMPLETE PLANT TESTS

173 When a section is large enough, or the possible distribution of the load is likely to affect the distribution of the flow, the section should be divided into two or more main panels, and these again divided into subpanels. An index point is then selected for each panel, preferably at the point of maximum velocity, which occurs usually at about 0.4 depth. In order to avoid the necessity of making a complete traverse of the section for each loading, the observations are made comparable by using two or

three meters. It is preferable to use three meters, one at the index point of each panel, while the second one is being used to make a traverse of the panel, the third meter being used as a master index meter fixed at one point in the stream. If only two meters are available, one should be fixed at the index point of one of the panels while the other is used to make the traverses of the various panels. All meter readings are to be reduced to percentages of the simultaneous index reading. Simultaneous observations should be taken of the time, time intervals, meter depths, (proportionate depths if water level varies), meter readings, and section gage readings, and notes taken from time to time regarding all matters pertaining to the work. Vertical velocity curves are plotted these being located on vertical center lines of the sub-panels. The points of determination should be the sub-surface and bottom and enough intermediate points at even proportions of the depth to insure a proper determination of the vertical velocity curve. The sub-surface depth in each case should be just sufficient to insure a proper submerging of the meter; the bottom depth in each case being just enough above the bottom to allow the meter to clear properly. One of the points selected should be at 0.4 of the depth to correspond to the index reading. The meters in each panel should be interchanged from time to time and inspected frequently. All velocity observations of the vertical curves are first reduced by dividing each by the simultaneously determined velocity at the index in the same panel, and expressing the quotient as a percentage. The average of the accepted percentages of each point is computed, and divided by the average for the 0.4 depth point of the same vertical. A plot for each curve is constructed with percentage depths as ordinates and percentage velocities as abscissas. A smooth curve is drawn through the points. The coefficient of the curve is derived by measuring the area, this area being divided by the proportionate depth gives the mean abscissa of the curve, and the mean abscissa divided by 100 (the percentage at 0.4 depth point), gives the vertical velocity coefficient. A transverse curve is then plotted, using the 0.4 depth points on the verticals as points on the transverse curve. As in the case of the vertical curves, the first step in the transverse curve reductions is to divide the observed velocity at each point by simultaneously observed velocity at the index in the same panel. The percentages are then tabulated, arithmetic means are taken of all the observations at each point, and a curve drawn through all of the resulting points. In each sub-panel the mean percentage ordinate of the transverse curve is determined, the results giving the transverse coefficient in terms of 100 per cent at the index. The sub-panel areas at the mean water elevation are determined and expressed as percentages of the entire area. The transverse and vertical coefficients in each sub-panel are weighted according to the relation which the area of the sub-panel bears to the whole panel area. Accordingly, the general coefficient for the index is obtained by multiplying for each sub-panel the transverse coefficient by the vertical coefficient and by the percentage area, adding the results and dividing by 100.

174 The elevation of the water surface should be continuously observed during a run of current-meter measurements, preferably by direct measurements down to the surface from fixed points on a bridge or by means of stilling boxes. If the supporting rods for the meters are in the same cross-sectional plane as the meters, the area of the rods should be deducted from the wetted area of the channel in calculating the quantity. The meter should preferably be supported by rods placed a sufficient distance behind them to avoid any obstructive effect. When a heavy mast or supporting frame is used, it should be designed to offer a minimum disturbance, and should be located several feet downstream from the meter.

175 Velocities below 0.5 ft. per second cannot be accurately measured. A Venturi meter flume of plank can sometimes be built into a channel to increase the velocity, the throat making an ideal current meter station.

Special Methods for Measuring Water

176 *Traveling Screen.* The traveling screen, also called the "diaphragm method" of measuring water, provides for the determination of the mean velocity from a single observation. This method requires elaborate preparations, but when the apparatus is once installed it may be used for as many observations as desired. It is adapted only to open channels of very regular cross-section. A very light canvas screen, varnished to insure imperviousness, is suspended by a stiff frame from a wheeled carriage mounted on tracks along the edges of the channels. The rate of movement of the screen must necessarily be the mean velocity of the water. A small crack about 0.5 inch should be provided between the screen and the sides and bottom of the channel to insure freedom of movement. Provision must be made for accurately observing the velocity of the screen, preferably by electric contacts and chronograph. The length of run of the screen should be sufficiently in excess of the portion used for measurement to provide ample space for starting and stopping the screen, so as to insure uniform conditions over the measured portion of the run. In determining the discharge, the velocity of the screen is to be multiplied by the average area of stream cross-section of the portion of the channel traversed. The variation of the level in the flume should be observed during the course of the run and the average elevation used in determining the area. It is possible to measure the flow of water within 1 per cent by this method under the most favorable circumstances.

177 *Volumetric or Bulk Method.* Volumetric methods of measuring water, which require the determination of the volume of water flowing in a given time by means of measuring vessels are limited to laboratory use and are outside of the scope of this code.

178 The bulk method is applicable only when there is available a reservoir of regular form, the volume of which, up to various water levels, may be accurately measured. In the case of a test on a turbine, the power must be measured continuously and the average obtained. It must be possible to shut off completely all inflow to the reservoir. The tightness of the gates and reservoir walls must be tested by closing all gates and observing over a time of several hours the rate of rise or fall of water level in the reservoir throughout the full range of variation of level which will be used in the turbine test. At the same time any leakage through the turbine head gates is to be measured. The surface elevation in the reservoir is not to be so affected by velocity or wind effects as to cause local variations in level of more than 5 per cent, of the total draw-down used in the turbine tests. This variation is to be observed by gages distributed over the whole reservoir, which are to be read simultaneously at short intervals through the test.

179 *Color Method.* When the water to be measured passes through a conduit suited to the purpose, the color method of quantity determination may be used. A solution or paste of coloring matter, commonly one of the aniline dyes, is injected into the conduit and the time required for it to pass through a known distance observed. This distance should be at least 200 times the mean velocity in feet per second. The coloring matter may be introduced as a paste at the intake to the conduit or it can be injected by a force pump or gun into the conduit at any convenient point. The particles of coloring matter will usually remain within a section having a length equal to 10 per cent of the distance traveled. Time observations should be made at the instant the coloring matter is introduced and at the first and last appearance of the coloring matter at the second point of observation. The mean rate of flow will be the volume included between the two points of observation divided by the mean of the two time intervals. If the conduit is not of uniform area it must be of sufficiently regular form to permit its volume to be accurately determined between the two stations.

180 This method may be very accurate if proper care is used in introducing the coloring matter to avoid any leakage of it into the water prior to the stated starting time, and to insure a prompt entraining of the entire amount by the body of the stream.

181 *Brine Velocity Method.* This method of measuring water is a modification of the color method, and is carried out by introducing in place of the coloring matter a concentrated salt brine or other chemical that is a good conductor of electricity. The time of passage of the brine is detected by the variation in electrical resistance indicated by a galvanometer which is connected to batteries and to an electrical circuit having poles inserted into the conduit at measured observation points. The galvanometer will show a stronger current while the prims containing the brine is passing the poles. This method has the advantage over the color method in that is it not necessary to see the water. The points of observation can be at any point in the conduit, as it will only be necessary to drill small holes in the pipe to insert the poles.

182 Experimental work now in progress indicates that this method of measuring water is capable of giving very accurate results (probably within 0.5 per cent of the true value) when properly used. (These experiments are being conducted by Prof. Chas. M. Allen, Worcester Polytechnic Institute.) Such tests as have been made lead to the conclusion that the time of maximum conductivity should be used; i.e., the time between the introduction of the brine and the time when maximum conductivity is indicated at the downstream station. It has also been found that it is possible and desirable to combine the two electrodes into a single fixture which can be inserted through one hole in the wall when used with closed conduits.

183 *Pressure—Time Method.* This method of determining the velocity of flow in a closed conduit is one recently invented by Norman R. Gibson, in which the changes of pressure in the conduit when closing a valve or the turbine gates are recorded by means of special apparatus. The record thus obtained results in a diagram called the "pressure time diagram" which, when properly interpreted, is a measure of the mean velocity that existed in the conduit prior to the interruption of flow. This method depends upon the principle that impulse is equal to momentum. A complete description of this method appears in Proceedings of the American Society of Civil Engineers, April, 1919, pages 173–206 and in Mechanical Engineering, April, 1921, pages 247–248.

Head-Measuring and Pressure-Measuring Apparatus

184 *Measuring Stick.* A good method for determining the elevation of the surface of flowing water is by direct observation. For surface determination in channels, a horizontal bar with its upper edge at a fixed or determined elevation, or a stretched wire, should extend across the race-way. The perpendicular distance from the upper edge of the bar or wire to the water surface should be measured at each station by means of a measuring stick with a graduated scale on its side. The graduations should preferably be marked so that the elevation of the water surface can be directly read off opposite the upper edge of the horizontal bar or wire at the instant the bottom of the measuring stick touches the surface of the water. An access bridge should be provided to facilitate measurements from the bar or wire.

185 *Float Gage.* For cases of great range of levels, a graduated tape, attached to a float and passing over a pulley, and provided with a suitable counterweight, makes a sensitive indicator.

186 For cases of small range of level, a graduated rod is attached to the float.

187 For flowing water the float must always be placed in a stilling box. (See Par. 189.)

188 *Hook Gage.* The hook gage consists of a sharp pointed hook attached to the lower end of a graduated rod, equipped with a vernier and sliding vertically in fixed supports. To take a reading on a water surface, the point of the hook is lowered below the surface and then slowly raised by a screw at the top of the instrument. Just before the point of the hook pierces the skin of the water surface a pimple is seen to rise above it; the vernier should be immediately read.

189 *Stilling Box.* Stilling boxes for use in connection with float, hook and other gages must be so constructed that they will not cause systematic

errors resulting from velocity effects and should, whenever possible, be open to full view of the observer, so that no errors due to sticking of the float may be introduced. For flowing water in open channels, the stilling box is placed outside the channel and communication is made by a small pipe, the end of which must be flush with the inside wall.

190 *Pressure Gage.* These gages are liable to error after having been in use for some time, especially when used with high or suddenly varying pressures, and should be frequently calibrated. Great care must be exercised in connecting dial pressure gages so that all air in the connection and the gage coil can be removed. There must be a point in the connecting pipe near the gage which is higher than the gage, and a petcock must be located at this point so that any entrained air may be removed. The gage must be so connected that it can be turned upside down while water is filling the connection, thus allowing the air in the gage coil to escape to the high point. The pressure observed then is that at the center of the gage dial.

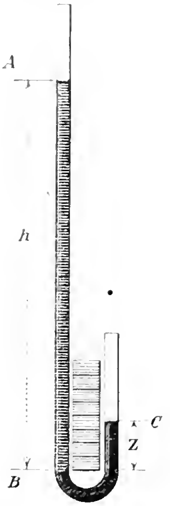


Fig. 109 Simple Manometer

191 *Manometers.* The open liquid column manometer furnishes the most direct means of measuring the pressure head of water. Fig. 109 shows the principle of construction of such a gage. A bent glass tube ABC, with both ends open has mercury, or some other liquid heavier than water in its lower portion, the water column of a height h being balanced by the mercury or other liquid of height Z. If the atmospheric pressure at A and C are the same, then h (in feet of water) equals $s \times Z$, where s is the specific gravity of the indicating liquid. Obviously, water cannot be used as an indicating liquid because of the pressure pipes being filled with the same liquid. For measuring pressured heads between 1 and 50 feet of water, mercury should be used in the manometer. For measuring pressure heads less than 1 ft. of water, carbon tetrachloride or certain oils having specific gravities greater than 1.0 can be used instead of mercury to magnify the indication of the manometer. It is possible to get still further magnification by inclining the manometer or by using other magnifying devices such as gasometer gages, differential manometers using two liquids with different specific gravities, etc.

192 The manometer can be used to measure differential pressures by connecting the two ends of the bent tube to the two pressure pipes leading to the conduit or instrument containing the liquid under test.

193 Fig. 110 (a) shows a manometer used in an upright position and filled with mercury or some other liquid heavier than water. When filled with mercury a manometer so set up is suitable for measuring differential pressures between 1 and 50 ft. of water, which correspond approximately with 1 inch and 48 inches of mercury, respectively. For measuring differential pressures below 1 ft. of water the manometer should contain carbon tetrachloride (specific gravity 1.3 to 1.6) or some oil heavier than water in order to magnify the indications. Still further magnification can be obtained by inclining the gage or by using a gasometer gage. Because of the water above the indicating liquid in the manometer tubes the differential head h (in feet of water) equals $h' \times x(s-1.0)$, where h' is the measured head of the indicating liquid and s is its specific gravity.

194 Fig. 110 (b) shows an inverted manometer which when connected at D with a partial vacuum or a pressure above atmospheric, as the case may require, provides means for bringing the surface of the water in the pressure pipes or manometer within the glass tubes where the differential pressure can be read directly in feet or inches of water. In some cases it is desirable to magnify the indication by using kerosene or some other oil lighter than water and that will not mix with it, in the top of the manometer instead of air. The differential pressure head h (in feet of water) equals $h'(s-S)$, where h' is the measured head of the indicating liquid, s is its specific gravity, and S is the specific gravity of the material above the water in the top of the manometer.

SPEED MEASURING APPARATUS

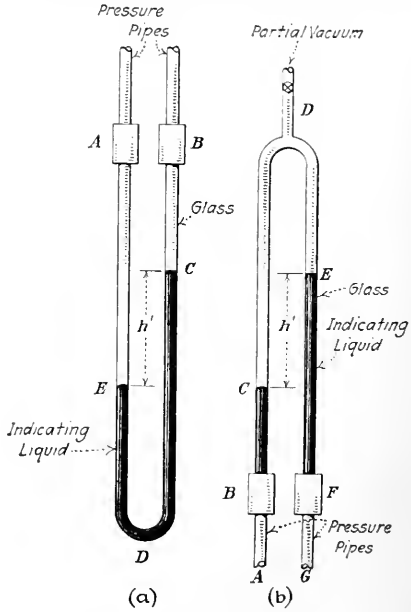
195 *Hand Revolution Counter.* The hand revolution counter or speed counter consists of a small shaft pointed at one end and geared to operate the counting device. If handled carefully and well made it is a reliable type of instrument, particularly for speeds from 200 to 2000 r.p.m. As there is a possibility of introducing considerable error in making the measurement by not accurately gaging the time that the counter tip is put in contact with and breaks contact with the end of the shaft under test, it is desirable to make the period of contact between the counter and the shaft two or three minutes instead of for only a few seconds. If a $^1/_5$ second stop watch is used to time the period of contact and there is an error of only one scale division on the watch made in measuring the period of contact the error in the observed r.p.m. will be as follows:

Period of contact	Error in r.p.m. (per cent)
15 sec.	±1.33
30 sec.	±0.67
1 min.	±0.33
2 min.	±0.17
3 min.	±0.11

To prevent slipping of the point at high speeds, a rubber tip is sometimes used. If the tip is not true or the instrument is so held as to allow the axis of the counter shaft and the axis of the shaft being tested to be out of alignment there will be an appreciable error in the speed measurement, as the rubber tip under such conditions becomes a reducing gear of unknown and variable ratio.

196 *Revolution Recorder.* This instrument consists of a series of gears operating a set of dials indicating, by successive digits, the total number of revolutions. For accurate work this instrument should be connected to the rotating shaft by means of a positive clutch or equivalent device which will prevent slip. This form of instrument is not suited for speeds much over 250 r.p.m.

197 *Tachometer.* A tachometer indicates the instantaneous speed of a rotating shaft. If it is driven at the proper instrument speed through a set of gearing between the shaft under test and the instrument, it is suitable for measuring speeds from 6 to several thousand r.p.m. The use of gearing instead of pulleys and belts eliminates slip which may be a source of considerable error with belt driven tachometers. The instrument should be calibrated in any case.



(a) (b)

Fig. 110 Manometer for Differential Pressures

Transactions of the International Engineering Congress, 1915, Now Available

The transactions of the International Engineering Congress which was held in San Francisco simultaneously with the Exposition celebrating the opening of the Panama Canal are now available through the Engineering Societies' Library. These papers form a valuable contribution to any collection of modern engineering literature, since the congress both in scope and in character, was truly international.

The entire set of these transactions consists of eleven bound volumes, having for their subjects, The Panama Canal, Waterways and Irrigation, Municipal Engineering, Railway Engineering, Materials of Engineering Construction, Mechanical Engineering, Electrical Engineering and Hydroelectric Power Development, Mining Engineering Metallurgy, Naval Architecture and Marine Engineering, and Miscellany. It is accompanied by an index volume which gives an historical and statistical account of the congress, abstracts of all the papers which were presented and a very usable table of contents and author index. With the exception of the volume on the Panama Canal the treatment given each subject has been in the nature of a broad survey with some special reference to important lines of engineering advance. The papers are accompanied by a bibliography of the literature of each subject so that the reader can extend his research into any one of the topics treated.

Only a few complete sets are left but the library has quite a large number of some of the individual volumes and papers which it will gladly supply to those who wish to purchase them.

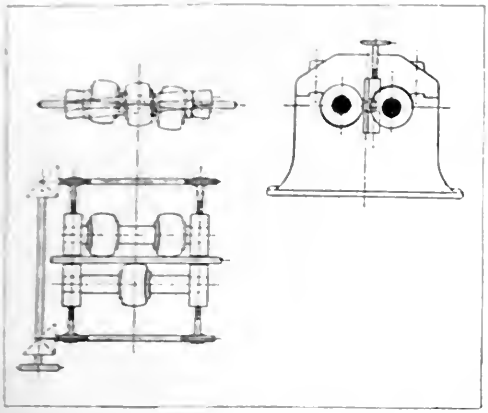
SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Friemel Cross-Rolling Mills

THE Friemel mills are designed for use on round iron, solid or hollow, where particularly high demands are made concerning the appearance and accuracy of measurement, and where a cross-rolling operation is effected after the main rolling process is finished. The Friemel cross-rolling mills are based on the same principle of operation as straightening machines, but differ from such cross-rolling mills as the Mannesmann inasmuch as the rolls are arranged not askew, but in parallel planes inclined to each other at certain angles determined by experiment.

The Friemel cross-rolling mills are chiefly used in the manufacture of tubes. The general effect of the machine is considerably enhanced by dividing one of the two rolls into two parts working on the same shaft, and then arranging the counter roll to fit into the gap between the two parts of the first roll (Figs. 1 to 3). With this arrangement of the rolls the material passing through the machine is forced to rotate around its own axis, and its exterior surface is subjected to a powerful treatment between the rolls.



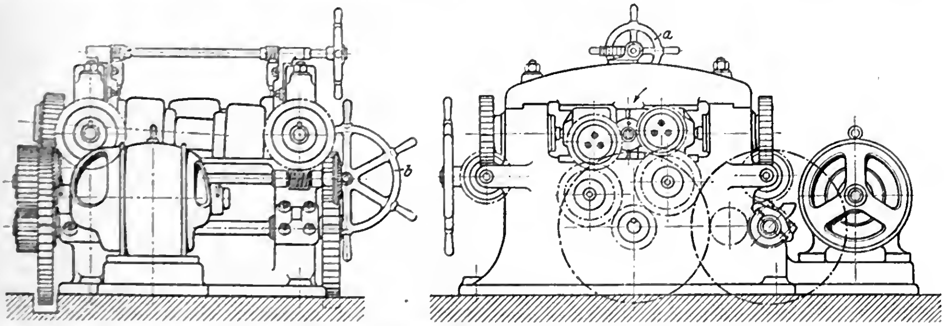
Figs. 1 to 3 Arrangement of Rolls in a Friemel Cross-Rolling Mill

It is claimed that the Friemel type of machine not only straightens the material but simultaneously unifies its diameter, and is therefore particularly suitable for finishing-off material intended to be worked later on turret lathes or automatic lathes. As the diameter of the entire piece is very uniform, no trouble is experienced afterwards in using conical grips or collets in machine tools.

Figs. 4 and 5 show a simple cross-rolling mill of the Friemel type. The machine has a powerful cast-iron frame, fitted with two guides for blocks containing the bearings of the rolls. On top the guides are covered over by strong lids, and between them the frame is designed in the shape of a trough, filled with water or oil as far as is necessary to let the rolls dip into the liquid. The blocks containing the bearings can be adjusted by means of screw-threaded spindles, particular care being taken in the design to make the blocks always move evenly toward the center of the machine, thus ensuring that the rod under treatment will never diverge from the exact center line of the machine in passing through it. The rolls must be adjusted in such a way as to exert a powerful pressure upon the rod which is being straightened.

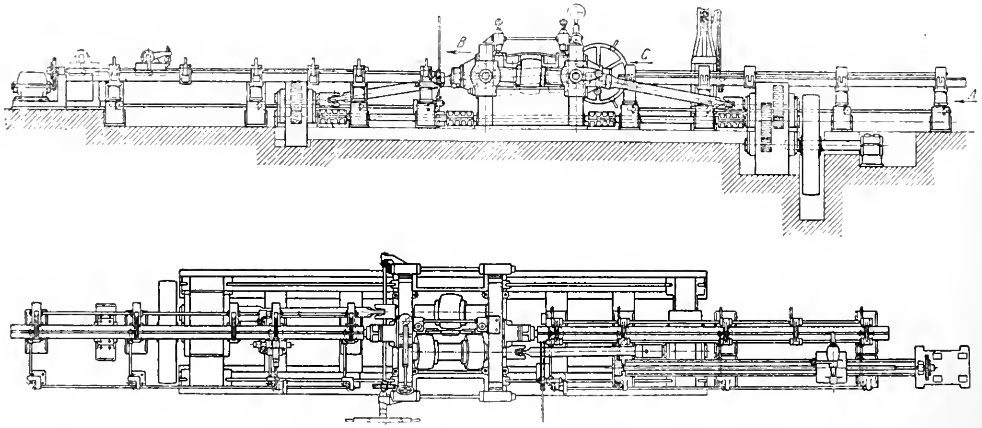
Between the rolls, the material to be straightened is guided in so-called polishing guides of iron, gunmetal, or wood, depending upon the kind of metal treated, as well as the desired exterior appearance of the finished rod. With the machine under discussion these polishing guides can be adjusted with absolute accuracy with respect to the center of the machine, in a direction vertical to the plane in which the rolls move when being adjusted. The working ledges of these guides are arranged to permit of easy exchanging. Both adjustments are effected by hand by means of worm wheels and threaded spindles. The two rolls, arranged on a joint shaft, can be shifted about on the latter, thus permitting adapting the distance between them to the thickness of the material passing through. The cross-rolling mill described is provided with individual electric drive through an intermediate spur-wheel gear. In view of the whole nature of the design, it was impossible to avoid using bevel spur-wheels for the gear. As the spur-wheel gear, forming a complete unit with the rolling mill, does not work very efficiently owing to the unsatisfactory conditions prevailing at the bearings, it has become more and more usual to employ an arrangement involving the use of separate spindle housings and intermediate shafts with ball-and-socket joints. Of course, the initial cost of this arrangement is somewhat higher, but this is soon compensated by the resulting reduction in wear and tear.

In addition to the actual Friemel cross-rolling mill, straightening plants of this kind also need guiding troughs. For small machines these simply consist of a strong angle or V-section, the latter being adjusted for height by means of threaded spindles; under ordinary circumstances this arrangement will fully serve its purpose. However, as a good deal of time is wasted in adjusting the various spindles separately, the troughs are frequently equipped with a joint drive for adjusting the spindles. To this end the nuts of the



Figs. 4 and 5 Friemel Cross-Rolling Mill for Round Iron Sections and Tubes

spindles are fitted in worm wheels, the driving worms themselves on the other hand all being arranged on a joint shaft. A further improvement consists in the trough being provided with lids which can be turned up, an arrangement to be commended especially for the feeding trough. These lids are intended to prevent the rod from jumping out of the trough. Experience has proved that long rods particularly have a great tendency to behave in this way owing to their passing through the machine unstraightened, while simultaneously rotating at a comparatively high speed. This leads to the rods knocking and lashing about wildly.



Figs. 6 and 7 Heavy Friemel Cross-Rolling Mill for Straightening Superfine Steel up to 150 mm. Diameter

To handle the heavy rods in large machines, it is well to equip the delivery trough with a transferring appliance. The latter simply consists of levers cutting into the trough, and arranged to be swung out of the trough together with the rod. The operation of the levers can either be made by hand or mechanically, i.e., electrically or hydraulically, depending on the size of the plant and the output. With machines designed for straightening hot and heavy rods, an inserting device located alongside the feeding trough will facilitate operations materially. Such an inserting device consists of a sliding table on some kind of a guide, motion being imparted to it by a threaded spindle with electric drive. A bracket fastened to the slide (with a set of springs between) extends into the trough, where it presses the rod forward and into the machine.


View A

View B

View C

Figs. 8 to 10 Detail Views of Parts of Figs. 6 and 7

Figs. 6 and 7 illustrate a Friemel machine of particularly powerful construction, designed for straightening highest-grade steel sections in the hot state, the machine being capable of dealing with sections up to diameter of 150 mm. (6 in.). The guiding troughs have a length of 6 m. (20 ft.) and the machine is driven by pinions and coupling pinions. A belt drive and jockey pulley are inserted between the driving gear proper and the motor. Most of the other special contrivances mentioned previously will also be found on this machine; but it has a common height adjustment for the spindles, raising and lowering the guiding troughs, turn-up lids on the troughs, as well as an inserting device.

The biggest Friemel cross-rolling mill hitherto built is capable of straightening tubes of ball-bearing steel in the cold state with an outside diameter up to 270 mm. (10.10 in.) and an internal diameter of 200 mm. (8 in.). This machine, which incidentally already possesses huge dimensions, was also provided with pinion drive and mechanical adjustment of the rolls. (*Engineering Progress*, vol. 3, no. 1, Jan., 1922, pp. 4–6, 12 figs., *d*)

Short Abstracts of the Month

AERONAUTICS

Goodyear Gear-Driven Airship. One of the important features of the new military airship built for the U. S. Army by the Goodyear Tire and Rubber Company is its gear drive from engine to propeller. In the past considerable difficulties have been experienced with such transmissions. There was heating up of the oil; excessive vibrations due to torsional reactions; and the tendency of the transmission to get out of step with the motors, resulting in excessive gear noise.

In designing the Goodyear transmission, it was decided to make the entire assembly one integral unit wherein the clutches, couplings, gears, shafts and propeller gear housing would be built together in the most direct manner. The transmission was designed with spiral bevel gears in which considerable experience was available in view of their popular use in the automobile industry. In the preliminary test run on a dynamometer it was found that there was an entire absence of gear hum and very little heating. To get an absolute measurement of efficiency of this unit, a large wooden stand was constructed upon which were mounted two Aero-marine 135-hp. motors with two clutches connected thereto, and additional elements to take up misalignment. A test load of 1000 lb. was hung on the propeller tip with the deflection of only 0.098. This was done to obtain an assurance that a propeller which weighs only 80 lb. would not cause any excessive bending movement on the transmission tube. (The tubes were cast of aluminum and heat treated.)

The transmission driven airship permits the motors to be placed within the car, thereby making them very accessible. In the case of non-rigid and semi-rigid airships, it permits Sirocco type fans to be attached directly to the motors, thereby permitting the elimination of scoops, which offer considerable resistance and add a large amount of weight. It permits any mechanical adjustments to the motors, and in the case of the above unit, a complete cylinder head could be removed while in flight. As the heating up in any transmission is a direct indication of power losses, due to the entire absence of this trouble in the Goodyear type transmission, it is conservatively estimated that an efficiency of 98 per cent is obtained

The fact that the propellers are 11 ft. in diameter, and have a pitch of 10 ft. 6 in., and also the reduction of head resistance and the absence of protruding members, should presage a considerable gain in the speed of the unit.

In view of the unit arrangement of the transmission, a reverse gear was inserted, permitting the propellers to be reversed without difficulty. The tractor-type propellers were so arranged as to permit the edge of the tube to be stream-lined. The radiators are to be set on bosses located on the tube, thereby placing them directly in the slip stream. The tractor type propellers offer the advantage of safety by keeping all these mechanical parts to the rear of the blade.

The characteristics of the unit are as follows:

Speed, m.p.h.	60
Rate of climb, ft. per min.	1000
Rate of descent, ft. per min	800
Cruising radius—full throttle, hr.	14
Cruising radius—reduced throttle, hr.	20
Percentage of useful load	39
Length, ft.	170
Diameter, ft.	48
Crew	7

While this unit is an experimental airship, it has proven, a decided improvement in the non-rigid type of airship, even with the enclosed car, transmission, reverse feature and two additional passengers. Ships of this design could be constructed up to 300,000 cu. ft. capacity without the slightest difficulty. The entire design adapts itself to the insertion of a rigid keel, which would permit ships up to at least 1,000,000 cu. ft. to be built, with a saving in structural weights and increased useful lift. (*Aerial Age Weekly*, vol. 14, no. 20, Jan. 23, 1922, pp. 473–474 and 479, 2 figs., *d*)

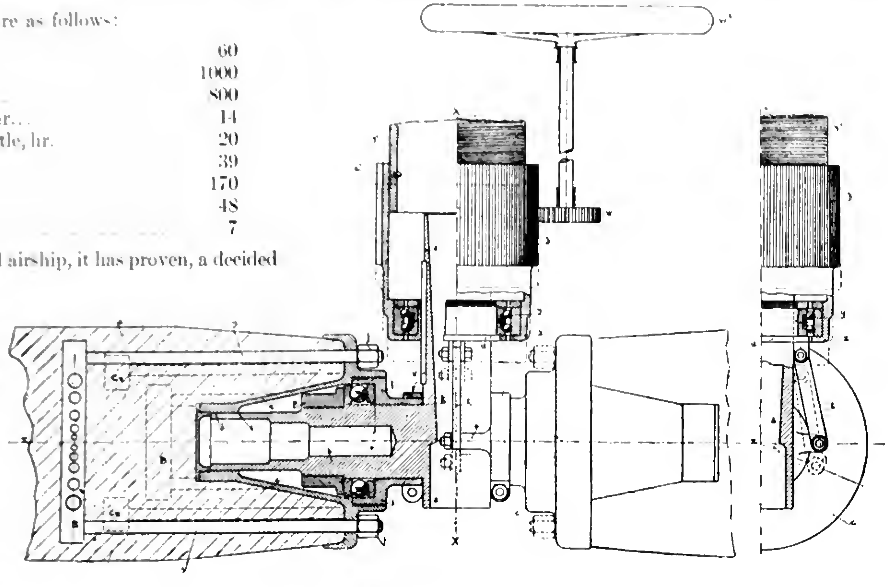


Fig. 1 Levasseur Variable-Pitch Propeller

Variable-Pitch Propeller

Levasseur Variable-Pitch Propeller. At the 1921 Aeronautical Exhibition in Paris, there was shown the variable-pitch propeller designed by Pierre Levasseur who has been identified with the aeronautical industry practically since its inception as an inventor and builder.

In the Levasseur variable-pitch propeller, the wooden hub is in compression from the inside instead of being held in compression from the outside.

The general view of the Levasseur propeller is shown in Fig. 1. The propeller blades are connected by anchor bolts, with castings mounted on lateral hollow shafts in the propeller hub. The pitch variation is carried out by displacement of these mountings on their respective shafts. The centrifugal forces are taken up by the ball bearing shown in the drawings.

Tests carried out in the laboratory of the School of Arts and Manufactures and at the Chalais-Meudon Field have shown that the new propeller gave satisfaction. The weight, at least in the first types, was somewhat greater than of a constant-pitch propeller, but a reduction is expected from an improvement in the design and material of the metal parts. A ten-hour test of the propeller run by a motor has shown that variations of pitch could be carried out under all conditions of operation without requiring any excessive muscular effort on the part of the pilot. It is pointed out that the development of the variable-pitch propeller will play an important part in the wider use of superchargers. (In this connection, attention may be called to the variable-pitch propeller developed at McCook Field, Dayton, Ohio, by the engineers of the Air Service of the United States Army and described in McCook Field and American Aeronautics, *Mechanical Engineering*, August, 1920, p. 442.) (*L'Aerophile*, vol. 29, nos. 23–24, Dec. 1–15, 1921, pp. 18–19, 2 figs., *dA*)

ENGINEERING MATERIALS (See also Machine Shop and Foundry)

A New Heat Resisting Alloy

Calite, New Heat-Resisting Alloy. It is stated that calite is a new alloy that melts at 2777 deg. fahr., softens at 2500 deg., and is safe to use at temperatures not exceeding 2200 deg. though it has been used at somewhat higher temperatures without bad results. Its specific heat is 0.123, thermal conductivity one-quarter that of iron, and elastic limit 36,800 lb. per sq. in.

Calite containers are used for carbonizing, annealing, heat treating and for the holding of molten lead, salts and cyanides.

From other sources information is available that calite readily casts into various shapes and can be ground, but is not suitable for machining. It should not be used in the presence of molten aluminum. No reliable data as to its composition are available. (*Coal Age*, vol. 21, no. 5, Feb. 2, 1922, p. 209, *d*)

High-Carbon Seamless Steel Tubing, W. W. Hackett. Data on experiments made on aeroplane tubing during the war. It was found then that excellent results could be obtained by using 0.5 per cent carbon—steel tubing, giving in the bright or glue state a yield point of 40 to 45 tons per sq. in., and an ultimate stress of 45 to 50 tons per sq. in. In the motor trade there was a disinclination to use these high-carbon steel tubes, which it was thought would necessarily be brittle. No extra care had been used in heat treatment, but the results of hundreds of tests carried out showed that 0.3 per cent carbon was always better than 0.15 per cent, and 0.5 invariably superior to 0.3 per cent. Details were given of a number of these tests. In one series 20-gage tubing made of 0.54 per cent carbon steel had practically as long a life under the same weight and shocks as 17-gage tubing manufactured of 0.338 per cent carbon steel. Figures were given showing the greater strength of high-carbon than of medium- and low-carbon steels. One experiment showed that a 20-gage high-carbon steel was practically as strong as a 15-gage low-carbon steel, though only half as thick. This was attributed to the fact that after undergoing the brazing process the elastic limit of a 0.5 per cent carbon steel was about twice as high as that of a 0.15 per cent carbon steel at the brazed joint, and consequently the high-carbon steel was able to stand much more stress than the low-carbon. It was also concluded that the high-carbon quality had twice the life of a low-carbon when subjected to the same fatigue. (Paper read before the Joint Meeting of the Institution of Automobile Engineers and the Birm-

ingham Metallurgical Society. Abstracted through *Iron and Coal Trades Review*, vol. 104, no. 2811, Jan. 13, 1922, p. 42, *et*)

Manufacture and Properties of Steel Plates Containing Zirconium and Other Elements, Geo. K. Burgess and R. W. Woodward. This investigation originated from the need of the Ordnance Departments of the Army and Navy for information regarding the effects on the ballistic properties of light armor plate, of certain chemical elements, such as zirconium.

A joint program was outlined according to which the Bureau of Mines was to produce and analyze ingots of the desired compositions; the Bureau of Standards to manufacture and heat-treat plates, to carry out physical tests, micro-examinations and chemical analyses, and develop methods of chemical analysis, when needed, for the more unusual elements in steel and in the presence of each other; and the Navy Department to carry out the ballistic tests.

Although the results of the ballistic tests are not available for publication, an account of the mechanical properties and tests of this series of somewhat unusual steels was considered worthy of publication. These results may be summarized as follows:

About 193 heats of steel containing in various combinations the following principal variable elements; carbon, silicon, nickel, aluminum, titanium, zirconium, cerium, boron, copper, cobalt, uranium, molybdenum, chromium and tungsten, have been studied.

None of the steels presented any difficulties in rolling into plate except those containing boron.

The usual mechanical properties and impact tests were carried out on all the steels. It is shown that steel containing 0.40 to 0.50 per cent carbon, 1.00 to 1.50 per cent silicon, 3.00 to 3.25 per cent nickel, and 0.60 to 0.80 manganese, and deoxidized with a simple deoxidizer such as aluminum, can be produced having a tensile strength of approximately 300,000 lb. per sq. in. and with excellent ductility and toughness. This type of steel is recommended for a structural material.

Although the same high properties are obtained in steels of the above composition with the aid of additional elements, it does not appear necessary to resort to such additions of expensive alloying elements.

Zirconium, like titanium and aluminum, acts primarily as a scavenger, and when it is not removed as part of the slag it remains in the steel in the form of square bright yellow inclusions not directly visible at magnifications lower than 500 diameter. It is not considered that these inclusions can be very beneficial, and if they are segregated and rolled out into thin plate-like streaks they may be deterimental, especially in armor plate.

Of the other elements that are regarded as special alloying additions, chromium, tungsten, vanadium and molybdenum go into solution and produce a martensitic pattern in the air-cooled specimens. Cerium and uranium act in a similar manner but also show characteristic inclusions. Copper goes into solution but a larger amount is required to produce a martensitic-pattern in the air-cooled samples than for the others. Boron forms a complex eutectic, probably that of an iron-carbon-baron compound with iron. This eutectic is fusible at the temperatures ordinarily used in rolling, but at slightly lower temperatures steel containing boron can be rolled successfully. Hot working breaks up the eutectic and spherical hard particles, similar to iron carbide globules, are formed. (Abstract of *Technologic Paper No. 207 of the Bureau of Standards, e*)

FOUNDRY

Air and Electric Molding Machine. Description of a machine in which air is used for ramming the sand in the molds, and electricity for rolling the flask and afterward drawing the pattern.

The reason advanced for retaining the air-ramming device rather than electrifying the machine entirely is that air gives a cushion shock when the table drops.

A lever at one end which can be thrown into, or out of engagement with a cam slot determines whether the table automatically rolls over in its upward or downward travel, or remains in the original position. In the ordinary routine of operation, the lever is thrown into engagement at the same time, or a few seconds before, the motor is started to raise the table. The flask is located on the table to permit of a slightly over-balanced load, and the table is rolled on its approximate center of gravity. The table swings through an arc of 180 deg. on its upward travel and the remaining 180 deg. on the down trip. The lever then is thrown out of engagement and when the motor is started again the table is raised vertical and rigid while drawing the pattern. The action is positive and instantaneous, and may be regulated to produce the very slowest speed desired when starting the pattern. Then when the pattern has been loosened it may be raised to full speed at the will of the operator. The entire operation of rolling to the table or drawing the pattern is under the control of the operator at all times and may be stopped at any point. Automatic contact points are provided at rolled three stages—where the plungers have reached the limit of their stroke either up or down and where the flask comes to rest on the transfer car. At either of these three points the power is cut off and the motor is brought to rest by a quick-acting brake operated by electricity. (*The Foundry*, vol. 50, no. 2, Jan. 15, 1922, pp. 75–76, 1 fig., *d*)

German and British Experience with Synthetic Cast Iron

Synthetic Cast Iron. By synthetic cast iron is meant material produced by recarburizing steel. His article describes in particular a series of trials made at the Rombach Works in Germany during the war. In these trials a cupola of about $37^1/_2$ in. diam. was used. It was charged with 2 tons of coke to a height of $7^3/_4$ in. above the tuyeres. After the blast was put on, more coke and 350 lb. burnt lime was charged. Then charges were put in, of 1100 lb. structural steel scrap, 200 lb. coke and 66 lb. lime, and with the first 5 tons of scrap, 900 lb. of 10 per cent ferrosilicon was charged. About three times the usual amount of slag was produced, and the slag was acid. Some runs were made without ferrosilicon but with more lime, ferrosilicon (110 lb., 75 per cent) being, however, added to the ladle when tapping.

In some of the tests the iron was too sluggish, and about one lb. of lime had to be added in each foundry ladle. In all cases it was found that the lining of the cupola was badly eaten away, the coke consumption was very high, and in addition to this, notwithstanding the high lime charge, high increase in sulphur was observed. The high coke consumption is due to the difficulty of melting low-carbon steel scrap in the cupola, and the high sulphur is due to the use of large amounts of coke.

If the coke consumption could be seriously reduced, then simultaneously all these difficulties could be removed. Liquid low-carbon metal was available from the steel works, and if the whole could be charged with molten iron the whole burden of melting would be removed, and only the carburizing remain.

On this hypothesis the following experiment was based: The first test was carried out in a pipe about $6^1/_2$ ft. long and 3 ft. 3 in. diameter, lined with one layer of ladle brick and provided with a bottom and a taphole. Before each test a fire was made, the whole pipe filled with coke, and the whole blown as hot as possible. Molten low-carbon basic Bessemer metal was then poured into the white-hot column of coke in the pipe. In order to prevent pits being formed in the coke the ladle was moved slightly during pouring, the coke thrown continuously into the stream of metal.

During the pouring, or shortly before, ferrosilicon and manganese were added. Five minutes after the filling with the 5 or 6 tons of molten metal, the taphole was opened and the metal teemed into the molds. The resultant iron was examined chemically and microscopically to ascertain whether the carbon was really combined, and not simply mechanically mixed with the iron. The results on several casts are shown in Table 1.

TABLE 1 SHOWING THE ANALYSES OF LIQUID STEEL RUN THROUGH A COLUMN OF COKE CONTAINED IN A PIPE

Si.	Mn.	Ph.	S.	C.
0.07	0.24	0.05	0.08	1.95
0.60	0.53	0.15	0.08	1.70
0.80	0.58	0.19	0.09	1.70
0.36	0.53	0.10	0.08	2.52

Similar results have been obtained with the corresponding tests carried out over a period of eight months. Only traces of mechanically included carbon have been found. The iron is extremely tough and shows a martensitic structure. The increase in phosphorus is interesting; an investigation showed this came from the slag carried over by the metal.

These experiments show that the metal must be hot and fluid, and the coke column thoroughly heated. Then there is no danger of the metal solidifying inside the coke column.

From the experience gained, a furnace similar to a cupola was built near the foundry-ladle track. At the charging-floor level, the furnace was equipped with a large door for charging coke on one side, and on the other side with a launder for the molten metal.

The furnace was provided with two sets of tuyeres and oil burners, through which blast could be blown for heating the coke. A receiver of about 25 tons capacity, heated with two tar-oil burners was provided. In front of the taphole lay the casting bed.

The *modus operandi* is to heat the receiver, and the hot gases ignite the coke in the shaft. As soon as the receiver and column of coke are sufficiently hot, a ladle of basic Bessemer steel is brought along and slowly poured down the launder, the charging door being kept closed. The metal runs down into the receiver, where it is mixed. Sometimes the process is carried out with the receiver taphole open so that the metal simply flows through it, but even this gives a uniform metal, the difference in carbon between the first and last cast being only 0.20 per cent. As soon as the metal is cast the shaft is refilled, and the furnace prepared for the next cast. Metal made in this way contains usually 2.6 to 2.8 per cent carbon, and corresponds to the so-called low-carbon special iron. The great toughness of this material is due to the metal being carburized at comparatively low temperatures.

Comparative synthetic tests with the Rombach synthetic pig iron, produced by the above process, and with Swedish charcoal pig iron, show that as produced experimentally the Rombach iron may be used as a substitute for the Swedish iron. However, the great advantage of the Swedish iron lies in its uniformity, and whether the same uniformity can be attained in the synthetic pig iron under commercial methods of production remains to be proved. The serious drawback of the Rombach iron is its spongy and rough appearance, which has not yet been eliminated. (*The Foundry Trade Journal*, vol. 25, no. 282, Jan. 12, 1922, pp. 29–30, *e*)

In this relation, attention is called to an editorial in the same issue (p. 25) to which reference is made to other processes of synthetic-pig-iron production developed during the war, primarily in Italy and France where cheap electric power and very large amounts of steel turnings were available at a time of great shortage of pig iron. In Great Britain there was another difficulty, namely, the shortage of Swedish white pig iron, which is one of the bases of Sheffield tool-steel manufacture. For making a synthetic iron in this case a most rigid specification had to be met, namely, sulphur and phosphorus below 0.02 per cent.

The manufacture of synthetic white pig iron of Swedish quality was investigated by Victor Stobie of Dunston-on-Tyne. Realizing that the intense reduction of the sulphurs associated with the building up of the carbon content meant the establishment of powerful reducing conditions, Mr. Stobie doubted whether the most expert slagging-off of the slag from a phosphorus-free bath could be accompanied sufficiently well to prevent the phosphorus from passing the 0.02 per cent mark on the introduction of reducing conditions. He therefore constructed two 20-ton stationary electric furnaces at two levels. The primary furnace, on the higher level, was the one in which melting and the refining based on oxidizing reactions was conducted; when the metal had been refined to the usual "slagging-off period" composition of C. 0.07, Si. 0.02, P. 0.009 and S. 0.03 to 0.06 per cent, a taphole was opened and the metal allowed to run into the secondary furnace, the slag on its appearance being diverted by a Y-shaped runner. In the secondary furnace the metal met an excess of pure carbon and lime, which set up intensely reducing conditions seldom met with in workshop metallurgy. No difficulty was experienced in reducing the sulphur to well within the limit, but though the phosphorus specification of 0.02 per cent was usually met, there was the same increase in phosphorus noted by the Rombach firm. In both this and Mr. Stobie's process the phosphoric slag will contain between 20 and 35 per cent of metallic iron, while the metal with which it is associated contains an unknown but possibly very high quantity of gas. Obviously, in the cold there would be a strong differentiation in the specific gravities of the two, but at steel-making temperatures they appear to be sufficiently near one another as to be at least partially miscible. Important progress in this line of work was made in France.

FUELS AND FIRING (See also Internal-Combustion Engineering)

GAS ENGINEERING

Gas Made by Carbonizing Straw, Harry E. Roethe. Description of the experimental unit installed on the Government farms at Arlington, Va., to be used by the Bureau of Chemistry. The retort is charged with unbaled straw through two oval openings at the front end, after which covered plates are tightly clamped in place. The heat is applied to the retort from beneath by the straw or wood in the firebox. Gas begins to come off when a temperature of about 200 deg. cent. (392 deg. fahr.) is reached, with the maximum production between 500 and 600 deg. cent. (932 and 1112 deg. fahr.).

Tests have shown that straw gas gives a very good light when used in gas mantle lamps, and that its use in gas hot-plates, stoves and heaters is very satisfactory. Excellent results have been obtained with the gas as a source of power for operating stationary internal-combustion engines. In this connection the gas apparently proves most satisfactory when mixed with little air and ignited under a compression slightly greater than that found in the ordinary stationary gasoline engine.

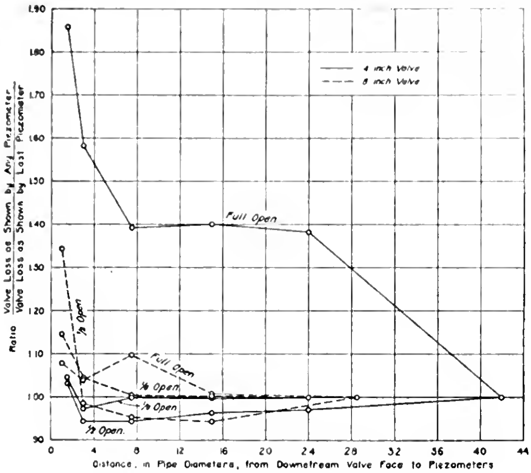


Fig. 2 Results of Experiments on Relation Between Piezometer Location and Measurement of Valve Loss

The article cites statistics which would indicate that important amounts of power could be secured from that material. (*Gas Age-Record*, vol. 49, no. 3, Jan. 21, 1922, pp. 75–76, 2 figs., *g*)

HOISTING MACHINERY (See Machine Parts and Design)

HYDRAULICS

Piezometer Location and Measurement of Valve Loss

Measurement of Valve Loss as Affected by Piezometer Location. Data of experiments carried out at the University of Wisconsin during the school year 1919–20 by M. C. Neel and C. A. Willson, thesis students, with a 4-in. and an 8-in. gate valve to determine the influence of the location of piezometer on the measurement of loss of head due to a valve.

The various piezometer openings along each main pipe were connected to a differential-gage board where the head differences could be read. The apparatus was first set up in each case without the valve in place, and the loss of head due to pipe friction only was determined. The valve was then inserted and the loss for valve and pipe determined for a number of valve openings. The results from 1/8, 1/2 and wide open conditions for both valves (4-in. and 8-in.) are shown in Fig. 2. From this it would appear that piezometers located within 3 diameters distance from the valve show in every

case an excessively large loss, and that in the region from 3 to 15 diameters downstream the disturbance of flow has caused the piezometers to register in an uncertain way.

Another figure in the original article appears to indicate that the loss is different from the normal pipe-friction loss for 40 or more diameters downstream, but when a point from 15 to 20 diameters has been passed this loss is negligible from a practical standpoint. It would also appear that there is in a section of the pipe a partial reconversion of the velocity head back into pressure head, indicated by a negative value of the loss. It is concluded that a valve causes disturbed flow in the pipeline downstream for some distance from it, and that a Piezometer opening, which is connected so as to be in this region, will be affected giving a false record of pressure within the pipe. It would appear, therefore, that the true loss is indicated only by the piezometer located at least 15 or 20 diameters of straight pipe from the valve. (*The Wisconsin Engineer*, vol. 26, no. 4, Jan., 1922, pp. 61–62, 4 figs., *e*)

INTERNAL-COMBUSTION ENGINEERING (See Railroad Engineering)

Deutz Compressorless Diesel Engine

The New Deutz Compressorless Diesel Engine, Schneider. The article is partly historical and partly descriptive. It describes and illustrates the new Deutz engine, as shown by a German patent application which has recently been vigorously and unsuccessfully contested, and also gives the previous history of the development of the art as shown by the patents to Brandis (1910 and following).

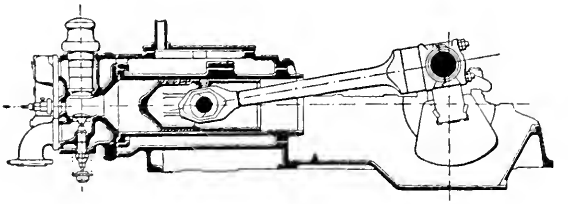


Fig. 3 Deutz Compressorless Diesel Engine

The Deutz compressorless Diesel engine is built horizontal, single-acting, 4-stroke cycle. The single-cylinder type is built in sizes of 8 to 100 hp. output and the double-cylinder for outputs from 130 to 250 hp. The basic principle of the design of this type of compressor is that an auxiliary element is used, usually placed at the end of the working cylinder and so arranged that it acts as an injector for the fuel. As shown in Fig. 3 this is effected in the following manner. A "restricted space" is provided between the cylinder proper and the combustion chamber, this restricted space is so shaped that the air flowing through it towards the combustion space moves, in the direction of the left front wall of the latter, in the form of a cone, the apex of which is located somewhere near the fuel-injection tube. The fuel-injection valve is extremely simple and no air-admission passages are needed. Neither are there any injection-valve needle, compressed-air injection flasks and the other accessories of compressed-air fuel-injection systems, which simplifies the entire design in a very material manner. (*Oel-u. Gasmachine, Motor Fahrzeuge*, vol. 18, no. 12, Dec., 1921, pp. 186–188, 4 figs., *hd*)

Kraus Fuel Oil Engine. The Kraus oil engine is an internal-combustion engine in which air is compressed in separate compression cylinders, mixed with the jet of atomized oil and ignited by an electric spark. Once this jet of gas has become ignited, it burns continuously and the resulting hot flame is brought into contact with small quantities of water which cool the gases to a working temperature. At the same time steam is generated, which, combined with the gases of combustion enters the power cylinders and performs work upon the pistons. This results in elimination of hot gases and excessive temperatures within the working cylinders. No special light fuel for starting is used, starting being accomplished directly with the oil without any previous heating by means of hand or mechanical cranking. Only one spark plug is used, and this only for igniting the initial jet of gas at the beginning of operations. Once this has been lighted it is no longer necessary. The motor is controlled by a simple throttle valve.

As regards water jackets, the cooling water enters the exhaust manifold, passes around the working cylinders and when heated to practically the boiling point, is admitted into the gas jet and converted to steam as mentioned before.

No experimental data as to power developed, fuel efficiency, amount of water used, etc., are given. The engine was exhibited at the Motor Boat Show in February, 1922, in New York City. (*Motor Boating*, Show Issue, Feb., 1922, p. 33, 1 fig., *d*)

Burning Mixtures of Alcohol and Gasoline in Internal-Combustion Engines. During the war the question of fuel for internal-combustion engines, especially those of the the automobile type, became a very acute one in France. Gasoline had to be imported from afar and it became necessary to determine whether fuel from some other sources could not be substituted for it or at least used to supplement its supplies. Even though no very large quantities of alcohol were in sight, it was decided that it would be desirable to determine the combustibility in automobile motors of mixtures of alcohol and gasoline, if only for use at some later date. The Department of Inventions asked to have this question investigated at the laboratory of the Technical Division of the Artillery, at that time under the command of Colonel Nicholardot. A report was prepared on the subject by this officer, well known as chemist and scientist, and the present article is a reprint of that memorandum. (Regarding the means by which this memorandum fell into the hands of the publishers, the latter state that they prefer to be silent in order to protect the vanities of certain French military services.)

The report investigates the following subjects: Variation of solubility of 90 per cent industrial alcohol in gasoline as determined by temperature; variation of solubility of alcohol as determined by the percentage of pure alcohol at ordinary temperatures, and for industrial alcohol, variation of solubility produced by the addition of certain quantities of ether, benzene, and benzol. Data of tests are given in the form of tables and curves.

The author comes to the conclusion that the minimum temperature at which the homogeneous system alcohol-American gasoline-benzol may exist, rises very rapidly with the water content of the alcohol. This immediately suggests a practical point, namely, that containers in which such mixtures are produced should be either carefully dried or rinsed in alcohol, the latter being then recovered. For an alcohol of a given degree of strength, the above minimum temperature of homogeneity is the lower, the greater the proportion of alcohol, the lighter the gasoline and the less the content of higher homologues (toluene, etc.) in the benzol. (*La Technique Automobile et Aerienne*, vol. 12, no. 115, 4th quarter of 1921, pp. 116–124, 6 figs., to be continued *et*)

MACHINE PARTS AND DESIGN

Double Helical Gearing, H. H. Broughton. Data on the strength of helical gearing, and particulars of a number of individual gears used for winders and haulages. In the original article two extensive tables give technical data of a number of helical gears that have been actually used, one of the tables referring to Citroen gears and the other to gears made by the Power Plant Company in England.

A typical split wheel is shown, to illustrate the method of registering the two halves by means of tool steel ferrules located at opposite ends of a diameter.

For a helical or herringbone gear of given dimensions, the moment of inertia of the teeth may be figured as 40 per cent of a hollow cylinder of the limiting dimensions, and the rim (exclusive of teeth) may be figured as a hollow cylinder. Adding 25 per cent of the sum of these two moments of inertia will make the necessary allowance for the hub and arms of the wheel. If the weight and pitch diameter only are given, the moment of inertia may be considered to be the moment of inertia due to 60 per cent of the total weight concentrated at the pitch circle. A numerical example of calculation is given. Concerning gears made by various manufacturers in England, the

author points out that the tooth, pitch and width of the wheels transmitting a given amount of power for a definite speed are by no means standardized, and a comparison of gears by four different makers is given which shows the very wide variation in practice. In particular, it is pointed out that not only is a different formula used for designing the pitch but different factors of safety are also employed. (The product of pitch and width varies directly as the factor of safety.) Thus, until quite recently one firm made it a practice to allow a factor of safety of 10 on peak loads, which corresponds to a factor of 15.5 on the rated horsepower of the motor. It should be remembered, however, that such high factors are necessary for securing durability and not actual strength or safety, so that really a durability factor, as distinct from a safety factor, is introduced. By adopting improved methods of manufacture and by careful selection of pinion material, a factor of safety of 5 or 6, reckoned on peak loads, may be regarded as sufficient to ensure satisfactory service.

A remarkable thing brought out by Table IV is that the cost of gears quoted by four firms to the same specification varied from 1183 to as high as 2875 pounds sterling. (*The Electrician*, vol. 88, no. 2278, Jan. 13, 1922, pp. 34–37, 1 fig., *dpc*) Serial article.

MACHINE SHOP

Making Spur Gears by Grinding

Grinding Hardened Gear Teeth. Description of the machinery and processes developed by a British concern (The Gear Grinding Co., Ltd., Handsworth, Birmingham, England) for finish-grinding spur-gear teeth to within definite limits of accuracy.

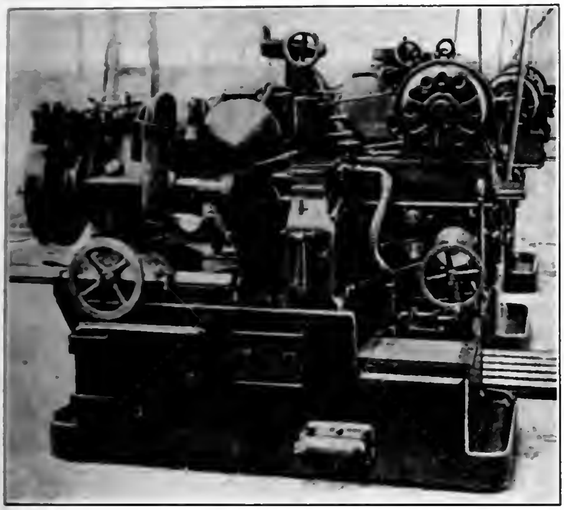


Fig. 4 General View of Machine for Finish Grinding Spur Gear Teeth

This grinding is done, of course, after heat treating, and it is stated that the finish on the surface of the work and the results obtained are far superior to the usual finishing of gear teeth with a hardened cutter.

In the present system, gashing the teeth has been reduced to a rough-milling operation, leaving on both sides of the tooth for finish grinding from 0.012 to 0.018 in. on small gears such as used in automobile gear boxes, and from 0.040 in. to 0.060 in. on large gears.

The machine is shown in Fig. 4. Briefly, the principle of operation consists of forming the edges of the grinding wheel to the desired profile of the gears being ground, and of controlling that form throughout the operation by trimming as the wheel becomes worn. In actual practice this is only necessary after the rough grinding has been completed. The bed of the machine has a reciprocating carriage at the rear, on which is mounted the wheel head. This carriage is driven by a link action, while the wheel head is fitted to a vertical slide in such a manner that end play is eliminated and the wheel head is only moved after retrimming the wheel as the cut is applied by raising the work to the wheel.

The work arbor is carried on the head shown to the left, and this also embodies the dividing mechanism for bringing each tooth into position. Both longitudinal and vertical adjustments are provided for this head—one for bringing the gear teeth into the desired position in relation to the traverse of the wheel-head, and the other for regulating the depth of cut.

This adjustment is very fine and is so arranged that extreme accuracy may be attained, and when the teeth on the first wheel of a batch have been ground to the correct depth, uniformity can be maintained throughout by working to the same setting.

It will be obvious that the degree of success obtained in the finished product depends to a great extent upon the efficiency of the indexing mechanism in the direction of precision and positive locking. A separate index-plate is, of course, required for different gears, and these are fitted to the end of the work arbor by a special type of holder which enables the notches to be set on either side in relation to the locking pawl, thereby reducing the stroke of the indexing pawl to a minimum.

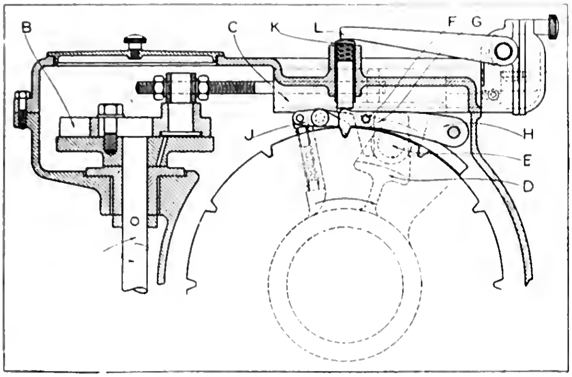


Fig. 5 Indexing Mechanism for Trimming Grinding Wheels of Gear Grinding Machine

A detailed view of this motion is shown in Fig. 5. This mechanism is actuated through the medium of the shaft *A* and the crank disk *B*, in conjunction with the sliding member *C*, which in turn operates the arm *D* through the pin *E*. Arrangements are made so that each revolution of the crank disk is synchronized with the traverse of the wheel carriage.

The dividing plate revolves in the direction indicated by the arrow, while the lever *D* travels in the opposite direction, and by reason of the small pin *F*, running on the cam face *G*, the locking pawl *H* is withdrawn from the notch, and is retained in the "open" position until the return stroke commences.

Moving simultaneously with the member *G* is the indexing pawl *J* and at the termination of the outward stroke it drops into the next notch, thus pulling the index-plate round one division on the return stroke, at the end of which the locking pawl is in its correct position over the notch. It is then pushed in by the action of the spring plunger *K*, and simultaneously the swinging lever *L* is brought into contact with the end of the plunger, firmly locking the whole mechanism until the end of the cutting stroke of the grinding wheel.

The length of stroke given the indexing pawl is regulated by moving the stud along the slot in the crank disk, while final setting is obtained by the nuts at the end of screwed portion of the sliding member *C*.

The wheel-trimming device consists of three diamonds, two arranged for trimming the concave flank edges of the grinding wheel and one for dealing with the edge that cuts on the bottom of the teeth. Means are provided to compensate for the receding of the edges of the wheel from the datum line as the wheel wears. Hitherto only spur gear wheels have been ground. It is stated that the machines here described are not made for sale, but to be used for

production purposes by the manufacturers themselves. (*Engineering Production*, vol. 4, no. 67, Jan. 12, 1922, pp. 42–44, 6 figs., *dA*)

MARINE ENGINEERING (See Steam Engineering)

The Bassett Process of Direct Manufacture of Steel from the Ore, Fritz Wuest. General discussion of the Bassett process, based on an address made by the author before the meeting of the Verein deutsche Eisenhuettenleute, November 26, 1921.

The article discusses the history of the effort to produce steel direct from the ore, and concludes that the process described cannot be carried out without losing in the slag a material part of the reduced iron. Furthermore, it is stated that the Bassett process is as little capable of securing complete reduction of metal from ore as the former processes for the direct reduction of steel. (*Stahl und Eisen*, vol. 41, no. 51, Dec. 22, 1921, pp. 1841–1848, 4 figs., *g*)

POWER-PLANT ENGINEERING

Pioneer Boilers Fired with Pulverized Coal, F. P. Coffin. An article on the history of the firing of boilers with pulverized coal. Among others, the author mentions the Bettington boiler, the boiler of the Erie City Iron Works, and of the American Locomotive Works.

Mention is made also of some of the work done in South America. (The Utilization of Coal on a Multiple Product Basis in Bacon and Hamor's book "American Fuels," abstracted through *Combustion*, vol. 6, no. 2, Feb., 1922, pp. 74–77 and 95, 2 figs., *h*)

Baffle Bridge for Cleaning Fire Under Boilers

The Gallagher-Crompton Baffle Bridge. A device for assisting in cleaning out fires under boilers.

The appliance consists of an extended platform of firebrick behind the grate, supported by standard sectional castings adapted to particular size of flue and type of grate, and inclining upwards towards the rear. The method of operation is as follows:

Without being previously burned down, the live fuel on the grate is pushed back by means of a rake on to the baffle bridge, and is there piled up, almost completely blocking the flue. The effect of this is that the cold air is prevented from entering the flues in large quantities, and combustion continues to a limited extent on the bridge. Thus the cooling of the flues is minimized and a higher percentage of CO_2 maintained. Further, the furnace door can be closed and the fire left in this condition for several minutes to allow the combustible remaining on the grate with the clinker to be burned off. The clinker and ash are now readily removed, and as the operations of the fireman are not hampered by the presence of live fuel on the grate, he is able to remove them more quickly and thoroughly than by the ordinary methods.

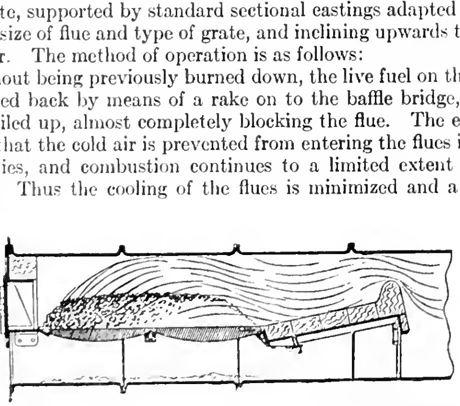


Fig. 6 Condition of Fire under Normal Methods of Cleaning

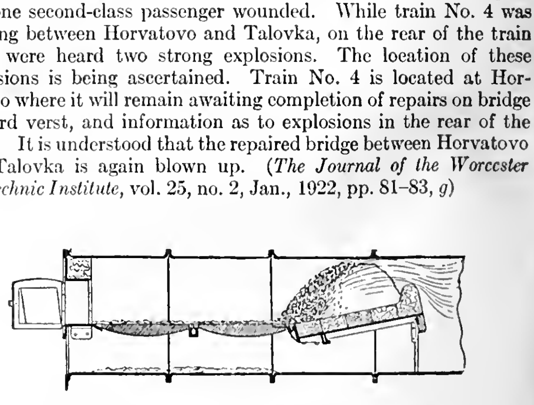


Fig. 7 Condition of Fire when Removing Clinker with Baffle Bridge

The next operation is to draw the live fuel forward again and redistribute it over the grate. Here again the baffle bridge offers advantages, for it is possible to save a much larger and hotter body of live fuel, thus enabling the firemen to recover normal furnace conditions in minimum time. Fig. 6 illustrates the condition of the fire under normal conditions, and Fig. 7 when the fire is pushed back ready for the clinker to be removed.

In tests in two plants, each comprising two Lancashire boilers and one plant equipped with the baffle bridges, it is claimed that an important saving in fuel was effected, notwithstanding the fact that in the plant equipped with baffle bridges only coke breeze was used, while the plant not so equipped used a mixture of coal and coke breeze. (*Iron and Coal Trades Review*, vol. 104, no. 2811, Jan. 13, 1922, p. 46, 3 figs., *d*)

RAILROAD ENGINEERING

Gasoline Switch Locomotive, L. C. Josephs, Jr. Description of a light-type switching locomotive, built by the International Motor Company, with many parts standard in the Mack trucks.

The locomotive is of the common steeple-cab type, with an engine located longitudinally at each end and an operating cab between, and the transmission located below the floor of the cab.

As the new engines face in opposite directions, their rotations are opposite. They are arranged, therefore, to drive through the regular clutch assemblies and bevel pinions to the opposite sides of the bevel gear on a shaft mounted across the locomotive. Thus, either one or both engines may be used as required, the clutches being controlled by adjacent pedals at the operating position. From this main bevel the drive passes through a simple reverser of the spur gear and jaw clutch type to the transmission. The driven end of this transmission carries a spur pinion geared to a cross jackshaft below, while the jackshaft carries four small sprockets and drives the locomotive axles by two 2-in. roller chains to each axle.

The locomotive on its initial test was able to start and accelerate the 600-ton train on level track. (*Railway Review*, vol. 70, no. 3, Jan. 21, 1922, pp. 82–84, 4 figs., *d*)

Railroading in Siberia, Col. Benj. O. Johnson. General discussion of the situation in Asiatic Russia. The following report is cited to give a sample of railroading under difficulties.

"The report received this morning from Pogranichya is to the effect that there was a bridge blown up at 4.30 a.m. on Ussury Ry., between Horvatovo and Lipovtzy stations. The track is damaged and eight wooden braces and the bridge foundation are also damaged, with the span in direction of Horvatovo brought down. Train No. 4 departed from Talovka on 72nd verst,[1] was fired upon, and one second-class passenger wounded. While train No. 4 was running between Horvatovo and Talovka, on the rear of the train there were heard two strong explosions. The location of these explosions is being ascertained. Train No. 4 is located at Horvatovo where it will remain awaiting completion of repairs on bridge on 53rd verst, and information as to explosions in the rear of the train. It is understood that the repaired bridge between Horvatovo and Talovka is again blown up. (*The Journal of the Worcester Polytechnic Institute*, vol. 25, no. 2, Jan., 1922, pp. 81–83, *g*)

SPECIAL MACHINERY

Cutting Metal Under Water by Acetylene Torch

Blow Pipe for Under Water Working. British Patent No. 168,929, blow pipe, designed primarily to enable oxyacetylene welding and cutting to be carried out under water. Briefly, the principle consists in utilizing compressed air to form a water-free zone around the flame of the blow pipe. The essential part is a casing having internal spiral vanes arranged so that compressed air, in passing from the rear of the casing, issues around the nozzle with a cyclonic or spiral effect, giving a region of maximum pressure at a point below the nozzle. For mounting the casing, a back plate is attached to the burner by means of a union nut, while the plate itself carries an internally screwed ring, which may be rotated to provide axial adjustment for the casing without rotation of this member relatively to the burner.

A pipe secured to the stem of the blow pipe supplies the compressed air to the space at the rear of the casing, suitable ports being provided as shown. The burner is then completed by a cup-shaped cap screwed to the outer end of the casing, and this cap may have a

---

[1] One verst = two-thirds of a mile.

series of recesses across the outer edge, or it may be provided with projections to prevent the face from being pressed into close contact with the work. (Abstracted through *Engineering Production*, vol. 4, no. 66, Jan. 5, 1922, p. 21, 1 fig., *d*)

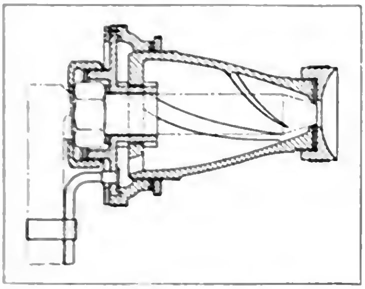


Fig. 8 Blow Pipe for Oxyacetylene Welding and Cutting Under Water

STEAM ENGINEERING

Hawthorn-Armstrong Marine Water-Tube Boiler with Superheater

Hawthorn-Armstrong Water-Tube Boiler for Merchant Ships. The purpose of the new boiler is to combine the steam generator and the superheater in one unit. Apart from the superheater elements, the new boiler has the main characteristics of the Yarrow type, but is provided with larger water surfaces and steam spaces than is usual in water-tube boilers of the ordinary type. Also, the circulation in evaporating elements is always continuous and in one direction, the outside tubes forming downcomers and thus establishing a figure-eight circulation through the cross tubes at high velocity, which scours the insides and prevents deposit even with poor feedwater.

The construction, Fig. 9, consists of four drums, *A*, which, together with the $1^3/_8$-in. diameter tubes, *B*, form the evaporating unit connected together crosswise by the tubes interlaced with each other, and three rows of downcomer tubes *C* which form the water wall at the sides.

The combustion chamber is formed under the evaporating tubes *BB*, and between the two lower water pockets *AA*.

Incorporated with the evaporating unit are the superheating tubes *FF*, which are connected to the two lower pockets *GG*, and one large central steam drum *F*, the latter being divided into three parts, *JJK*, the middle portion *K* being the superheat container, and the two wing portions *JJ* forming the passage, by way of the pipes *NN*, for saturated steam down to the lower pockets *GG* of the superheater through a portion of the tube and rising up to the central portion of the drum through the remainder of the superheating tubes *FF*, the steam being superheated in its passage through the small tubes *FF*. These tubes are 1 in. in diameter.

The experiment was made with the boiler worked with auxiliary feed make-up from water containing a large proportion of chalk and lime in solution, and also from sea water. After three weeks of continuous run the boiler was opened up; all the deposit was found in the lower drums and nothing in the tubes.

The arrangement of the superheater element is such that by manipulating three stop valves this portion can be converted into a saturated steam producer, either to supplement the total steam supply or as a precaution against damage to superheater tubes when lying under banked fires or when working engines in or out of port; that is, when little or no circulation takes place in the superheater tubes. (*The Marine Engineer and Naval Architect*, vol. 45, no. 532, Jan., 1922, pp. 10–11 and 40, 2 figs., *d*)

TESTING AND MEASUREMENTS (See Hydraulics)

The Application of the Ultra-Micrometer to the Measurement of Small Increments of Temperature, W. Sucksmith. The ultra-micrometer invented by Prof. R. Whiddington was described in *Mechanical Engineering*, Jan., 1921, p. 49. It is an instrument working with two oscillating valve circuits and measuring up to one-two-hundredth of a millionth part of an inch. In one of the circuits there is a condenser consisting of two parallel plates, and the variation in the distance of these plates produces variations in the note emitted from a telephone, thus affording a basis of measurement.

In the present experiments the method used was to attach a metal bar or tube to one of the condenser plates and measure change in the temperature of the bar by the change in the note produced in the telephone which in turn was produced by the change in length of the bar. The original article describes the installation in detail. The copper tube on which the measurement was made was heated electrically. It was found that the arrangement is capable of detecting a change of temperature of the order of one sixteen-thousandth part of a deg. cent., and it was observed that while the heating current was flowing the note emitted by the telephone changed very smoothly, showing that no discontinuity in expansion could be detected, even with an apparatus capable of measuring one two-hundredth of a millionth part of an inch.

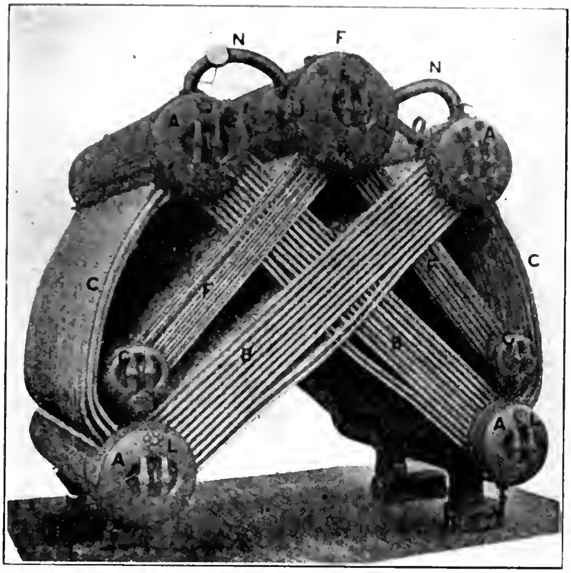


Fig. 9 Hawthorn-Armstrong Marine Water-Tube Boiler with Superheater Element

It may be mentioned in this connection that the possibility of applying the ultra-micrometer to the investigation of the relation between temperature and expansion of metals for very small increments of the former was pointed out in an editorial in *Mechanical Engineering*, Jan., 1921, p. 59, commenting on Professor Whiddington's ultra-micrometer. (*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, vol. 43 (6th series) no. 253, Jan., 1922, pp. 223–226, 2 figs., *ct*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

By introducing heat rapidly into the coal, and thus bringing about an immediate decomposition of the hydrocarbons in the cold coal, a concern at Granite City, Ill., succeeded in producing metallurgical coke from 100 per cent Illinois coal, hitherto considered as non-coking. The new product has been tried in the laboratory and in the blast furnace, and is said to have given excellent results. For further information see Making Coke from Illinois Coal, by M. W. Ditto, *Iron Trade Review*, March 9, 1922 (vol. 70, no. 10).

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 355, 375 (reopened), 377 to 383 inclusive, as formulated at the meeting of January 19, 1922, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 355

Inquiry: An interpretation is requested of the application of the formulas in the Boiler Code for crown bars to a form of reinforcement for crown sheets where the top sheet of the fire box is a half of a true circle and is braced with arch bars extending over the top and down below the top row of staybolts at the sides, these arch bars being riveted to the water side of the crown sheet through thimbles. Recommendations of the Boiler Code Committee are requested covering low pressure steam heating boilers, as well as high pressure boilers.

Reply: This construction is not covered by the Code, but when the unstayed portion of the crown sheet does not exceed 120 deg. in arc, it is recommended that the maximum allowable working pressure should be determined by adding to the maximum allowable working pressure for a plain circular furnace of the same thickness, diameter and length by the formula in Par. 239, the pressure P_1 determined from the following formula, which is a modification of that in Par. 241, section *a:*

$$P_1 = 10{,}000{,}000\ \frac{b \times d^3}{p \times D^3}$$

where

b = width of crown bar, in.
d = depth of crown bar, in.
p = longitudinal pitch of crown bar, in.
D = outside diameter of furnace, in.

providing that the maximum allowable working pressure must not exceed that determined by the formula for furnaces of the Adamson type, in Par. 242 when L is made equal to p, and also providing that the diameter of the holes for the staybolts in the crown bars does not exceed $^1/_3\ b$, and the cross-sectional area of the crown bars is not less than 4 sq. in. Par. 199 would govern the spacing of the staybolts, rivets or bolts attaching the sheet to the bars.

CASE NO. 375 (REOPENED)

Inquiry: Is it permissible, under the requirements of the Boiler Code, to weld a seam in a vertical fire box not over 38 in. in diameter and in length ranging from 20 in. up, by the autogenous or fusion process where the fire box has no support other than the tube sheet, mud ring and fire door?

Reply: It is the opinion of the Committee that, under the requirements of the Code, autogenous or fusion welding is not permissible for the seam in the firebox of a vertical-tubular boiler, unless the sheet containing the seam is properly supported by staybolting or other form of construction.

CASE NO. 377

Inquiry: An opinion is requested from the Boiler Code Committee concerning the applicability of Par. 428 of the Code relative to the composition of the tin filling for fusible plugs, if used, where the boiler is to be operated under a working pressure of from 350 to 500 lb. per sq. in., so that the temperature of the steam under working conditions will be far above that specified for the melting point of tin.

Reply: There is nothing in the Code pertaining to the use of fusible plugs on boilers operated at pressures involving temperatures near or above the melting point of tin. It is accordingly proposed to revise Par. 428 by the addition of the following:

> Where the boilers are to be operated at working pressures in excess of 225 lb. per sq. in. gage, the use of fusible plugs is not advisable.

CASE NO. 378

Inquiry: If an internal boiler feed pipe enters at full size into a steam and water drum and then into a closed vessel within the drum, wherein the end of said feed pipe is open and the said closed vessel has a series of openings, accessible for inspection and the combined areas of which openings are largely in excess of the open end of the pipe, and means are provided for blowing down the interior closed vessel, does the construction meet the requirements of Par. 314 of the Code?

Reply: If the closed vessel within the drum, into which the open end of the feed pipe projects, has openings largely in excess of the area of the open end of the pipe so that there may be no possibility for them to become clogged by incrustation and providing the vessel has means for blowing down in cleaning, it is the opinion of the Committee that the construction described will meet the requirements of Par. 314.

CASE NO. 379

Inquiry: Would it meet the requirements of the A.S.M.E. Boiler Code for an authorized inspector to stamp a boiler as a 200 lb. pressure boiler if the same meets all the requirements regarding the boiler proper but the cross connection between the drums is composed of extra-heavy pipe and extra heavy flanged cast iron fittings?

Reply: It is the opinion of the Committee that a boiler so fitted with the cross connection using extra-heavy cast-iron fittings would not meet the requirements of Par. 9 of the Code.

CASE NO. 380

Inquiry: Is it necessary, under the requirement of Par. 336*b* of the Boiler Code, that a boiler head must be stamped by the manufacturer in two places when it is less than 12 in. in diameter and, due to the tube spacing, it is impossible to find room for more than one stamping?

Reply: It is the opinion of the Committee that as long as there is one stamp legible on a miniature boiler, the intent of the Code is met, where the parts are so small that it is impossible to apply two stamps.

CASE NO. 381

Inquiry: An interpretation is requested of the requirement in the last sentence of Par. 257 that calking shall be done with a round-nosed tool, where a form of flat-faced tool of the full width of the plate is being successfully used so as to thicken out or upset the end of the plate with pressure, instead of hammering It is pointed out that with this method there is no danger of scoring or damaging the plate underneath the calking edge and the result is a very firm and effective result in calking.

Reply: It was the intent of the Committee in imposing this requirement that calking should be done so that the plate at or beneath the calking edge will not be scored or damaged. If the tool is of such shape as to upset or compress the edge of the plate without splitting it and will not score or damage the adjacent plate, the requirements of this paragraph may be considered as fully met.

CASE NO. 382

Inquiry: Is it not permissible, under the requirements of Par. 180 of the Code, to use plate thicknesses for the shells and tube

sheets of h.r.t. boilers thinner than those specified in Pars. 18 and 20, provided the maximum allowable working pressure formula gives the desired pressure with a factor of safety of 5?

Reply: It is the opinion of the Committee that it is not permissible under the rules of the Code, to use plate thicknesses in any case for shells or tube sheets less than the minimum thicknesses specified in Pars. 18 and 20 of the Code.

Case No. 383

Inquiry: Par. L-18 states in the first sentence that the gage thickness of the tubes shall not be less than a certain amount. In the second sentence it states that the gage thickness shall be measured by the B. W. gage and the thickness at any section must not vary more than one gage below or one gage above that specified. Does this require using one gage heavier than the nominal gage in order to meet the requirements?

Reply: The intent of the Committee in formulating this rule was that the gage thickness referred to in the first paragraph of L-18 of the Locomotive Code, described a nominal gage to be used. The gage thickness referred to in the second paragraph specifies that whichever gage is used, the limitations are minus one gage and plus one gage. Therefore, if a particular gage is specified for the boiler tube, the limits in gaging are one gage less and one gage more than that specified.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Cement and other Building Materials A3-22. Effect of Moisture Content upon the Expansion and Contraction of Plain and Reinforced Concrete. While the properties of concrete have been investigated for many years, attention has largely been given to considerations of strength alone. Studies of the less important properties, however, are also needed to explain phenomena that are observed in reinforced concrete structures, and to give information on questions relating to the appearance and durability of the material.

Aside from the action of direct load, deformations are produced in concrete by changes in temperature and in moisture content. With reference to temperature changes in reinforced concrete, it is well known that, regardless of differences in the mixture, concrete has practically the same coefficient of expansion as steel, so that the two materials contract or expand together. Moisture content, on the other hand, has the undesirable property of affecting concrete alone. Concrete, like wood, clay, and some other materials, expands when it absorbs moisture and contracts when it is dried; steel has no such action. After the concrete is poured the steel remains unchanged with changes in moisture conditions, while concrete ordinarily shrinks a considerable amount. Aside from the stresses set up in steel and concrete by the shrinkage of the latter, the resulting formation of cracks large or small will produce a condition which may be favorable to the corrosion of the steel or the disintegration of the concrete after repeated changes from dry to wet condition.

The tests which are described were made to investigate the amount of shrinkage which may be expected in a mortar or a concrete, the relation between the change of moisture content and the change of length of these materials, the difference in shrinkage of plain and reinforced concrete, and the internal stresses set up in the latter. For purposes of comparison with the results obtained with concrete, a few tests were made on the effect of the absorption of water by sandstone and limestone.

The paper contains numerous plots which present clearly to the eye the data obtained. It also contains a theoretical discussion of Shrinkage Stresses in Reinforced Concrete and closes with the following comments in the form of conclusions.

1 Concrete expands when it absorbs moisture and contracts when it is dried. Concrete of a 1:2:4 mixture is likely to contract during hardening as much as 0.05 per cent in an ordinary structure.

2 Contraction of concrete by the loss of moisture causes stress in the concrete when it is restrained by an external force. The amount of this stress is not as small as is generally supposed.

3 The shrinkage stress caused in the steel in reinforced concrete may reach the usually accepted working stress of steel when the amount of reinforcement is less than 1.5 per cent.

4 The shrinkage stress developed in 1:2:4 concrete may reach the ultimate tensile strength of the concrete when the amount of reinforcement is greater than 1.5 per cent. With richer mixtures the increase in shrinkage stress may be relatively greater than the increase in ultimate strength.

5 The greater the percentage of reinforcement the greater the tensile stress that may develop in the concrete, and concrete having a higher percentage of reinforcement than 1.5 per cent is likely to have cracks formed unless proper provision is made.

6 In reinforced concrete out of doors, subject to alternate wet and dry conditions, cracks may readily be formed under the repeated stress which is nearly equal to the tensile strength of the concrete.

7 Reinforced concrete does not appear likely to be a durable material in a place where a corrosive influence on steel such as sea air is active, unless proper protection against the formation of shrinkage cracks is made.

8 It is suggested that the prevention of shrinkage stress in concrete might be accomplished in two ways, either by finding a cement giving less expansion and contraction, or by the use of a perfect water-proofing treatment.

9 It may be expected that an integral waterproofing compound might lessen the change of volume for a short time, but it would not prevent the final diffusion of moisture with consequent change in volume.

This paper is issued as Bulletin No. 126 of the Engineering Experiment Station of the University of Illinios, Urbana, Illinios. Price, 25 cents.

Fatty Oils, Fats and Soaps, A1-22. Cutting Fluids. See *Machine Tools A1-22.*

Heat A3-22. Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel and Aluminum. The increasing use of nickel, monel metal, stellite, stainless steel, and aluminum for spark plugs, steam valves, automobiles, and in household and surgical appliances has created a considerable demand for the accurate determination of the thermal expansion of these metals and alloys.

Scientific Paper No. 426 of the Bureau of Standards, which will soon be for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents per copy, considers this subject fully. Ten samples of commercial nickel containing from 94 to 99 per cent nickel, 5 of which were heat rolled and 5 heat rolled and annealed, 10 samples of monel metal, 60 to 69 per cent nickel, of which 2 samples were cast, 3 hot rolled, and the remaining of various compositions and treatments, 5 samples of stellite of different grades, 2 samples of stainless steel, and 2 samples of 99.4 per cent aluminum were used in the work. The conclusions should prove of assistance to engineers using these metals in connection with varying temperatures.

Machine Tools A1-22. Cutting Fluids. Technologic Paper No. 204 of the Bureau of Standards is divided into two parts, theory and practice. In the first part, the difficulties attending the proper lubrication of the cutting tool in machine work are described, and the reasons why lard oil is particularly suitable for this work are set forth. It is shown that the viscosity of an oil is not the only factor to be considered in this connection. Oils for cutting purposes should have a high adhesion, and it seems possible to improve mineral oils by adding such fluids as oleic acid, pine oil, and fixed oil.

An important function of cutting fluids is to cool the tool and chip, and for this purpose alone water with its high specific heat is well suited but it rusts the machines, and for this reason where water is used such alkaline substances as soda or soap are always added. In conclusion, part 1 suggests methods for the measurement of the adhesion of oils.

Part 2, practice, considers the correspondence which the Bureau conducted with many large machine shops throughout the country as to their experience with cutting fluids. The different kinds of oil which have been used for this purpose are listed, and attention is given to the possibility of using emulsions made up of mineral oil compounded with neutralized sulfonated oil and formed into a permanent emulsion with water.

Mineral oils compounded with alcoholic solutions of soap and a thick soap solution and mineral oil, marketed as a paste, are also described. In choosing any cutting fluid, it is pointed out that the character of the metal to be worked should be considered. Brittle metals, such as cast iron, are easier to lubricate than the so-called

"draggy" metals, such as soft steel and wrought iron. This Paper may be obtained at 15 cents a copy by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C.

Paints, Varnishes and Resins A3-22. Preservation of Mine Timber. One of the recently issued Reports of Investigations of the Bureau of Mines is devoted to a study of the Growing Need for Preservation of Mine Timber. This report is written by Mr. R. R. Hornor a mining engineer of the Bureau. After demonstrating the large quantity of timber used in Mines the author discusses the decrease in the supply and quality of timber and the consequent need for general timber conservation.

The average life of untreated wooden surface structures is placed at 10 to 12 years; however, the average life of timber entering into mine and mill equipment subjected to replacement from decay is probably not over 6 to 8 years. Assuming the average period of usefulness of all kinds of mine construction is 20 years, then the timber subjected to decay will require replacement at least once during its period of service, in the case of surface structures, and twice in case of mine and mill equipment.

With proper preservative treatment of the original timber entering into this construction, it could be made to last throughout the entire period of service, thus effecting an important saving in the cost of material and labor.

To determine the advisability and economy of treating underground timber, also timber used in surface structures and equipment Barth formulated a rule which is substantially as follows: Timber that is permanent in character; that is which is not exposed to destruction by mechanical wear or crushing before the expiration of its natural life, or the usefulness of which does not cease before the advantages of chemical preservation can be realized, should be treated. Bureau of Mines, Washington, D. C., address H. Foster Bain, Director.

Petroleum, Asphalt, and Wood Products A3-22. Preservation of Mine Timber. See *Paints, Varnishes and Resins A3-22.*

Railroad Rolling Stock and Accessories A1-22. Thermal Stresses in Steel Car Wheels. See *Heat A2-22.*

Safety Devices A2-22. Survey of Elevator Interlocks in U. S. Technologic Paper No. 202 of the Bureau of Standards prepared by C. E. Oakes and J. A. Dickinson is entitled Results of a Survey of Elevator Interlocks and an Analysis of Elevator Accident Statistics.

This report gives the results of a field survey of several thousand elevator landings equipped with various types of mechanical and electromechanical interlocks and contact devices. The survey was conducted in connection with the preparation of an elevator safety code, in which work the Bureau of Standards engineers have coöperated with engineers of The American Society of Mechanical Engineers. The elevators are classified as follows: A, elevators in buildings having heavy service and where maintenance service is provided; B, elevators located in buildings where the service is heavy but without maintenance; and C, elevators on which the service is light and for which no maintenance service is provided. The statistics show that 73.8 per cent of all fatal accidents might be prevented by well-designed interlocks. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.

Steel Its Treatment and Products A3-22. Tensile Properties of Some Structural Alloy at High Temperatures. An investigation of this subject has been recently made by the Bureau of Standards and the results have been published as Technologic Paper No. 205. In this Paper the results are given of a number of determinations of tensile strength, proportional limit, elongation, reduction of area, and strength at fracture throughout the range 20 to 500 deg. cent. for 4 steels containing about 0.38 per cent carbon as follows: (*a*) Plain carbon steel; (*b*) 3½ per cent nickel steel; (c) 3 per cent nickel and 1 per cent chromium steel, and (*d*) 1 per cent chromium 0.2 per cent vanadium steel.

Brief reference is made to the types of fractures made in testing steels at various temperatures, and particular attention is paid to comparison of the tensile properties of these alloys at 550 deg. cent. Of the 4 steels tested in normalized condition, it appears that the two alloys containing chromium show greater resistance to weakening by increase in temperature to about 550 deg. cent. than either the plain carbon or 3½ per cent nickel steels, and at this high temperature the chromium vanadium steel is to be preferred from the standpoint of high tensile strength and limit of proportionality. The carbon and 3½ per cent nickel steels behaved alike with rise in temperature above that of the room and at about 550 deg. cent. the addition of 3½ per cent nickel appears to have but little effect upon the strength of the carbon steel. For copies of this Paper address the Superintendent of Documents Government Printing Office, Washington, D. C., 5 cents a copy.

Steel, Its Treatment and Products A1-22. Gas Cylinders. See *Gases, General A1-22.*

Transportation A1-22. Survey of Elevator Interlocks in U. S. See *Safety Devices A2-22.*

Welding A1-22. Oxyacetylene Welding and Cutting Blow-pipes. A very thorough investigation of oxyacetylene welding and cutting blowpipes was conducted by the Bureau of Standards at the request of the War Department. In this investigation special reference was given to their economy in operation, safety and design. Apparatus from 14 different manufacturers was submitted to test, and the character of the test was only decided upon after a thorough study had been made of the various operations in which these blowpipes are used.

The tests to which all the blowpipes were submitted were developed with the idea of minimizing the personal equation of the operator and securing data which were representative only of the blowpipe itself. In order to accomplish this result, a rather elaborate testing equipment, consisting of a weighing system, gage board equipment, welding table, cutting table, and safety flashback testing apparatus was designed and used throughout the investigation.

The paper describes in detail these various parts of the equipment and then considers the different classes of tests which were used for the cutting and for the welding blowpipes. The conclusions arrived at as a result of this work should prove of considerable assistance in improving the design of apparatus of this kind, with the object of securing better work, greater economy, and increased safety to the operator.

This investigation is fully described in Technologic Paper No. 200 of the Bureau of Standards, for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 35 cents a copy.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Heat Transmission B1-22. Heat Transmission through Insulation of Dynamo-electric Machinery. A study of heat transmission through insulation, the dissipation of heat from surfaces, and the problems relating to air flow which are involved in the construction of dynamo-electric machinery is being made by the Research Department of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. Address Mr. C. E. Skinner, Manager.

Highways B2-22. Tractive Resistance of Concrete Roads. See *Transportation B2-22.*

Oils B1-22. Physical and Chemical Characteristics of Oils used in meter bearings is one of the problems which are receiving attention of the Research Department of the Sangamo Electric Co., Springfield, Illinois. Address Mr. F. C. Holk, Chief Engineer.

Paints, Varnishes and Resins B2-22. The properties of Paints and Varnishes as well as those of all insulating materials employed in the construction of electric machinery are being investigated by the Research Department of the Sangamo Electric Co., Springfield, Illinois. Address Mr. F. C. Holk, Chief Engineer.

Transportation B2-22. Tractive Resistance of Concrete Roads. The tractive resistance of Concrete roads to motor vehicles is now under investigation. In the tests 1½ and 3-ton Army trucks and trailer and 7.5 ton Mack are used at variable loads and speeds with varied tire equipment, including measurement of vibrations in road material. Tire losses and internal vehicle losses are being determined in the Mason Laboratory, Yale University; the road tests are made conducted in both Connecticut and Massachusetts under Sub-Committee on Tractive Resistance of Roads, representing the War Department, Bureau of Public Roads, Highway Commissions of Conn. and Mass. Institute of Technology, Harvard University, Yale University, Society of Automotive Engineers, and National Research Council Committee on Economic Theory of Highway Improvement. Address: Major Mark L. Ireland, Q. M. C., U. S. A., Director, Room 10-219, Massachusetts Institute of Technology, Cambridge, 39, Mass.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Mining F1-22. Subject List of Reports of Investigations. Serial No. 2316 of the Reports of Investigations issued monthly by the Bureau of Mines. This list covers all reports issued up to December 31, 1921. Address Bureau of Mines, Washington, D. C., Mr. H. Foster Bain, Director.

Petroleum, Asphalt and Wood Products F2-22. Petroleum and Allied Substances. Reports of Investigations of the Bureau of Mines Serial No. 2317. This is a continuation of the bibliography reported in the March issue as Serial No. 2305. Address Bureau of Mines, Washington, D. C., Mr. H. Foster Bain, Director.

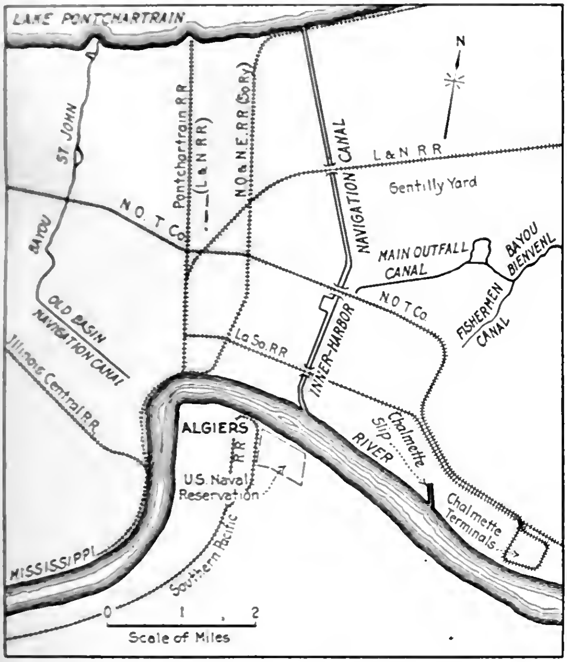
Windmills F1-22. Windmills. A bibliography of two pages. Search 3519.

NEW ORLEANS NAVIGATION CANAL NEARS COMPLETION

One of the interesting port development projects on foot in this country is the so-called Inner-Harbor Navigation Canal which will soon be completed by the City of New Orleans at a cost of upwards of $20,000,000. This new channel is expected by its supporters to be the means of greatly increasing the standing of New Orleans among the ports of the world.

The city has been handicapped in its port development by the fact that the water frontage is all publicly owned, and it has been impossible for industries to function as they do where they can own and develop their water fronts as they see fit. In recent years the Dock Board has done what it could to improve conditions, but it was not within its power to be of any benefit to industries that wanted to buy. With the opening of the new canal however, it will be possible to develop a large privately owned water frontage, which, if properly planned, should take care of the utmost requirements for many years.

So far the plans provide for the opening up of eleven miles of new water front at practically constant water level, on which long term leases will be allowed. This frontage can be indefinitely extended by lateral dredging and that part of the development has been suggested for private ownership.



New Orleans Inner-Harbor Navigation Canal

The Inner-Harbor Navigation Canal is nearly five and a half miles long and extends from the Mississippi River across the city to Lake Pontchartrain. The Inner Harbor proper starts near the river at the lock and will be at the level of the Gulf of Mexico and subject only to its tidal fluctuations. It is dredged to a depth of 30 ft. below Gulf level over a section 150 ft. wide and is 300 ft. across at the surface. A depth of from 9 to 14 ft. already exists from the Lake Pontchartrain end of the canal out to the Gulf through Mississippi Sound. Eventually this could be dredged to a depth of 30 ft., which would give deep sea-going vessels a route into New Orleans some fifty miles shorter than by the river.

The Inner Harbor will be paralleled throughout its length on both sides by the Public Belt Railroad which connects with nine railroad trunk lines and is municipally owned and operated.

The lock that is being constructed to provide for passage of vessels from the outer harbor on the Mississippi into the Inner Harbor, is sufficiently large to accommodate ships of approximately 20,000 tons. This structure contains some 90,000 cu. yd. of reinforced concrete on 24,000 sixty ft. piling. It is 1050 ft. long and has a usable length of 640 ft., a clear width of 75 ft. and a depth at low water of 30 ft. It is equipped with four sets of miter gates 55 ft. high and another set 42 ft., each gate being operated by a 52-hp. electric motor. Also there is an emergency dam consisting of eight girders 80 ft. long, 3 ft. wide and 6 ft. high which weigh about 90 tons each and which can be operated in recesses in the lock walls by an emergency dam girder bridge operated by a 300-hp. motor. The location is about 2000 ft. inside the main river levees and the channel connecting is 125 ft. at the bottom by 300 at the surface by 30 ft. deep at low water.

The Canal is crossed by four double track railroad bridges of the Strauss-Bascule type, having a clear span of 117 ft. and each bridge is provided with a 20-ft. driveway on each side.

It is expected that an immediate result of the completion of this development will be the bringing into the Mississippi River by barge, and making available to ships there, great quantities of lumber, coal, iron and other products from Louisiana, Mississippi and Alabama. (Prepared from material submitted by Walter B. Moses, Correspondent to Mechanical Engineering from New Orleans.)

Government and Industry Coöperate in Standardization

At the request of Secretary Hoover, the American Engineering Standards Committee has designated Mr. A. A. Stevenson, the retiring Chairman of the Committee, as a special representative to work with the Department of Commerce in bringing about closer and more effective coöperation between the Department's Division of Simplified Practice and the A.E.S.C.

It is the function of the Division of Simplified Practice to stimulate simplification in industry to decrease the cost of production and distribution of manufactured articles through the elimination of varieties and sizes. The work of the Division, which was organized in 1921 and is under the direction of Mr. W. A. Durgin, formerly of the Commonwealth Edison Company, Chicago, is actively under way. The A.E.S.C. has offered Secretary Hoover the use of its machinery in carrying technical projects initiated in the simplification program of the Department of Commerce. As a result of this offer Mr. Stevenson was designated as representative.

Mr. Stevenson, who is a Past President of the American Society for Testing Materials and has had a most extensive experience in standardization work, is Vice President in charge of manufacture, of the Standard Steel Works Company, which is a subsidiary of the Baldwin Locomotive Works.

Annual Meeting of Engineering Foundation Board

The Seventh Annual Meeting of the Engineering Foundation Board was held at the Engineering Societies Building in New York on February 9, 1922. The Board voted to print the Annual Report of the Engineering Foundation and the abridged report on Fatigue of Metals. Progress reports were presented on the research work of the American Bureau of Welding and on the investigation of the Properties of Steam to which the Engineering Foundation is contributing.

The Board consists of four trustees of the United Engineering Society, Messrs. George H. Pegram, Edwin Ludlow, George M. Basford and Bancroft Gherardi; eight members nominated by the governing bodies of the Founder Societies, A.S.C.E., Messrs. Edward Dean Adams and Silas H. Woodward; A.I.M.E., Messrs. Arthur L. Walker and Herbert M. Boylston; A.S.M.E., Messrs. John H. Barr and D. S. Jacobus; A.I.E.E., Messrs. F. B. Jewett and E. Wilbur Rice, Jr., three members at large, Messrs. Elmer A. Sperry, Charles F. Rand, H. Hobart Porter, and Mr. J. V. Davies, ex-officio, President U.E.S.

The following officers were elected to serve until the Annual Meeting in February, 1923: Charles F. Rand, Chairman, Edward Dean Adams, first vice-chairman, Frank B. Jewett, second vice-chairman, Joseph Struthers, treasurer, Henry A. Lardner, assistant treasurer, Alfred Flinn, secretary, Vernon Kellogg, assistant secretary, and George H. Pegram and H. Hobart Porter additional members of the Executive Committee.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* Alex. G. Christie
Ralph E. Flanders John T. Wilkin
O. G. Dale

PUBLICATION STAFF:
C. E. Davies, *Managing Editor*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

The Engineering Resources and Possibilities of Muscle Shoals

J. W. Joyes

"More foolish things have been said about Muscle Shoals, pro and con, than about any other matter I ever investigated," was the gist of a remark made recently by a prominent witness before the House Military Committee in response to an inquiry about some rumor or other. It is true that, in the mass of discussion spoken and published, there has been so much misstatement and exaggeration and so much picturesque and imaginative prediction that there is difficulty in visualizing the actual physical situation and in appraising its reasonable possibilities.

The subject is large and intricate, and such a brief statement as can here be presented must be but a bare outline. It will be uncolored by prejudice and as accurate as is possible.

The term "Muscle Shoals" has been used loosely to embrace all the actualities and all the dreams that center about the Muscle Shoals section of the Tennessee River, extending some thirty-five miles upstream from the cities of Florence and Sheffield, Ala. In this thirty-five miles the river has a fall of some 130 feet, so that power-development possibilities offer advantages offsetting the navigation disadvantages but there has been much propaganda in the adjacent states for both the navigation improvement and the power development.

Importation from Chile of sodium nitrate to make nitric acid for military explosives was precarious. Therefore the Chief of Ordnance, U. S. Army, called attention to the desirability of establishing nitrogen fixation plants and advocated making such plants support themselves in peace-time by producing fertilizer material.

The chance to realize the Southern "cheap fertilizer" ideal by giving such plants cheap power, while at the same time achieving the long-desired power development and navigation improvement of the Tennessee River, led to the linking together of the nitrate plant and the Muscle Shoals propaganda, and to the inclusion in the National Defense Act of 1916 of the Section 124, which appropriated $20,000,000.00 for "Nitrate Supply."

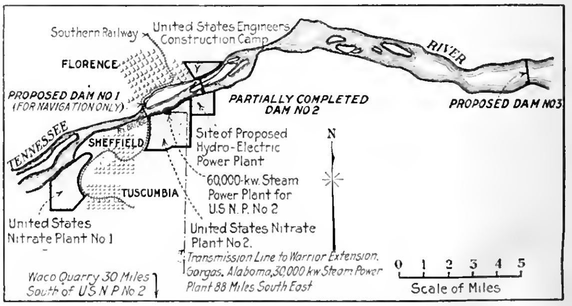
Under that law and upon the advice of a committee of prominent scientific, technical and business men, it was decided first to build a plant to make ammonia by synthesis of gaseous nitrogen and hydrogen, using a process then in a promising state of development and similar to the Haber-Bosch process then known to be successfully operated in Germany. This plant is U. S. Nitrate Plant No. 1, just southwest of Sheffield, Ala. It produced very little ammonia, due to not achieving continuous operation and the changes shown by deliberate study since 1918 to be necessary to assure efficient operation have not been made. This plant is therefore not a "going" plant and its water-gas installation, gasometers, 1500 lb. per sq. in. gas compressors, heat interchangers, reaction vessels, etc., are carried at salvage value only. There are, however, useful industrial buildings, and auxiliary plant apparatus of some value. The 1900 acres of land, 100 or so dwellings, roads, railroad, water and sewer lines, etc., will have value dependent upon the general vicinity development—small at present.

Urgent need for large quantities of explosive for munitions during the War, and other considerations combined to induce the building of the great U. S. Nitrate Plant No. 2 to make the explosive ammonium nitrate without either nitrate or ammonia from any extraneous source.

The flow sheet of this plant is briefly:

a Limestone crushed and lump coke

b Lime (in 7 kilns) and coke (crushed and dried) in



Map Showing Location of Parts of Muscle Shoals development

Twelve electric furnaces, giving calcium carbide

d Carbide, plus nitrogen (from liquid air plant) give, in 1536 ovens

e Lime-nitrogen, which when crushed and ground and treated with steam in 56 autoclaves, gives

166 tons gaseous ammonia per day

g 90 tons of ammonia oxidized in 696 catalyzers, gases giving, in 18 towers (31 × 31 × 34 ft.), dilute nitric acid (equivalent 280 tons HNO_3)

h Remainder of ammonia and the acid react in neutralizers to ammonium nitrate solution, which then concentrated and evaporated in 5 buildings give

i End product 300 tons per day, 110,000 per year, crystallized ammonium nitrate.

The rectangle embracing those processes is 5310 by 2860 ft. The seven lime kilns are 125 ft. long. The twelve electric furnaces are each 22 × 13 × 6 ft. inside have three electrodes 16 × 48 × 80 in. and use 8300 kva. The liquid air plant is the largest in the world—30 Claude units. There are twenty-nine acres of actual process buildings of standard concrete and steel-mill type.

For rated production some 90,000 horsepower is required.

As half production was needed six months after breaking ground a 110,000-volt, 33,333 kva. transmission line had to be built and contract made for part of the power requirement from an established power system. To insure continuity of this supply the United States had to build the "Warrior Extension"—a 30,000 kw. addition to the power company's steam station at Gorgas.

For the remaining power requirement, a steam power station was built at U. S. Nitrate Plant No. 2 on the river bank. This has twelve B. & W. Stirling boilers of 1507 nominal boiler horsepower, a 60,000 kw. Westinghouse Parsons double flow cross-compound

turbine in three elements and three 23,000 kva., 12,200 volt, 3-phase, 60 cycle Westinghouse generators, with surface condensers and complete accessories throughout. Fuel is dumped into overhead hoppers from standard railroad cars on a track over the powerhouse roof at about the level of the ground adjoining the gully in which the power house is located. Ample space is left in the generator room for an additional turbo-generator of 30,000 kw. or greater capacity. This plant has high efficiency and will have large value as a steam stand-by when the water power is developed and at small cost can transform 80,000 horsepower from secondary to primary power.

Nitrate Plant No. 2 has one other accessory, the limestone quarry owned in fee at Waco, 30 miles south of the plant proper. Here there is a supply of stone for probably 50 or more years. The bed is flat, with shallow overburden, giving a pit quarry which has been opened and provided with a crushing plant for 2000 tons of stone per day, with power from the transmission line mentioned. Diamond drilling, etc., show a good 50 foot thickness with average composition up to specification, that is about 98 per cent calcium carbonate.

The U. S. N. P. No. 2 site of 2300 acres, which is owned in fee, is bounded by the river, the joint tracks of L & N and Southern railroads and by highways and has 188 good dwellings besides 263 negro houses, a 100-room administration quarters, etc. All are of value to a going plant. There is also an adequate water supply system with reservoir and filter, 20 miles of sewers, 22 miles of slag and chert roads, 37 miles of railroad, an ice plant, etc.

The process plant is most carefully designed with modern material-handling devices and each process showed, upon test, high efficiency and even more than rated production. It will be seen from the flow-sheet that there are opportunities to divert all or part of several of the intermediate products to a different final product. For instance, ammonia may be diverted to be made into sulphate and the calcium cyanamide might be sold without further processing than hydrating. Other possible end-products now obvious are ammonium phosphate, urea, calcium nitrate, nitroguanadine, veronal and many others, providing of course certain additions of special process-apparatus and additional raw materials called for were made.

The original end-product, ammonium nitrate, has excellent fertilizer value containing 35 per cent nitrogen as against 21 per cent in sulphate and 15 per cent in Chile nitrate; but it is an explosive and so deliquescent that it would be troublesome to handle. This may be treated to diminish its deliquescence but is still explosive. It may be combined with sulphate giving the double ammonia salt or it may be mixed with potassium chloride thus bringing in another valuable fertilizer ingredient, potash.

The ideal of the fertilizer research man is a crystalline substance, not deliquescent, containing in soluble form the three essentials, nitrogen, potash, phosphoric acid, and as little of any other substance as possible. With that, freight need be paid upon only the plant foods and not upon useless matter such as the present commercial fertilizer contains to the average extent of 85 per cent.

Research has already produced some most promising results. Of these, electric furnacing of phosphate rock offers prospect of being a more advantageous method of rendering phosphoric acid available than the present method.

It is correct to say that in such advanced methods to be developed by the laboratory and efficient technicians lies the main hope of this plant—for ammonium nitrate is objectionable, calcium cyanamide has objectionable features limiting its use, and sulphate can, even with water power costing less than one-tenth of a cent per kwh. hardly be produced at a cost to compete with by-product coke-oven sulphate or Chile nitrate.

A word as to quantity. Of the 8,000,000 tons or so of complete fertilizer used in this country in a year (speaking very generally) nitrogen makes up only 200,000 tons. The U. S. Nitrate Plant No. 2 product, 110,000 tons of ammonium-nitrate or equivalent, contains roughly 40,000 tons of nitrogen—about one-fifth of the aggregate.

Such are the properties of the United States at Muscle Shoals—other than the dam—and such are some of the possibilities that may with reason be now predicted for them. It remains to speak of the dam and its possibilities.

Dam No. 2 (the Wilson Dam) has about 30 per cent of the permanent structure done. It is to have a normal head of 95 feet and may probably be rated as capable of delivering about 100,000 hp. primary, 100,000 hp. secondary (10-month power) with some 150,000 hp. available for six months and even more for shorter periods. If the efficient steam plant at U. S. Nitrate Plant No. 2 (80,000 hp.) and the Warrior Extension steam plant (40,000 hp.) be used as stand-by power, a corresponding amount of secondary water power is of course converted at small cost into more valuable primary power. Dam No. 1, proposed, is for navigation only and to give no power. Dam No. 3, not commenced, is planned for about 40 ft. head and would add correspondingly to the primary and secondary power usable. The pools of these dams would no more than take care of daily fluctuation. The possibilities of steam regulation by up-river storage are large, but too indefinite to discuss here. Tie-lines to other systems offer other possibilities of increase of usable power and of course industries run by the owner of the power may use very short-period power that could hardly be sold.

It is safe to say that development of this power should bring in to the vicinity many electrometallurgical industries and many electrochemical industries other than nitrogenous fertilizer. The nearby iron ore, coal, limestone, phosphate, bauxite and other minerals speak for themselves. Ferromanganese and ferrosilicon are already in production in Alabama and Tennessee. Almost to a certainty much general manufacture would spring up and power not used locally may be distributed over a large area. J. W. Joyes.[1]

Mr. Prindle's Signal Service in Patent Relief

Every member of the engineering profession should recognize the able and painstaking contribution on their behalf by Mr. Edwin J. Prindle, who, as Chairman of the Patents Committee of American Engineering Council, and as a representative of The American Society of Mechanical Engineers on that Committee, was largely instrumental in securing the passage of the Lampert Bill, providing much needed relief and increasing the salaries and staff of the Patent Office.

"Throughout the long fight from the time that the project started as embodied in the Nolan Bill, during times thereafter when it seemed that everything was against progress, and until the Lampert Bill was signed by the President, Mr. Prindle spared no personal time or effort in advancing the movement. In this work he kept his committee with him, and made sure of every step, but his fellow members do not hesitate to concede that his efforts stand out far above those who had the honor of serving with him, and they gladly accord him all the credit."

This extract from a letter by Dr. D. S. Jacobus, a co-worker with Mr. Prindle on the Patents Committee is a fitting tribute to his energy and sacrifice in advancing this important work.

The history of the enactment of the bill is familiar to many since the political procedure necessitated public hearings before committees of the Houses, and the members of the profession had to be called upon frequently to make their influence felt at Washington and to back up the Committee in its efforts.

The fight for relief was started in 1917 when the National Research Council was requested by the Patent Office itself to appoint a committee to find out what could be done about relieving a situation of inability to obtain suitable men in the Patent Office in view of the insufficiency of salaries which had only been increased eight per cent since 1848. The recommendations of this Committee resulted in the formulating of the Nolan Bill H. R. 11,984, immediately approved unanimously by the Patents Committee of the House. Mr. Prindle was appointed to this committee as a representative of the A.S.M.E. and he served as secretary.

The work was brought closer to the Engineering Societies through the agency of Engineering Council which appointed a Committee to aid in the passage of the bill, and on this Committee Mr. Prindle's name also appeared. Mr. Charles A. Terry was Chairman but soon resigned, and Mr. Prindle took his place. Mr. Prindle was also made a member of the Patent Committee of the National Association of Manufacturers, and Chairman of the Patent Committee of the American Chemical Society, the latter honor being

---

[1] Colonel Ordnance Dept., U. S. Army, Washington, D. C.

a recognition of his ability to assume the leadership in this reform.

After a hearing organized by Mr. Prindle and attended by representatives of the sixty organizations supporting it, the Nolan Bill passed the House but in the Senate it became involved with a Federal Trade Commission amendment. This amendment prejudiced the bill and the Senate failed to pass it. Then came an adjournment of Congress and the work had practically to be started all over again with the new Congress. The first step was the elimination of the Federal Trade Commission Amendment which was successful. Re-introduced into the new House by Mr. Lampert, then Chairman of the Patent Committee, the bill took his name. Opposition now came from the floor leader who held that the increases recommended were too high and that it would interfere with a bill for the general re-classification of governmental service. This necessitated another campaign to bring the bill up for a vote, which was successful in spite of strenuous opposition. The tide had now turned and the introduction of the bill into the Senate resulted in its passage without a single negative vote. The bill became law on February 18, 1922 by the signature of President Harding.

In recognition by the Patent Office of his able and painstaking work, the Commissioner of Patents presented to Mr. Prindle the pen with which the President signed the bill.

The Bill adds $451,000 to the payroll of the Patent Office, and increases the salaries of the Examiners approximately 45 per cent, and the number of Examiners 10 per cent. The Bill also contains a patent law amendment, proposed by Mr. Prindle, which will make a money recovery possible in all patent infringement cases where the patent has been held to be valid and there has been any substantial use of the invention. Heretofore the rules governing accountings in patent infringement suits have been so technical and illiberal that a money recovery has been impossible in most cases. Recently a few decisions have been rendered in which a more equitable principle has been applied to a limited class of infringement cases. The amendment makes the said principle statutory and extends its application to all classes of infringement cases. The amendment has been approved in principle by a number of United States Judges, and no judge has disapproved of it. It is believed that it will greatly stimulate the production of inventions, which is the object of the patent system.

Richard H. Rice, Manager G. E. Lynn Works, Dies

Richard H. Rice, late manager of the Lynn Works of the General Electric Co., an outstanding member of the engineering profession and a leading authority on steam turbines, died on February 10, 1922, at Bolton on Lake George, N. Y. Mr. Rice was born on January 9, 1863, at Rockland, Me. He was educated in public schools and Stevens Institute of Technology from which he received his M.E. degree.

He served his apprenticeship with the Pittsburgh, Columbus, Cincinnati and St. Louis Railroad, then becoming a draftsman at the Bath Iron Works in Maine. His enthusiasm and ability as chief draftsman with E. D. Leavitt, Cambridge, Mass., brought him the position of general superintendent of the Wm. A. Harris Steam Engine Co., Providence, R. I. Later he was secretary-treasurer of the Rice Sargent Engine Co. and the Providence Engineering Works.

In 1903 he became associated with the General Electric Co. as engineer in the turbine department of their Lynn Works where he started work on the development of the turbine to its present extensive proportions. In 1918 he was made manager of the plant.

Mr. Rice combined the qualities of a skilled engineer and inventor with marked ability as an executive. He had a warmth of human sympathy, a regard for the feelings of others and a democratic spirit which made him a man easy of approach. He leaves as a monument to his memory the plan of representation in effect at the Lynn Works whereby his fellow employees reap the advantages of a new, yet very old idea—good will, friendship and coöperation.

Many business and professional organizations counted him as a member. He became a member of The American Society of Mechanical Engineers in 1890 and from 1904 to 1907 served as one of its managers. For the first two years of its existence he was president of the Associated Industries of Massachusetts; he was a past-president of the National Conference of State Manufacturers' Associations. He was also a member of the Providence Engineering Society and the American Institute of Electrical Engineers. He was a member of the Boston Chamber of Commerce, a director of the Lynn Chamber of Commerce, a member of the State Committee on Unemployment and during the War served as a member of the Lynn Fuel Commission. He was the author of several technical papers dealing with turbine engines and the inventor of some fifty patented devices for use of steam, air and water, chief among which was his design for the first turbo-blower for blast furnaces in America. In June of 1921 he was awarded degree of Doctor of Engineering by Stevens Institute.

U. E. S. Report for 1921

The report[1] of the treasurer of United Engineering Society for the calendar year 1921 shows a balancing account on December 31, 1921, of $26,434.31, as compared with a balancing account on December 31, 1920, of $16,954.72. The cash on hand as of December 31, 1921 amounted to $14,219.35. Following is a statement of the treasurer's receipts and payments for the year:

RECEIPTS

Cash on hand January 1, 1921		$15,029.02
From Founder and Associate Societies for offices, storage, halls, telephones and miscellaneous	$98,666.45	
From societies not in building for halls and miscellaneous	17,530.79	
For Library, General Maintenance and Operation	25,291.61	
For Library Service Bureau	16,738.16	
For Library Recataloguing	12,291.53	
Income collected on Investments and Deposits of U. E. S.	12,116.83	
Income collected on Engineering Foundation investments	24,533.57	
Sale of Securities	27,874.38	
From A. I. E. E. for Building Addition	2,500.00	237,543.3
		$252,572.34

PAYMENTS

To Engineering Foundation		
Income from Investments less Collection charges	$24,258.31	
For Securities purchased	25,400.00	
" Building Operating expenses	101,370.21	
" Library	27,588.43	
" Library Service Bureau	15,755.41	
" Library Recataloguing	13,606.01	
" A.S.M.E. Note	2,500.00	
" A.S.M.E. Interest on note	206.20	
Collection, custodial and Adv. charges and exchanges	650.83	
For Engineering Council	14,500.00	
" Engineering Soc. Service Bureau	406.74	
" Permanent Improvement charged to capital	1,786.36	
" Renewals in steam system charged to Depreciation and Renewal Fund	9,395.91	
For American Delegation Dinner	805.10	
" Miscellaneous	123.48	
Grand total		$238,352.99
Cash on hand December 31, 1921		14,219.35
		$252,572.34

The assets and liabilities as of December 31, 1921, were as follows:

ASSETS

Property		$1,959,140.67
Land	$510,000.00	
Building	1,361,969.51	
Equipment	33,171.16	
Founders' Preliminary Expenses	24,000.00	
Investments Foundation		502,066.05
Library		93,351.25
Depreciation and Renewal		98,639.47
General Funds		10,000.00
Cash	10,477.25	
Special Cash Funds	50.00	
Due from Cleveland Trust Co.	99.16	

---

[1] Extracts from treasurer's report for 1921.

Cost of renewals paid from Operating Cash to be reimbursed from Depreciation and Renewal Fund Assets	1,698.47	
Accounts Receivable	8,835.98	
Accrued interest receivable on Library Endowment Investments	1,246.14	22,407 00
Deferred charges, prepaid insurance		4,230 31
		$2,689,834.75

LIABILITIES

Founders Equity in Property	$1,959,140 67
Engineering Foundation Reserve	502,066 25
Library Endowment Reserve	93,351 25
Depreciation and Renewal Reserve	98,639 47
General Reserve	10,000 00
Collection on account Osterberg Fund	91.50
Income from Engineering Foundation Investments collected and to be paid to Engineering Foundation Board	58 60
Deferred credit—unexpended balance in American Delegation Dinner Account	52 90
Balance December 31, 1921	26,434.31
	$2,689,834 75

NEWS OF OTHER SOCIETIES

American Institute of Electrical Engineers

The tenth annual Midwinter Convention of the American Institute of Electrical Engineers was held in New York, February 15 to 17, 1922. This function is traditionally devoted to the presentation and discussion of highly technical subjects.

President McClellan opened the first session Wednesday afternoon with a short address emphasizing the opportunities of the engineering profession in the readjustment and developing of the country at the present time. He considered the transportation problem one of the most important and suggested that electrification of railroads might be the solution. He also pointed out that with greater development of power sources, a trend which is already making itself felt, the age will be one where engineering genius of every type and especially along electrical lines will more than ever be in demand.

The papers were then presented: The Key West-Havana Submarine Telephone Cable System, by W. H. Martin, G. A. Anderegg and B. W. Kendall; Submarine Cable Telegraphy, by J. W. Milnor; and Printing Telegraph Systems Applied to Message Traffic Handling by A. H. Reiber.

In the evening the Questionnaire on Lightning Arresters, by F. L. Hunt was read and it was followed by Deviations from Standard Practice in Lightning Arresters, by E. E. F. Creighton, and Condenser Discharge through a General Gas Circuit by Charles P. Steinmetz.

On Thursday morning, after the meeting was opened by the President, E. B. Meyer, chairman of the Transportation and Distribution Committee presided. Papers were presented as follows: The Peterson Earth Coil, by R. N. Conwell and R. D. Evans; the Effect of Moisture on the Thermal Conductivity of Soils, by G. B. Shanklin; Five Hundred Tests on the Dielectric Strength of Oil, by J. L. R. Hayden and W. N. Eddy, and An Analytical Investigation of the Causes of Flashing of Synchronous Converters, by E. B. Shand.

H. R. Woodrow, Chairman of the Protective Devices Committee, occupied the chair in the afternoon and the following papers were read: The Use of Superimposed Imaginary E. M. Fs., Currents and Fluxes in the Solution of Alternating-Current Problems, by V. Karapetoff; Question on the Economic Value of the Overhead Grounded Wire by E. E. F. Creighton; Wave Form and Amplification of Corona Discharge by J. B. Whitehead and N. Mouye; Prevention of Transient Voltage in Windings, by J. Murray Weed.

On Thursday evening the Edison Medal was presented to Cummings C. Chesney which was followed by an address on Colloids by Dr. W. D. Bancroft.

Friday morning C. E. Skinner acted as chairman and the papers were: Heating of Railway Motors in Service and on Test Floor Runs, by G. E. Luke and The "Indumor," by V. Karapetoff.

The following papers were read by titles only: Skin Effect and Proximity Effect in Tubular Conductors, by Herbert Bristol Dwight, Heat Losses in Stranded Armature Conductors, by Waldo V. Lyon, Current Locus of Single-Phase Induction Motors, by J. K. Kostko, and Polyphase Commutator Machines, by A. B. Field.

Friday afternoon about 300 members registered for an inspection trip to various power plants and in the evening the usual dinner dance was held at the Hotel Astor, completing a most beneficial and enjoyable convention.

American Institute of Mining and Metallurgical Engineers

The 125th meeting of the American Institute of Mining and Metallurgical Engineers was held in New York, Feb. 20-23, 1922. The total registration of 744 members and 587 guests was larger than in any previous year and it was considered the most successful convention ever held by the Institute.

At the annual business meeting three new officers, headed by Arthur S. Dwight, Director and President, and five new directors, were elected.

From Monday afternoon through Wednesday afternoon there were four simultaneous sessions being carried on both morning and afternoon. Of these the symposium on Foreign Oil Possibilities and Details of the Oil Industry aroused the greatest interest and attracted the largest attendance. The first two sessions were devoted to addresses by eighteen different men on Oil Reserves in the various countries and continents.

The Mining Sessions, also four in number, were well attended throughout, and 30 papers covering subjects from Sampling and Estimating Ore Deposits to General Outlines for Obtaining Data were read. The latter was in connection with the collecting of data from all the big mines of the United States for the benefit of those who contemplate making a choice in mining methods.

There were three Safety Sessions, joint meetings of the Mining Section of the National Safety Council and Industrial Relations Committee of the Institute. The first was on Wire Ropes and Hoisting, the second on Ventilation and the third dealt with miscellaneous features.

The Session on Industrial Relations included reports from subcommittees on Americanization all along the line to Mental Factors in Industry and Safety. A paper was also read on Preservation of Natural Scenery and Attractiveness of Mining Camps.

The Institute of Metals Division had two sessions in which nine papers were read and a lecture given by Prof. Wilder D. Bancroft on Colloid Chemistry and Metallurgy attracted a great deal of interest.

One of the two Iron and Steel Sessions was in memory of Prof. J. W. Richards who was for many years its very able and efficient chairman. Seven papers were read at the two meetings.

Other features were: A noteworthy joint meeting with the Mining and Metallurgical Society, considered by some a rival organization, and at which five papers on Waste in the Mining Industry were read; a Local Sections Convention, which was a most successful innovation; and entertainments. The latter included the annual smoker on Monday night at which J'Aime presented the Folies Minieres, a Review with Pangs; and the annual banquet and ball in the Grand Ball Room of the Pennsylvania Hotel. An informal dance, reception and excursions contributed toward making it the pleasantest as well as the most successful convention in the history of the Institute.

American Boiler Manufacturers' Association

The winter meeting of the American Boiler Manufacturers' Association was held at the Fort Pitt Hotel, Pittsburgh, Feb. 13, 1922, A. G. Pratt of the Babcock and Wilcox Company presiding. Secretary H. N. Covell reported the Association having 77 active and 20 associate member companies. For the Committee on Ethics, George B. Bach reported that no breach of the Association's Code had been reported in spite of strenuous competitive conditions during the preceding year.

A report from the committee appointed to determine how thoroughly the A.S.M.E. Code is being lived up to by members of the Association was presented by W. C. Connelly. To the question, "Are you complying with the A.S.M.E. Code, par. 14, 28, 36, 180 and interpretation no. 295?" fifty replied "Yes," one "No," and three "Not always." Other questions such as the advisability of having the Code Committee set a maximum thickness for shell plate and what that thickness should be, brought varying replies.

Of the 36 who answered the first part only ten opposed a maximum, but when it came to setting a figure the opinions varied from $^7/_{16}$ to $1^1/_4$ in. Seven favored $^5/_8$ and six suggested $^9/_{16}$ in. An inquiry as to the use of a single sheet for boiler bottoms brought forth a good deal of discussion, the concensus of opinion seeming to be that plates about an inch thick if of sufficient tensile strength are much better than heavier ones.

Mr. C. W. Gorton presented a paper on the National Board of Boiler and Pressure Vessel Inspectors and its relation to the Boiler Manufacturing Industry. Through a policy of One Code, One Stamp, One Inspection, this Board makes it possible to have a boiler accepted in any of a constantly growing number of states, if it is according to the A.S.M.E. Code.

An invitation was received from the American Society of Mechanical Engineers for the Association to appoint a representative on the Committee on Bolts, Nuts and Rivets.

Engineering Institute of Canada

The Engineering Institute of Canada held its annual meeting at the Montreal headquarters, January 24 and 25, 1922. The officiers elected for 1922 include, President, J. G. Sullivan, consulting engineer; and vice-presidents, Brigadier General C. B. Mitchell and Arthur Surveyer.

Three new branches were founded, one at Sydney, Nova Scotia, one at London, Ontario, and one at Lethbridge, Alberta. Among the most interesting technical papers were: An explanation of the design features of the latest hydroelectric development of the Shawinigan Water and Power Co., by Julian C. Smith, who is a vice-president and general-manager of the company; and an illustrated lecture by Major Draper on the construction of the new St. John cantilever bridge.

The entertainments included a visit to the Dominion Engineering Works at Rockfield, the annual banquet and a smoking concert.

LIBRARY NOTES AND BOOK REVIEWS

Airplane Engine Encyclopedia. By Glenn D. Angle. First edition. Otterbein Press, Dayton, Ohio, 1921. Cloth, 6×9 in., 547 pp., illus., diagrams, $7.50.

A reference book for those interested in airplane engines. Contains information concerning the design, sizes, construction and performance of the engines of about one hundred and seventy-five makers, arranged by names. Based on information from original sources and the leading books and periodicals. Includes every engine known to the author.

Architects' and Builders' Handbook. By Frank E. Kidder. Seventeenth edition. John Wiley & Sons, Inc., New York, 1921. Fabricoid, 4×7 in., 1907 pp., illus., tables, $7.

Two new chapters, on Specifications for the Steelwork of Buildings, and on Domical and Vaulted Structures, have been prepared for this edition. The chapters on Fireproofing of Buildings and on Reinforced-Concrete Construction and the sections on Heating and Ventilation and on Chimney Construction have been rewritten. In addition the whole text has been revised, numerous new articles inserted and a new index made. The total additions amount to 90 pages. The book is intended to contain information on every subject, except design, likely to come before an architect, structural engineer, draftsman or builder, and to be a thorough handbook of architectural engineering.

Automotive Repair. By J. C. Wright. Vol. 1. John Wiley & Sons, Inc., New York, 1921. Cloth, 6×9 in., 530 pp., illus., diagrams, $3.50.

This book is for the repairman or owner who is expected to make general repairs and keep a car fit for operation. One hundred and eighteen jobs are given, with complete instructions. These are divided into chassis, engine, electrical, body and radiator work and "trouble shooting," and cover, it is said, 95 per cent of all the problems which will confront the repairer. The second section of the book presents the theoretical and mechanical information required to understand the construction and operation of the automobile.

Burning Liquid Fuel. By William Newton Best. [Revised edition.] U. P. C. Book Co., Inc., New York, 1922. Cloth, 6×9 in., 341 pp., illus., diagrams, $4.

This revised and enlarged edition of Dr. Best's book, formerly entitled the Science of Burning Liquid Fuel, is a plain, straightforward summary of long practical experience in designing and erecting oil-fuel installations. Specific information is given upon the use of liquid fuel in many industries and upon all the various forms of equipment. Drawings show how the equipment is applied to various purposes. The book discusses, among other topics, locomotive, stationary, marine and low-pressure boiler equipment; practice in foundries and forge shops; and equipment suitable for the sugar, copper, ceramic, cement, baking, candy and oil industries.

Deep Well Drilling. By Walter H. Jeffery. W. H. Jeffery Co., Toledo Ohio, 1921. Cloth, 6×9 in., 531 pp., plates, illus., diagrams., tables, $5.

The author has undertaken to cover the two methods most generally used, the cable tool and the hydraulic rotary, including the building of the derrick, drilling, handling casing, fishing lost tools and the completion of the well, according to the best practice of the day. Supplementary chapters deal with oil and gas geology, cost of drilling, strength of materials and laws relating to gas and oil wells; other general information of use to the driller is also included.

Design of Steel Mill Buildings and the Calculation of Stresses in Framed Structures. By Milo S. Ketchum. Fourth edition, rewritten. McGraw-Hill Book Co., Inc., New York, 1921. Fabrikoid, 6×9 in., 632 pp., illus., diagrams, $6.

Covers the calculation of the stresses in framed structures and also the design of buildings having a self-supporting steel frame with a light covering, usually fireproof. In this edition the book has been rewritten, enlarged and reset. It is intended as a textbook in structural engineering and also as a book of reference for engineers.

Part 1 covers the calculation of the stresses in simple beams, trusses, portals, the transverse bent and the three-hinged arch. Part 2 covers the calculation of the deflections of structures, the stresses in statically indeterminate girders, trusses and frames, and secondary stresses in trusses. Part 3 covers the design of steel frame buildings for mines, mills, smelters and other industrial plants. The appendix is a complete specification for steel frame mill buildings.

Elements of Fractional Distillation. By Clark Shove Robinson. First edition. McGraw-Hill Book Co., Inc., New York, 1922. (International chemical series.) Cloth, 6×8 in., 205 pp., tables, diagrams, $2.50.

This book explains the principles of fractional distillation and illustrates them by carefully selected examples of their application. The first portion of the book treats of fractional distillation from the qualitative viewpoint of the phase rule; the second discusses some quantitative aspects from the engineering point of view; and the third section treats of the design of distilling apparatus. Part four gives examples of modern apparatus for distilling ammonia benzolized wash oils and alcohols. An appendix of useful tables is included.

Essentials of Industrial Costing. By George S. Armstrong. D. Appleton and Co., New York, 1921. Cloth, 6×9 in., 297 pp., tables, forms, $5.

This book is concerned solely with the principles and methods by which the cost of production may be determined. It is based upon an extended experience in many different industries and represents the author's mature views. The book shows the purpose of costing, summarizes good practice and is a guide to the analysis necessary for the establishment of costing systems.

Etude Geometrique des Transformations Birationnelles et des Courbes Planes. By Henri Malet. Gauthier-Villars et Cie, Paris, 1921. Paper, 7×10 in., 259 pp., diagrams, 32 fr.

A study, by synthetic methods, of birational transformations and plane curves. It strives particularly to establish the first principles and to set forth precisely, in logical and geometrical fashion, the conditions under which the homographic correspondence of laws is based. The author's exposition of modern geometry is based on the methods of Chasles and Poncelet.

Handbuch der Drahtlosen Telegraphie und Telephonie. By Eugen Nesper. Julius Springer, Berlin, 1921. Cloth, 7×10 in., 2 vol., illus., diagrams.

Dr. Nesper's book on radio communication attempts an exhaustive survey of the subject from a modern point of view and from every aspect. It is apparently more extensive than any previous work on the subject. It has been planned for easy reference, the material having been so arranged that each chapter is a complete account of a certain topic, so that reference to other chapters, or systematic reading of the whole work, can be avoided. The theory of radio communication, its history, uses, the measuring and detecting instruments, the physical phenomena in quasi-stationary circuits, coupling, damping, radiating, the technique and apparatus of high frequency measurements are described in volume one. Volume two describes typical radio stations for different purposes, and their apparatus, the uses of radio communication in railroading and radio telephony. It also includes a valuable bibliography of the important books and articles. Good indexes are provided.

History of Aeronautics. By E. Charles Vivian. Harcourt, Brace and Co., New York, 1921. Cloth, 6×9 in., 521 pp., plates, portraits, $5.

The author of this work says that hitherto there has been no attempt to furnish a detailed account of how the aeroplane and the dirigible of today came into being, but each author has devoted his attention to some special phase or period. In this book he attempts to record the facts of development and to state, as fully as is possible within the compass of a single volume, how flight and aerostation have evolved.

Hydroelectrical Engineering. By Richard Muller. G. E. Stechert & Co., New York, 1921. Cloth, 7×10 in., 431 pp., diagrams, $6.

A systematic exposition of those principles of hydraulic and electrical engineering which underly the design of hydroelectric plants. Intended for engineers engaged in designing and constructing plants or reporting on their commercial possibilities.

Hydraulics and Its Applications. By A. H. Gibson. New edition, revised and enlarged. D. Van Nostrand Co., New York, 1921. Cloth 6×9 in., 813 pp., illus., diagrams, $6.

This book opens with a description of the physical properties of water, followed by a brief treatment of the fundamentals of hydrostatics. The science of hydraulics is then presented, first theoretically and then with regard to its application to the design of hydraulic machinery. The work is written primarily for students, but the author hopes it may also prove of value to those actively engaged in the practice of hydraulic engineering. This edition has been practically rewritten, with considerable additions and much rearrangement of the material.

La Loi de Newton est la Loi Unique. By Max Franck. Gauthier-Villars et Cie, Paris, 1921. Paper, 6×10 in., 158 pp., 12.50 fr.

The question considered in this book is whether it is possible, with our present knowledge, to formulate the law governing the mechanism of the universe. Upon two postulates, that all potential energy resides in the absolute space of the physicist, and that all matter is formed of an element of inertia movable in space, the author erects a hypothesis, and compares its consequences with known facts, to determine how nearly the two agree. The first consequence is the confirmation of Newton's law, which may now be given its exact interpretation; this is the reason for the title given the book. The author's theory uses only the notions of space, time, force and inertia admitted in Euclidean geometry and mechanics.

Manufacture and Uses of Explosives. By R. C. Garmer. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Technical primer series.) Cloth, 4×6 in., 116 pp., diagrams, $0.85.

Information on explosives is so scattered and so much concerned with the details of individual explosives, that some difficulty is experienced in obtaining a general view of the nature and functions of explosives. The present work endeavors to provide this within a short compass, dealing first briefly with the historical development of explosives, and then with the manufacture and use of those most used today. Includes a brief bibliography.

Die Pressluftwerkzeuge. By P. Iltis. Second revised edition. Vereinigung Wissenschaftlicher Verleger, Berlin, 1921. (Goschen Collection.) Cloth, 4×6 in., 117 pp., illus.

After a brief general and historical introduction, this little book treats of the application of compressed air to hammers, percussion drills, punching, stamping and riveting machinery, drills, hoists and blasting machines. Within its limits, a large amount of information is given on the practical uses of compressed air.

Special Libraries Directory. Edited by Dorsey W. Hyde, Jr. Special Libraries Association, Washington, 1921. Paper, 6×9 in., 123 pp. $2.

This directory is a comprehensive survey of the specialized collections of literature upon various subjects in the United States. Over 1300 libraries belonging to universities, societies, business houses and other agencies are listed, with their location, rules for use and brief accounts of their resources. The list is arranged by subject and also geographically. Many of these libraries are concerned with engineering and allied subjects. The list will prove valuable to research students, in indicating possible sources of information.

Steam Boiler Maintenance. By Reg. Clayton. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Pitman's technical primers.) Cloth, 4×6 in., 118 pp., diagrams, $0.85.

This brief account of good practice is clearly written in language devoid of unnecessary technicalities. The author hopes it will illustrate how breakdowns may be avoided and maintenance costs reduced by systematic supervision. It is not intended to be a guide for firemen so much as to show the weak spots in the apparatus and to lead to the discovery and remedying of incipient defects and malpractices.

System Building and Constructive Accounting. By Raymond D. Willard. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 307 pp., forms, $4.

A textbook for students of accounting, devoted to the design of systems for various lines of business. The book analyzes a number of systems in use, thus illustrating the principles involved, and illustrates by charts and forms suitable methods for the necessary records

Die Warmwasserbereitungs, und Versorgungsanlagen. By Wilhelm Heepke. Second edition, revised and enlarged. R. Oldenbourg, München, 1921. (Oldenbourgs Technical Handbook No. 5.) Paper, 6×9 in., 706 pp., diagrams, 120 M.

An exhaustive treatise on the installation of hot water plants, covering the subject in great detail. Confined to water-heating systems for domestic and industrial use. Methods of heating, boilers, piping, regulating and measuring instruments, insulating, etc., are fully covered.

Wharf Management, Stevedoring and Storage. By Roy S. MacElwee and Thomas R. Taylor. Appleton and Co., New York, 1921. Cloth, 6×9 in., 350 pp., forms, diagrams, tables, $5.

This, it is said, is the first book to deal comprehensively with wharf administration, the loading and unloading of cargoes, and the handling and storage of outward and inward freight. It describes the duties of pier superintendents, receiving clerks, tally men and foremen of stevedores. Other chapters deal with wharf layout and construction, cargo-handling machinery, longshoremen, labor problems. Particular attention is given to the economic aspects of the subject.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

AERONAUTICS

Research. Aeronautic Research, Joseph S. Ames. Jl. Franklin Inst., vol. 193, no. 1, Jan. 1922, pp. 15–28, 17 figs. Describes types of investigations in progress in aeronautics and methods pursued, with especial reference to wind-tunnel experiments.

The Importance of Research in Aeronautics. Flight, vol. 14, no. 4, Jan. 26, 1922, p. 55. An epitome of views of Council of Royal Aeronautical Soc. on need for better safeguards to prevent submerging of applied scientific research in aeronautics by technical experimental work.

AIR

Liquefaction and Separation. The Liquefaction and Separation of Air (Luftverflüssigung und Lufttrennung), Richard Linde. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1356–1360, 4 figs. Air liquefaction considered as connecting link between the compressed-air and refrigerating industry; physical principles, and the different working processes. Notes on air separation; arrangement of large modern plants; present efficiency and future prospects.

AIR COMPRESSORS

Piston. Modern Piston Compressors (Neuzeitliche Kolbenkompressoren), P. Ostertag. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1325–1332, 28 figs. Points out increasing importance of compressed air and its influence on design of piston compressors. Notes on standardization and simplification, drive and regulation. Experimental results with modern types of German low- and high-pressure compressors.

Sullivan Angle-Compound. Angle-Compound Air Compressors at a Colliery. Engineer, vol. 133, no. 3448, Jan. 27, 1922, pp. 111–112, 5 figs. Details of compressor installed at Bowden Close Colliery near Newcastle-on-Tyne, England, consisting of two angle-compound compressors made by Sullivan Machy. Co., Chicago, arranged on each side of, and driven in common by, a 350-hp. Allis-Chalmers self-starting synchronous motor.

Turbo-Compressors. Turbo-Compressors and Blowers (Turbokompressoren und -gebläse), H. Baer. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1333–1338, 14 figs. Notes on operation, basis of calculation and construction of modern turbo-compressors; speed, number of stages, losses, housing and intermediate cooling, regulation. The so-called "pumping" and its prevention. Comparison of piston and turbo-compressors. Useful field.

AIR CONDITIONING

Aero-Hydro-Fan-Separator. Improvements in the Process for Drying and Cleaning Air Mechanically, William J. Baldwin. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 1, Jan. 1922, pp. 49–52, 1 fig. Describes recent improvements made in fan known as an aero-hydro-fan-separator, for washing, drying and conditioning air.

Factories. Industrial Hygiene in Workshops (Ueber gewerbehygienische Einrichtungen in Arbeitsräumen), Otto Brandt. Glasers Annalen, vol. 89, no. 12, Dec. 15, 1921, pp. 149–152, 3 figs. Notes on dust-removal plants, most important parts of which are (1) exhaustor, (2) draft tubes, (3) pressure tubes, and (4) centrifugal dust separator; suction plants for drawing off of smoke, gases and acid fumes; and installations for utilization of flue-gas waste heat for generation of warm air.

Novel Scheme For Regulating Humidity in an Airplane Propeller Factory, A. C. Knauss. Heat. & Vent. Mag., vol. 19, no. 1, Jan. 1922, pp. 33–36, 4 figs. Details of air-conditioning apparatus developed at U. S. Forest Products Laboratory at Madison, Wis. From paper published by Forest Prod. Laboratory in Coöperation with Univ. of Wis.

AIRCRAFT

Armament Limitation Conference. Text of the Conference Discussion on Aircraft. Aerial Age Weekly, vol. 14, no. 21, Jan. 30, 1922, pp. 490–492. Text of official communiqué issued by Conference on Limitation of Armament dealing with discussion of aircraft in session of Committee on Limitation of Armament.

The Washington Conference and Aircraft. Aviation, vol. 12, no. 5, Jan. 30, 1922, pp. 128–132. Report of Sub-committee on limitation of aircraft as to numbers, character and use.

Maintenance. Canadian Technical Memoranda. Aviation, vol. 12, no. 4, Jan. 23, 1922, pp. 105–106. Copy of technical memoranda issued by Canadian Air Board, on aircraft maintenance.

Strength of Great Powers. Air Strength of the Great Powers. Aviation, vol. 12, no. 6, Feb. 6, 1922, pp. 164–166. Tables prepared by sub-committee on aircraft of Washington Conference giving authorized and actual air strength data for United States, France, Great Britain, Italy and Japan.

AIRPLANE ENGINES

Fuel Pump. The "Sylphon" Fuel System for Liberty "12" and Wright Model "H" Engines. Aerial Age Weekly, vol. 14, no. 19, Jan. 16, 1922, pp. 440–442, 5 figs. Describes sylphon pump designed to fill need for an engine-driven fuel pump to obviate use of air pressure where sufficient gravity head is not available. From Air Service Information Circular, vol. 3, no. 281.

Installation. Engine Installation, R. K. Bagnall-Wild. Flight, vol. 14, no. 4, Jan. 26, 1922, pp. 56–57. Discusses need for improvement, and principal features which are required for evolution of a sound installation.

Tests. British Tests for Aircraft Engines, Aerial Age Weekly, vol. 14, no. 19, Jan. 16, 1922, pp. 438–439. Gives schedule of standard tests to determine airworthiness of aircraft engines, issued by British Air Ministry.

AIRPLANE PROPELLERS

Levasseur Adjustable. The Levasseur Adjustable Propeller (L'hélice à pas variable Pièrre Levasseur). L'Aerophile, vol. 29, no. 23–24, Dec. 1–15, 1921, pp. 18–19, 2 figs. Especially useful for flying at high altitude.

AIRPLANES

Aerofoils. New Method for Testing Aerofoils in Flight, F. H. Norton. Aviation, vol. 12, no. 5, Jan. 30, 1922, pp. 134–136, 4 figs. Consisting in suspending an aerofoil from an airplane and measuring resultant force by tension in wires. N. A. C. A. Technical Note No. 77.

Bombers. The Wibault Night Bomber. Flight, vol. 14, no. 2, Jan. 12, 1922, pp. 21–22, 2 figs. French all-metal airplane; wing spars built of duralumin sheet; engine, 600-hp. Renault; speed at 6500 ft., 125 m.p.h.; total loaded weight, 9450 lb.

British. Aeronautics in 1921. Engineer, vol. 133, no. 3445, Jan. 6, 1922, pp. 18–21, 13 figs. partly on supp. plate. Review of British airplanes constructed during year.

Commercial. The "Bristol" 10-Seater Commercial Aeroplane. Flight, vol. 14, no. 3, Jan. 19, 1922, p. 39, 1 fig. 400-hp. Bristol "Jupiter" engine; speed at ground level, 112 m.p.h., speed at 5000 ft., 110 m.p.h.

The D.H. Type 34 Commercial Biplane. Flight, vol. 14, no. 1, Jan. 5, 1922, p. 4, 3 figs. 450-hp. Napier "Lion" engine; wing area, 590 ft.; weight, empty, with water, 3365 lb.; useful load, 10 passengers, 2000 lb. freight, 80 gal. petrol; cruising speed, 105 m.p.h.

Development. Short Survey of the Development of Air Traffic (Kort overzicht over de ontwikkeling van het luchtverkeer, met inleiding tot het bezoek aan den Rijks Studiedienst voor de luchtvaart), E. B. Wolff. Ingenieur, vol. 36, no. 52, Dec. 24, 1921, pp. 1022–1031, 15 figs. Discusses especially form and stability, strength and safety, size of crew and comfort of arrangement.

Fokker. The Fokker F4 Passenger Transport Airplane. Aviation, vol. 12, no. 6, Feb. 6, 1922, p. 169, 2 figs. Latest design of A. Fokker is powered with 400-hp. Liberty; carries 10 passengers and hand baggage; high speed, 106 m.p.h.

Helicopters. See HELICOPTERS.

Huff-Daland Biplanes. The Huff-Daland Thick Wing Biplanes. Aerial Age Weekly, vol. 14, no. 22, Feb. 6, 1922, pp. 514–515, 522 and 531, 4 figs. Describes the HD-9A with 10 cylinder Anzani engine, and the "Petrol" HD-8A, a further development of this machine, incorporating OX-5 motor as power plant. See also Aviation, vol. 12, no. 6, Feb. 6, 1922, pp. 161–163, 2 figs.

Mummert Sport. The Mummert "Baby Vamp" Sportplane. Flight, vol. 14, no. 3, Jan. 19, 1922, pp. 40–41, 3 figs. Air-cooled twin-cylinder engine, developing 25-hp. at 1800 r.p.m.

Rib Forms, Strength of. The Strength of Airplane Rib Forms, D. T. Brown and R. J. Diefenbach. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 110–111. Description of investigation to determine strength of plywood webs, with lightening holes arranged as in airplane ribs.

AIRSHIPS

Commercial. Traffic Airships With Special Reference to Economy, Walther Leyenstetter. Aerial Age Weekly, vol. 14, nos. 21 and 22, Jan. 30 and Feb. 6, 1922, pp. 495–498 and 520–522, 8 figs. Jan. 30: Flight altitude and efficiency; flight speed; distance flown and useful load. Results so far obtained from practical experiments. Feb. 6: How airships should be constructed in order to fulfill economical conditions of purpose for which it is designed; establishment of an airship line; costs of operation and upkeep. Translated from Zeit. für Flugtechnik und Motorluftschiffahrt.

Goodyear Military. New Goodyear Military Airship, H. T. Kraft, Aviation, vol. 12, no. 4, Jan. 23, 1922, pp. 101–102, 2 figs. Nonrigid; 180,000 cu. ft. capacity; geared propellers driven by two 135-hp. Aeromarine type U-6-D engines; speed, 60 m.p.h.

Rigid. Rigid Airships, Garland Fulton. U. S. Naval Inst. Proc., vol. 47, nos. 10 and 11, Oct. and Nov. 1921, pp. 1565–1591 and 1697–1723, 21 figs. Oct.: Discusses German, British, French and Italian developments. Nov.: Modern types of rigid airships, and developments in United States.

Semi-Rigid vs. Rigid. Semi-Rigid v. Rigid Airships, Umberto Nobile. Flight, vol. 14, no. 4, Jan. 26, 1922, pp. 49–50, 2 figs. Discusses the Roma, Italian semi-rigid, and the German or Zeppelin type, and advantages of Roma over Zeppelin. From Giornale del Genio Civile.

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ALCOHOL

Tropical-Plant Fuel Alcohol. Possibilities of the Plant Growth of the Moist Tropics to Furnish Materials for Liquid Fuel, H. N. Whitford. Jl. Indus. & Eng Chem., vol 14, no 2, Feb 1922 pp. 151–152 Reviews possibility of tropics to produce crops of foodstuffs and wood capable of application to manufacture of cellulose and alcohol

ALLOY STEELS

Shock Tests. Shock Tests on Notched Bars (Die Beurteilung der Kerbschlagprobe), H. Moser. Zeit. des Vereines deutscher Ingenieure, vol 66, no 2, Jan. 14, 1922 p. 43. Results of tests for which carbon steels of low and medium tenacity and a nickel steel of high tenacity were used, from each of which standard bars of different widths were made

ALLOYS

Aluminum See ALUMINUM ALLOYS.

Copper. See COPPER ALLOYS

Iron. See IRON ALLOYS.

ALUMINUM

Brittleness of Brittleness Developed in Aluminum and Duralumin by Stress and Corrosion, Henry S. Rawdon, Alexander I Krynitsky and Julius F. T. Berliner Chem & Met Eng vol. 26, no 4, Jan. 25, 1922, pp 151 158 13 figs Aluminum is deeply corroded where impurities lodge between primary grains but if recrystallized, is note embrittled, duralumin is subject to true intercrystalline embrittlement, but intensified by corrosion and stress

Flasks, Manufacture of. Manufacture of Aluminum Flasks (Herstellung von Aluminiumflaschen), Karl Rieger Werkstattstechnik, vol. 16, no. 1, Jan. 1, 1922, pp 1–3, 24 figs. Describes process of manufacture from original aluminum sheet to finished product.

ALUMINUM ALLOYS

Aluminum-Silicon. A New Light Alloy (Silumin, eine neue Leichtlegierung), J Czochalralski. Zeit. für Metallkunde, vol 13, no. 14, Nov. 1921, pp. 507–510, 12 figs. Describes new alloy called silumin, consisting of aluminum and silicon refined through certain additions. It is claimed that its structure and technological properties are superior to similar casting alloys, and its use greatly increases possibilities of employing light alloys for structural purposes.

Bronzes. Macrography and the Pouring of Aluminum Bronzes (Emploi de la macrographie pour la mise au point de la coulée du bronze d'aluminium), J. Galibourg and A. Brizon. Révue de Métallurgie, vol. 18, no. 12, Dec. 1921, pp. 780–786, 15 figs. Difficulties of pouring, especially pipe; use of coolers, their position, etc.

Die Casting. Aluminum and Its Alloys—VI, F. A. Livermore. Metal Industry (Lond.), vol. 20, no. 2, Jan. 13, 1922, pp. 25–29, 7 figs. Deals with aluminum alloy die casting.

AMMONIA

Synthesis of. Synthesis of Ammonia (La recherche scientifique, ses applications a l'industrie et la synthèse industrielle de l'ammoniaque), Georges Claude. Révue Générale des Sciences, vol. 32, nos. 19 and 20, Oct. 15 and 30, 1921, pp. 534–543 and 570–581, 10 figs. Oct. 15: Difficulties of scientific research, its resources, etc.; manufacture of hydrogen, chlorine, helium, neon, etc. Oct. 30: Describes equipment and operations at Montereau Ammonia Extraction works working at a pressure of 1,000 atmos

AMMONIA COMPRESSORS

Starterless Induction Motors for. Starterless Induction Motors for Ammonia Compressors, J. Lebovici. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, pp. 24–25. Describes starterless motor, combining favorable characteristics of squirrel-cage and slip-ring types, making an ideal drive for ammonia compressors using up to 150 hp. Paper read before Nat. Assn. Practical Refrig. Engrs.

AUTOMOBILE ENGINES

Air-Cooled. Air-Cooling Systems: Past, Present and Future. Autocar, vol. 28, no. 1369, Jan. 14, 1922, pp. 47–50, 7 figs. Gives concise summary of the various points for and against use of air-cooled engines for small cars, directions in which developments must tend.

Single-Cylinder Air-Cooled Sleeve-Valve Motor-Cycle Engine Engineering, vol. 113, no. 2924, Jan. 13, 1922, pp. 44–45, 9 figs. Details of Barr and Stroud engine with 70-mm. bore and 90.5-mm. stroke, giving capacity of 349 cc., said to be first application of this type of engine to automobile work.

Braking Tests. Braking Tests with Automobile Engines (Kurze Anleitung zu Bremsversuchen an Kraftwagenmotoren), A. Heyne Allgemeine Automobil-Zeitung, vol. 22, nos. 19 and 20, May 7 and 14, 1921, pp. 37–39 and 36–38, 1 fig. Notes on determination of brake power, torsional moments, mean piston pressures, fuel consumption, and pumping efficiency. Gives example of how to conduct tests.

Cylinders. Cylinders for the Mack Motor, Fred. H. Colvin. Am. Mach., vol. 56, no. 5, Feb. 2, 1922, pp. 173–174, 7 figs. Fixtures, trams and gages for locating cylinder from bore. Inspection methods which secure results. Volume of compression chamber tested by liquid gage.

Operations on the Cylinders of the Wills Sainte Claire, Fred H. Colvin. Am. Mach., vol. 56, no. 5, Feb. 9, 1922, pp. 216–218, 12 figs. Closed end cylinders require special tools for machining combustion chambers. Special boring machine with inclined spindles. Heat-treatment removes strains.

Peugeot-Tartrais Direct-Injection. Peugeot To Produce Automotive Injection Engine, W. F. Bradley. Automotive Industries, vol. 46, no. 6, Feb. 9, 1922, pp. 269–271, 11 figs. Said to be capable of using any liquid fuel; two-stroke cycle, develops 50 hp at 1250 r p m.; weight, 550 lb.; uses 0 397 lb. fuel per hp hr at full load and 0.184 lb at quarter load See also Commercial Vehicle, vol 26, no. 1, Feb. 1, 1922, p 31, 3 figs

The Peugeot-Tartrais Engine Autocar, vol. 48, no 1370, Jan. 21, 1922, pp. 116 117, 8 figs. A 2 cylinder, 2-cycle, direct-fuel-injection power unit weighing 11 lb. per hp., allowing a wide choice for fuels

Two-Stroke Cycle. A New Two-Stroke Engine. Autocar, vol 28, no. 1369, Jan. 14, 1922, pp. 73 74, 2 figs Describes three-cylinder two-cycle Wege motor Each lower cylinder acts as a compressor for an adjacent upper cylinder, in which power impulse takes place.

The Two-Stroke Motor Car Engine, F. W. Lanchester and R H. Pearsall. Engineering, vol. 133, nos 2925 and 2926, Jan. 20 and 27, 1922, pp 90 92 and 122 121, 16 figs. Investigation of principal factors controlling performance of such engines. Paper read before Instn. Automobile Engrs.

AUTOMOBILES

Alfa-Romeo. The 35–50 Hp. Alfa Romeo Chassis. Automobile Engr., vol. 12, no. 159, Jan. 1922, pp. 2 6, 9 figs. Built by Nicola Romeo & Co., Milan. Main features are ease of inspection and facilities for repairs or replacements.

Berliet. The 20 hp. and 25 hp. Berliet Cars Autocar, vol. 28, no. 1369, Jan. 14, 1922, pp. 59 60, 5 figs. Monobloc four-cylinder engines; unit principle of construction.

Bugatti and Hillman. Some 1922 Car Features. Auto, vol. 27, no. 2, Jan. 12, 1922, pp. 29 32, 13 figs Particulars of new 16-valve 23.8-hp. straight-eight Bugatti, and the 11-hp. Hillman car, in chassis of which steel stampings are largely used.

Electric. A Modern Electric Passenger Vehicle, Herbert Chase. Automotive Industries, vol. 46, no 6, Feb 9, 1922, pp. 265–268, 6 figs. Describes new car of Ranch & Lang; weight of battery approximately 830 lb., distributed front and back; maximum speed, 28 m.p.h. in sixth controller position, and 25 m.p.h. in fifth.

Elgin. Elgin Chassis Has Been Completely Redesigned, P. M. Heldt. Automotive Industries, vol. 46, no. 3, Jan. 19, 1922, pp. 134–135, 4 figs. New model 700 is fitted with 6-cylinder valve-in-head type special Falls engine, new single-plate clutch, larger fan and radiator and new hand brake on gear set.

Front-Axle Stubs. Machining Automobile Front Axle Stubs, F. Hickling. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 497–499, 7 figs. Discusses layout for a particular type of stub, which has been in use for over two years, on a production of 50 to 100 pairs per week.

Frontenac 4-Cylinder. New Four-Cylinder Car Has Brakes on All Wheels, J. Edward Schipper. Automotive Industries, vol. 46, no. 1, Jan. 5, 1922, pp. 5–6, 4 figs. Describes new Frontenac car designed by Chevrolet and Van Ranst. Chain-driven overhead camshaft and location of electrical units alongside gear set gives a clean-appearing power plant.

Gear Boxes. Notes on Motor Car Gearboxes, H. F. L. Orcutt. Automobile Engr., vol. 12, no. 159, Jan. 1922, pp. 22–30, 7 figs. Discusses principal defects relating to design, workmanship and material. Describes gear-tooth grinding process. Costs of production. Paper read before Instn. Automobile Engrs.

Manufacture. Cars in the Making. Autocar, vol. 47, nos. 1365, 1366 and 1367, Dec. 17, 24 and 31, 1921, pp. 1254–1255, 1289–1291 and 1341–1343, 18 figs. Dec. 17: Practical working out of designs by experimental work. Dec. 24: Describes methods by which raw materials are worked up into forms suitable for economic processes of machine-shop production. Dec. 31: Deals with preparation of tools and jigs, and explains methods of using lathe to secure interchangeability of parts.

Napier. The 40–50 Hp. Napier Chassis, Automobile Engr., vol. 11, no. 158, Dec. 1921, pp. 430–437, 20 figs. Describes frame, engine (6-cylinder block), clutch (single-plate), gear box, foot brake, transmission and rear axle, front axle and steering, etc.

Repair-Shop Practice. Automobile Repair Shop Practice. Machinery (Lond.), vol. 19, no 485, Jan. 12, 1922, pp. 445–447, 4 figs. Describes methods and equipment commonly employed in automobile repair shop practice.

Service Equipment. Automotive Service Methods and Equipment, Howard Campbell. Am. Mach., vol. 56, no. 4, Jan. 26, 1922, pp. 125–127, 11 figs. Tools used for servicing Hudson and Essex Cars. Fixtures for testing and straightening. Attachments for lapping pistons and cylinders.

Wolseley Works. Famous British Works. Eng. Production, vol. 4, no. 70, Feb. 2, 1922, pp. 98 100, 6 figs. Describes works of Wolseley Motors, Ltd., Birmingham, engaged at present in manufacture of the 10-hp. Wolseley, the Wolseley "fifteen," and the 20-hp. car de luxe.

AVIATION

French Civil Transport. French Progress in Civil Air Transport, M. de Lavergne. Aviation, vol. 12, no. 6, Feb. 6, 1922, pp. 170–171. In three years French merchant air fleet expanded from 46 airplanes to 258, all of which are used on regular transport services.

Pilot and Aircraft Registration. Underwriters' Laboratories Aviation Record. Aviation, vol. 12, no. 6, Feb. 6, 1922, pp. 160–161, 1 fig. Gives first list of American pilot and aircraft registration, prepared at request of Nat. Aircraft Underwriters Assn., members of which are hereafter to require registration of aircraft which they insure against fire, theft, collision, stranding and sinking, etc.

B

BEARINGS, BALL

Design and Performance. Ball and Roller Bearings. Their Design and Performance, A. W. Macaulay. Engineering, vol 113, no 2925, Jan. 20, 1922, p. 87, 6 figs Points out that principal conditions which bearing must fulfill are (1) capacity for taking combined radial and thrust load, (2) self-contained unit having no loose parts, and without necessity of any adjustment, (3) high fatigue limit; (4) lowest possible friction; (5) absence of vibration. (Abstract.) Paper read before Instn. Engrs. & Shipbuilders in Scotland.

BLAST FURNACES

Hot-Blast Stove Rating. Hot Blast Stove Rating, F. H. Willcox. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 29 32. Actual test data showing effectiveness of hot blast stove equipment as applied to a 600-ton blast furnace.

Rebuilt. Rebuilds Stack on Historic Site, Richard Peters, Jr. Iron Trade Rev., vol. 70, no. 5, Feb. 2, 1922, pp. 325 328, 5 figs. Furnace succeeding famous Warwick unit has been replaced, work involving construction of new stack, top and downcomers. New blast furnace has skip bridge with independent shear leg support.

BLOWERS

Roots. Hints on Repairing Roots Blowers, F. R. Parsons. Mech. World, vol. 71, no. 1830, Jan. 27, 1922, pp. 64–65, 3 figs. Maintenance and efficient upkeep of Roots pressure blowers; sources of trouble and suggested remedies; lubrication and belt troubles.

Turbo. Turbo-Boosters and Exhausters for Town Gas. Engineering, vol. 113, no. 2926, Jan. 27, 1922, pp. 105 106, 8 figs. partly on p. 108. Deals with some of later developments by The Bryan Donkin Co., Ltd., Chesterfield, England, particularly the Rateau turbo-blowers and fans.

BOILER EXPLOSIONS

Causes. A New Boiler Explosion, G. W. Atkinson. Power, vol. 55, no. 6, Feb. 7, 1922, pp. 206–207, 3 figs. Leakage near flange of bumped head led to investigation which disclosed dangerous crack. Breathing of head probable cause.

BOILER OPERATION

CO_2 Values, Interpreting. Effect of Coal on Excess Air in Boiler Operation, Hugh R. Carr. Power Plant Eng., vol. 26, no. 2, Jan. 15, 1922, pp. 112–114, 2 figs. Considerations to be taken into account in interpreting CO_2 values with different kinds of coal.

Efficient. The Necessity for and Savings Possible with Better Boiler-Room Operation. C. W. De-Forest. Power, vol. 55, no. 4, Jan. 24, 1922, pp. 139 141, 3 figs. Deals with cost of fuel, organization, boiler-room instruments and records. (Abstract.) Paper read before Stoker Mfrs. Assn.

BOILER PLANTS

Ford Motor Co. Power House. A Large American Power Plant. Eng. Production, vol. 4, nos. 68 and 69, Jan. 19 and 26, 1922, pp. 61–64 and 85–88, 6 figs. Details of boiler equipment of Ford Motor Co. (Abstract.) Paper presented to Engrs. Soc. West. Pa., by George T. Ladd, with contributions by H. T. Savage and J. R. Le Valley.

Valuation. Valuation of the Boiler Plant, Allen F. Brewer. Combustion, vol. 6, no. 2, Feb. 1922, pp. 84–88. Notes on unit cost data; overhead charge estimation; salvage and service values.

BOILERS

Capacities. Boiler Capacities Obtainable per Cubic Foot of Furnace Volume, T. B. Stillman. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 171–173, 3 figs. Detailed test results on boilers operating at as high as 658.9 per cent rating. In one case 2285 lb. of oil was burned per hr. per burner. Paper presented before Assn. Edison Illuminating Companies.

High-Pressure. High-Pressure Steam up to 60 Atmos. for Power and Heat Generation (Hochdruckdampf bis zu 60 at in der Kraft- und Wärmewirtschaft), O. Hartmann. Elektrotechnische Zeit., vol. 43, no. 2, Jan. 12, 1922, pp. 45–47, 2 figs. Describes high-pressure boiler for 60 atmos. developed by Wilhelm Schmidt, which can safely generate steam at this atmosphere and up to temperature of 480 deg. It has a grate surface of 1.42 sq. m. and total heating surface, including superheater, of 72 sq. m. and has generated steam up to 1340 kg. per hr. (Abstract.) Address and discussion before Soc. German Engrs.

Locomotive. See LOCOMOTIVE BOILERS.

Marine. See MARINE BOILERS.

BOILERS, WATER-TUBE

Kestner. Developments in Power Station Design. Engineer, vol. 133, no. 3446, Jan. 13, 1922, p. 41, 2 figs. Describes Kestner water-tube boiler which, it is claimed, has acquired favor in France, Belgium, Denmark, Germany, Russia and the Argentine.

Marine. A New Water-Tube Boiler For Merchant Ships. Mar. Engr. & Naval Architect, vol. 45, no. 532, Jan. 1922, pp. 10–11 and 40, 2 figs. Describes the Hawthorn-Armstrong patent boiler in which an effort has been made to combine in one unit a steam generator suitable for use in merchant ships and to provide a high degree of superheat.

BORING MACHINES

Machining Locomotive Brasses. Machining Locomotive Brasses on Boring Mill, J. H. Moore. Can. Machy., vol. 27, no. 2, Jan. 12, 1922, pp. 17-19, 9 figs. Importance of proper fixtures if maximum production is to be attained. Describes machining of a 9-in. globe valve.

BRAKES

Freight-Train Vacuum. Vacuum Brake Trials on the Great Northern Railway, Henry Fowler. Ry. Gaz., vol. 36, no. 3, Jan. 20, 1922, pp. 87-88 and 100, 3 figs. Results of trials in connection with application of vacuum brake for long freight trains carried out between Peterborough and Firsby. Paper read before Instn. Civil Engrs.

Railway Brakes for Heavy Traffic. Engineering, vol. 113, no. 2924, Jan. 13, 1922, p. 43. Abstracts of two papers read before Instn. Civ. Engrs., entitled, Control of Trains Considered in Relation to Increase of Weight and Speed, Combined with Reduced Headway, by Alan Wood Rendell; and Trials in Connection with the Application of the Vacuum Brake for Long Freight Trains, Henry Fowler and Herbert N. Gresley.

BRASS

British Industry. Modern Developments in the British Brass Industry, Ernest T. Smith. Can. Chem. & Metallurgy, vols. 5 and 6, nos. 12 and 1, Dec. 1921 and Jan. 1922, pp. 345-348 and 8-12. Discusses extent to which existing scientific and technical knowledge has been utilized in British brass industry as a whole and describes development resulting from its utilization. Melting and foundry practice; electric furnaces; extrusion of brass; hot pressing and forging; rolling-mill practice; annealing; composition of brasses and special alloys; research and its organization. Paper read before Am. Electrochem. Soc.

Rod. Modern Methods of Making Brass Rod. Brass World, vol. 18, no. 1, Jan. 1922, pp. 3-4, 9 figs. partly on pp. 5-7. Describes development of extrusion process and present-day extrusion machines.

Season Cracking. Experiences of Season Cracking during the Great War, Owen W. Ellis. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 193-200. Points out success which attended ordnance factories' practice of low-temperature annealing.

The Prevention of Season Cracking in Brass by the Removal of Internal Stress, H. Moore and S. Beckinsale. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 162-192, 22 figs. Reduction of stress by low-temperature annealing was studied in 70-30 brass cold-rolled to 120, 160, and 200 Brinell hardness, in elastically bent test-strips of each hardness, initally stressed to 11, 17, and 22 tons per sq. in. maximum tension at surface. Results are presented in tables and summarized.

Spontaneous Cracking. The Spontaneous Cracking of the Necks of Small Arm Cartridge Cases, W. C. Hothersall. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 201-208, 6 figs. Said to be due to existence of stress in neck of case arising in some operation or operations subsequent to semi-annealing.

BRONZE

Manganese. Manganese Copper, Jesse L. Jones. Metal Industry (N. Y.), vol. 20, no. 1, Jan. 1922, p. 7. Discusses its use in manufacture of manganese bronze, and methods of obtaining best results.

C

CABLEWAYS

Aerial. Automatic Aerial Tramway. Rock Products, vol. 25, no. 3, Feb. 11, 1922, pp. 26-27, 2 figs. Tramway at Clinchfield Products Corp. operating a barytes mine at Evington, Va., is reversible; hauls both coal and ore.

Track Cables. Tensions in Track Cables and Logging Skylines, Samuel Herbert Anderson. University of Washington Eng. Experiment Station Bul., no. 13, June 1921, 27 pp., 5 figs. Deals with problem of catenary loaded at one point. Equations are derived and properties of such catenary discussed. It is shown how tensions may be computed and what the condition is for maximum tension.

CAR WHEELS

Flange Lubrication. Automatic Lubricating Apparatus for Flanges of Wheels of Electric Cars (Appareil de graissage automatique pour les boudins des roues de voitures automotrices électriques), H. Strehler. Bul. Technique de la Suisse Romande, vol. 47, no. 26, Dec. 24, 1921, pp. 301-303, 5 figs. Describes apparatus for railroad use and one for street cars for lubricating when negotiating curves, without dropping oil on rails.

Machining. Correct Machining and Mounting of Wheels and Axles and the Necessity for Carefully Measuring Axles Removed from Cars so that Proper Credits can be Allowed, Chas. Petran. Official Proc. of Car Foremen's Assn. of Chicago, vol. 17, no. 3, Dec. 1921, pp. 16-29 and (discussion) 30-57, 3 figs. Discusses boring of cast iron wheels; fitting wheels to axles; wheel mounting pressure and its automatic registration; instructions to guard against wrong inspection of axles; rolled-steel wheels; etc.

Manufacture. Wheels for Railway Rolling-Stock. Ry. Gaz., vol. 35, no. 27, Dec. 30, 1921, pp. 1000-1002, 6 figs. Describes new process of manufacturing wheel centers of the solid disk type.

Steel-Tired. Cast-steel and Steel-tyred Wheels, H. W. Mellor. Machinery (Lond.), vol. 19, no. 486, Jan. 19, 1922, p. 479, 4 figs. Suitable thickness for steel tires, and rims for steel wheels.

Sandberg Sorbitic Steel for Tyres. Ry. Gaz., vol. 35, no. 27, Dec. 30, 1921, pp. 991-992 and 999, 6 figs. partly on p. 993. Improvements due to Sandberg process which add considerably to capacity of rolling stock and reduce occupancy of repair shops. See also Ry. Engr., vol. 43, no. 504, Jan. 1922, pp. 16-17 and 35, 6 figs.

CARS

Reclaiming Metal Roof Sheets. Reclaiming Sheets of Outside Metal Car Roofs. Ry. Age, vol. 72, no. 4, Jan. 28, 1922, pp. 275-276, 4 figs. Savings in car-repair costs are result of moderate expenditures for facilities.

CASE-HARDENING

Charcoal Carbonization. Carbonization With Wood Charcoal, H. Schagrin. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 331-335 and (discussion) 335-338, 12 figs. Discusses tests made with drop forgings of acid bessemer steel which showed that charcoal was cheap and satisfactory casing material.

CAST IRON

Hardness Tests. Mechanical and Elastic Properties of Cast Iron and the Use of the Ball Hardness Test (Caractéristiqués méchaniques ét élastiques des fontes et utilisation de l'essai à la bille), Albert Portevin. Révue de Métallurgie, vol. 18, no. 12, Dec. 1921, pp. 761-779, 19 figs. Discusses tests required by French artillery for steeled iron shells, including elongation, compression, and hardness.

Malleable. American Malleable Cast Iron, H. A. Schwartz. Iron Trade Rev., vol. 70, nos. 5 and 6, Feb. 2 and 9, 1922, pp. 335-341 and 410-411, 14 figs. Mechanical effects of plastic deformation.

Malleableizing of White Cast Iron, Arthur Phillips and E. S. Davenport. Am. Inst. Min. & Metallurgical Engrs. Trans., no. 1117-S, 1922, 23 pp., 49 figs., and (in abstract) Min. & Metallurgy, no. 181, Jan. 1922, pp. 31-32. Presents data and observations resulting from series of experiments dealing with heat treatment and microstructure of commercial white cast iron and its derivative, malleable iron.

The Molding of Malleable Pig Iron (Aus der Formereitechnik des Tempergusses), Rudolf Stotz. Giesserei-Zeitung, vol. 19, no. 1, Jan. 3, 1922, pp. 1-5, 14 figs. Discusses difficulties encountered in molding of malleable iron due to its possessing strong shrinking and brittle properties, and makes suggestions for overcoming these difficulties.

Synthetic. Manufacture of Synthetic Cast Iron in the Electric Furnace, W. L. Morrison. Chem. & Met. Eng., vol. 26, no. 7, Feb. 15, 1922, pp. 312-316. Production on Pacific coast; detrimental effects of excessive dry slags; comparative operating costs.

Synthetic Cast Iron, Made in California, Larry J. Barton. Chem. & Met. Eng., vol. 26, no. 6, Feb. 8, 1922, pp. 270-271. Discusses production of iron from steel scrap and gives particulars of electric-furnace operations.

CASTINGS

Automobile. British Motor Castings Methods—III, Ben Shaw and James Edgar. Foundry, vol. 50, no. 3, Feb. 1, 1922, pp. 103-107, 23 figs. Making of patterns and coreboxes for a typical crankcase casting; detail and reasons for methods recommended.

CENTRAL STATIONS

Superpower, France. The Superpower Station at Gennevilliers (La supercentrale de Gennevilliers), L. D. Fourcault. Technique Moderne, vol. 13, no. 12, Dec. 1921, pp. 525-527, 9 figs. partly on supp. plate. Describes civil engineering work, including foundations, especially for machines.

CHIMNEYS

Calculation. Simplified Chimney Calculation (Vereinfachte Schornstein-Berechnung), Otto Hoffmann. Feuerungstechnik, vol. 10, nos. 6, 7 and 8, Dec. 15, 1921, Jan. 1 and 15, 1922, pp. 53-56, 65-68 and 79-82, 2 figs. Simple method is developed for determining, for all sizes and fuels, the correct chimney dimensions. Comparison of ten different methods of calculation.

CHROME-NICKEL STEEL

Krupp Rustproof. Krupp Rustproof Steel, Fritz Huth. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 120-121. Developed as result of investigations carried out at establishment during years 1909 to 1914 on corrosion of steel, and belonging to class of chrome-nickel steels. Translated from Metall-Technik, vol. 47, no. 17, Nov. 1, 1921, p. 123.

CHROME STEEL

Heat Treatment. The Heat Treatment of Special Steels in General and with Particular Reference to Chrome Steels (Ueber die Wärmebehandlung der Sonderstähle im allgemeinen und der Chrosmtähle im besonderen), E. Maurer and T. Hohage. Stahl u. Eisen, vol. 42, no. 2, Jan. 12, 1922, pp. 59-61. Deals with heat treatment of the steels, with special regard to notch test and tensile strength. (Abstract.) Mitteilung K.-W.-Inst. f. Eisenforschung, vol. 2, pp. 91-105.

Properties. Chromium Steels and Irons, Leslie Aitchison. Automobile Engr., vol. 11, no. 158, Dec. 1921, pp. 451-458, 5 figs. Discusses the three main advantages of alloy steels as against carbon steels, viz., high tensile strength, high toughness, ease in hardening and homogeneity in resulting product. Mechanical properties of chromium steels and irons. Paper read before Instn. Automobile Engrs.

CLUTCHES

Pomini Friction. The Pomini Friction Clutch. Engineering, vol. 113, no. 2925, Jan. 20, 1922, pp. 70-71, 32 figs. Partly on supp. plate. Describes clutch constructed by Societa Anonima Luigi Pomini, Castellanza, Italy, known as "Superpotente," and intended to transmit 3000 hp. at 330 r.p.m. It is suitable for coupling Diesel engines to propeller shafts in submersible boats. Several were delivered to Italian Navy for war service.

COLD STORAGE

Meat and Fish. On the Freezing of Food-Stuffs, Martin Krause. Eng. Progress, vol. 3, no. 1, Jan. 1922, pp. 7-10, 6 figs. Discusses investigations carried out in Germany regarding process of freezing pork, beef and fish.

COLUMNS

Buckling. Buckling of Elastic Structures. Am. Soc Civ. Engrs. Proc., vol. 48, no. 1, Jan. 1922, pp. 103-110, 1 fig. Discussion by George Paaswell of paper by H. M. Westergaard published in same journal (Nov. 1921.)

COMPRESSED AIR

High-Pressure Handling. Methods of Handling Very High Pressures, P. W. Bridgman. Compressed Air Mag., vol. 27, no. 1, Jan. 1922, pp. 17-19, 5 figs. Explains methods of packing pistons and joints in order to obtain pressures up to 500,000 lb. per sq. in.

CONDENSERS, STEAM

Surface. Measurement of Surface-Condenser Leakage by Electrolytic-Conductivity Method, Earl A. Keeler. Power, vol. 55, no. 4, Jan. 21, 1922, pp. 126-128, 6 figs. Discusses difficulties in applying electrical methods to measuring condenser leakage, and how some of these difficulties have been overcome. How measurements are made. Factors affecting accuracy of measurements.

CONNECTING RODS

Side Thrust Due to Obliquity. Side Thrust due to Obliquity of the Connecting Rod in a High Speed Reciprocating Engine, Tetsuji Sugihara. Technology Reports of Tôhoku Imperial University, vol. 2, no. 3, 1921, pp. 17-26, 7 figs. Writer seeks to obtain expression for side thrust due to obliquity of connecting rod, and expresses it graphically when these effects are taken into account.

CONVERTERS

Bessemer Side-Blown. New Side-Blown Bessemer Converter, T. Levoz. Mech. Eng., vol. 44, no. 2, Feb. 1922, p. 122, 1 fig. Historical account of development, with criticism of various types. Describes type developed by author and points out its advantages. Translated from Fonderie Moderne, no. 10, Oct. 1922, pp. 284-290, 3 figs.

CONVEYORS

Overhead System. Double-Rail Overhead Conveying System, G. L. Lacher. Iron Age, vol. 109, no. 6, Feb. 9, 1922, pp. 409-410, 5 figs. Safeguards against track-jumping. Trolleys have two, four or eight wheels, and can carry load of 3000 lb.

Steel Belt. Swedish Steel Belt Conveyors, Harry Carlson. Iron Age, vol. 109, no. 5, Feb. 2, 1922, pp. 321-323, 7 figs. Especially adapted to hot and sticky materials, which cannot be carried on rubber or fabric belts. Lower power cost.

Types. Conveying and Elevating Machinery, Gardner Mitchell. Eng. & Indus. Management, vol. 7, no. 4, Jan. 26, 1922, pp. 109-114, 6 figs. Deals with spiral or worm, screw, paddle, belt, gravity-bucket, tray, slat, push-plate or scraper, and drag-link conveyors; and chain, belt and bucket elevators. Paper read before (British) Instn. Mech. Engrs.

COOLING TOWERS

Recooling. The Recooling of Water in Self-Ventilating Tower Coolers (Ueber die Wasserrückkühlung mit selbstventilierendem Turmkühler), Carl Geibel. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 242, 1921, 98 pp., 128 figs. Tests carried out on experimental plant designed by author, in which different types of cooling towers and spraying nozzles were temporarily installed. Tests were conducted under widely differing atmospheric conditions with varying volumes of water and heat units. Results are given in equations indicating properties of the different cooling plants, and permitting comparisons between recirculated and fresh-water operation.

COPPER ALLOYS

Phosphor-Copper. Phosphor Copper, Jesse L. Jones. Metal Industry (N. Y.), vol. 20, no. 1, Jan. 1922, pp. 6-7. Discusses its increased use as a deoxidizer, and methods of obtaining best results.

CORROSION

Causes and Prevention. What It Pays to Know About Corrosion, G. A. Van Brunt. Factory, vol. 27, nos. 5 and 6, Nov. and Dec. 1921, pp. 621-623 and 763-766, 1 fig. and vol. 28, nos. 1 and 2, Jan. and Feb. 1922, pp. 49-52, 4 figs. and pp. 172-174. Nov.: Causes and best methods of preventing corrosion. Dec.: How coatings of various metals, variously applied, protect iron and steel. Jan.: Where to use coatings of paint and japan. Feb.: Oxides and phosphates: Where to use them as protective coatings.

Condenser Tubes. Results Achieved by the Corrosion Committee British Institute of Metals, Ernest E. Thum. Chem. & Met. Eng., vol. 26, no. 7, Feb. 15, 1922, pp. 301-306, 9 figs. Discusses failure of brass condenser tubes in marine service, caused by lodgment of solids which trap corrosive substances formed during process of slow general thinning.

Iron Pipe. Increasing the Safety against Rust and the Mechanical Resistivity of Iron and Iron Pipes (Fördern der Rostsicherheit und mechanischen Widerstandsfähigkeit von Eisenröhren bzw. Eisen), B. Haas. Zeit für die gesamte Giessereipraxis, vol. 42, nos. 10 and 11, Mar. 5 and 12, 1921, pp. 141–143 and 135–137. Discusses preventive measures.

Zinc and Tin. Corrosion Patterns on Cold-Worked Tin and Zinc, Henry S. Rawdon, Alexander I. Krynitsky and Julius F. T. Berliner. Chem. & Met. Eng., vol. 26, no. 5, Feb. 1, 1922, pp. 212–213, 3 figs. Properties of tin and zinc after deep corrosion.

COST SYSTEMS

Relation to Production. The Costing System and Its Relation to Production, G. H. Hales. Eng. & Indus. Management, vol. 7, nos. 1, 2, 3 and 4, Jan. 5, 12, 19 and 26, 1922, pp. 17–19, 31–34, 63–65, 5 figs. Jan. 5: Writer demonstrates value of coördination between costs and production department. Jan. 12: Questions relating to "productive hours," departmental expenses and establishment charges. Feb. 19: Premium bonus tickets. Jan. 26: Outlined system in practice. See also Eng. Production, vol. 4, nos. 66 and 67, Jan. 5 and 12, 1922, pp. 7–10 and 31–34, and (discussion), no. 68, Jan. 19, 1922, pp. 66–67. Paper read before Instn. Production Engrs.

CRANES

Electric Runabout. An Electric Runabout Crane. Eng. Production, vol. 4, no. 70, Feb. 2, 1922, p. 115, 1 fig. Describes trackless mobile cranes built by Ransomes, Sims & Jefferies, Ltd., Ipswich, England.

Hoisting Motors for. New Control for Lowering Speed on Three-Phase Cranes (Eine neue Senkbremsschaltung für Krane in Drehstromanlagen), Chr. Ritz. Siemens-Zeit., vol. 1, no. 12, Dec. 1921, pp. 476–480, 3 figs. Instead of one three-phase hoisting motor, two half-size motors, rigidly connected, are used. Hoisting is done with both motors in parallel, as if they were a single unit, but in lowering a load the two motors are energized in opposite torque sense. Characteristic operating curves of such a hoisting motor are given.

Locomotive. Increasing the Scope of Locomotive Cranes. Ry. Age, vol. 72, no. 6, Feb. 11, 1922, pp. 363–367, 4 figs. Experiences of Lehigh Valley demonstrates that a wide range of work can be handled advantageously.

CRANKCASES

Machining. Machining the Mack Crankcase, Fred H. Colvin. Am. Mach., vol. 56, no. 7, Feb. 16, 1922, pp. 256–257, 10 figs. Describes unusual milling cutter. Zylol used for detecting cracks. Methods of boring and reaming. Gages for final inspection.

CRANKSHAFTS

Forging. Radiagraph Aids in Forging Crankshafts, Fred E. Rogers. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 26–28, 9 figs. Mechanically operated cutting torches for cutting heavy crankshafts, for preliminary cuts and cutting after cranks have been twisted through 120 deg.

Machining. A Crank Arm Turning Machine, P. M. Heldt. Automotive Industries, vol. 46, no. 2, Jan. 12, 1922, pp. 77–78, 5 figs. Describes device which simultaneously turns non-circular contours of all of the arms of an engine crankshaft.

CUTTING TOOLS

Diamond. Manufacture and Use of Diamond Cutting Tools, Ellsworth Sheldon. Am. Mach., vol. 56, nos. 4 and 6, Jan. 26 and Feb. 9, 1922, pp. 140–142, 5 figs. and 210–212, 8 figs. Jan. 26: Polishing or lapping the stone; wire-drawing dies. Feb. 9: Diamonds for drawing dies; methods of reducing diamonds to dust.

D

DIE CASTING

Methods. How Diecastings Are Produced, Herbert Chase. Automotive Industries, vol. 46, no. 1, Jan. 5, 1922, pp. 21–25, 8 figs. Describes methods followed and various types of die-casting machines employed. Characteristics of various alloys.

Pressure. Pressure Die Casting. Metal Industry (Lond.), vol. 20, no. 1, Jan. 6, 1922, pp. 1–3, 2 figs. Advantages of die casting over other forms of manufacture. Discusses half-round bearing dies.

DIESEL ENGINES

Compressors for. The Use of Compressed Air in Diesel Engined Ships, William Reavell. North-East Coast Instn. Engrs. & Shipbuilders, advance paper no. 3222-P, for meeting Jan. 27, 1922, 16 pp., 26 figs. In author's opinion, main compressor of marine Diesel engines is usually made needlessly large, and better efficiency in operation and saving in cost, weight, power, etc., would be obtained if capacity were reduced. Discusses functions and construction of auxiliary compressors.

Deutz Compressorless. The New Deutzer Compressorless Diesel Engine (Der neue Deutzer kompressorlose Dieselmotor), H. Schneider. Oel- u. Gasmaschine, vol. 18, no. 12, Dec. 1921, pp. 186–188, 4 figs. Notes on design, operation and advantages of new compressorless horizontal Diesel engine, which can be operated with all heavy oils, including tar oil.

Flexibility. Diesel-Engine Flexibility, W. S. Burn. North-East Coast Instn. Engrs. & Shipbuilders advance paper, no. 3228-P, for meeting Jan. 6, 1922, 40 pp., 22 figs. Investigation of flexibility of Diesel engine with view to its application to direct-driven Diesel locomotive.

Fuel Injection. Devices for Injection of Fuel Oil with Use of Injection Air in Diesel Engines without Regulation of the Discharge Openings (Vorrichtungen zum Einspritzen von Brennöl unter Verwendung von Einblaseluft bei Dieselmaschinen ohne Regelung der Ausspritz-Querschnitte). Wirtschaftsmotor, no. 7, July 1921, pp. 19–21. Controversy between Max Lindemann and F. E. Bielefeld relative to article by Lindemann published in same journal (no. 4, p. 17) and article by Bielefeld published in Oel- u. Gasmaschine (no. 1, p. 1).

Manufacture. Production of Cylinders, Pistons and Segments for Combustion Engines (Fabrication des cylindres, pistons et segments des moteurs à combustion). L'Ouvrier Moderne, vol. 4, no. 10, Jan. 1922, pp. 407–410, 2 figs. Choice and treatment of metals used in manufacture for Diesel engines.

Marine, Nobel 1600 B.H.P. Nobel-Diesel Marine Engine, George J. Steinheil. Engineer, vol. 133, nos. 3448 and 3449, Jan. 27 and Feb. 3, 1922, pp. 91–93, 5 figs. partly on p. 102, and 126–128, 6 figs. Describes latest product of Swedish Nobel-Diesel Co., Ltd., at Nynashamn. Engine is of two-cycle single-acting direct reversible crosshead marine type with 2000 i.hp. and giving mechanical efficiency of 80 per cent. Result of official trials.

The Two-Stroke Diesel Engine for Ship Drive (Die Zweitakt-Dieselmaschine im Schiffsbetrieb), H. Flasche. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 3, Jan. 21, 1922, pp. 53–59, 33 figs. Design and operation of a new 2000-hp. engine with port valve gear, constructed by the Nobel-Diesel Corp., Nynashamn, Sweden. Gives results of tests and points out advantages of two-stroke cycle.

Merchant-Ship. Krupp's New Merchant-Ship Diesel-Engine, Otto Alt. Motorship, vol. 7, no. 11, Feb. 1922, pp. 99–103, 10 figs. Describes the Germaniawerft 2,000-i.hp. four-cycle-type marine oil engine. Acceptance tests.

DISTILLATION

Still Heating with Superheated Steam. Should Melting Kettles and Distillation Stills be Heated with Superheated Steam? (Sollen Schmelzkessel und Destillierblasen mit überhitztem Dampf geheizt werden?), H. Voss. Chemiker-Zeitung, vol. 46, no. 2, Jan. 5, 1922, pp. 17–18. Author explains why, in the manufacture of ceresin and distillation of sebacic acid, glycerine and mineral oil, he cannot recommend superheated steam for heating of still.

DRAWINGS

Dimensioning Dovetails. The Dimensioning of Dovetails on Drawings, H. M. Funnell. Am. Mach., vol. 56, no. 6, Feb. 9, 1922, pp. 221–222, 2 figs. System of giving all necessary figures and enabling checking. Two separate sketches made of each dovetail. Proper tolerances for each dimension.

DRILLING MACHINES

Heavy-Duty. Economy of Heavy-duty Drilling. Machinery (Lond.), vol. 19, no. 486, Jan. 19, 1922, pp. 472–477, 15 figs. Deals with the use of Colburn heavy-duty drilling machine for work where heavy cuts are required.

Jigs. Dividing Drill Jigs, Hubert Bentley. Eng. & Indus. Management, vol. 7, no. 1, Jan. 5, 1922, pp. 6–7, 4 figs. Engagement or disengagement of feed mechanism actuated by friction disks.

Multiple-Spindle. Some Special Machines for Intensive Production. Eng. Production, vol. 4, no. 68, Jan. 19, 1922, pp. 52–56, 7 figs. Describes different types of multi-spindle drilling machines developed by Defiance Machine Works, Defiance, Ohio.

Radial. Recent Machine Tool Developments, Joseph Horner. Engineering, vol. 113, no. 2927, Feb. 3, 1922, pp. 126–128, 43 figs. Describes 3-ft. 6-in. radial drilling machine constructed by James Archdale & Co., Ltd., Birmingham, England.

6-Ft. High-Speed Radial Drill. Engineering, vol. 113, no. 2923, Jan. 6, 1922, pp. 8–9, 9 figs. Describes machines manufactured by George Swift & Sons, Ltd., Halifax, running from 4 ft. 6 in. to 8-ft. radius.

DRILLS

Twist, High-Speed. Making the Latrobe High-Speed Twist Drill, S. Ashton Hand. Am. Mach., vol. 56, no. 7, Feb. 16, 1922, pp. 246–248, 9 figs. Steel rolled to obtain greatest density at points of wear. Flutes milled after twisting. Drills and shanks assembled by unusual methods.

DROP FORGING

Die Blocks. Die Blocks as Seen by the Drop Forge Plant, A. A. Blue. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 34–36. Qualities desired in a die block by various members of a drop-forge organization. Brief review of present practice and summary of established methods.

Die Blocks for Drop Forge Plant. Ry. Jl., vol. 28, no. 2, Feb. 1922, pp. 15–16. Desirable qualities of a die block. Brief review of present practice.

Fiber Stresses in Die Blocks, Leslie Aitchison. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 36–38, 2 figs. Emphasizes the appreciation that is given in England to the direction of the grain in die block with relation to maximum work to be done by the impression. Excerpt from address delivered before Assn. Drop Forgers & Stampers.

Stamps. Friction Lifters for Drop Stamps, W. H. Snow. Engineer, vol. 133, nos. 3446 and 3447, Jan. 13 and 20, 1922, pp. 34–36 and 60–62, 13 figs. Describes modified kick stamps, board drop stamps, and clutch-operated lifters.

Variables in. Variables in Drop Forge Practice, J. H. Nelson. Automotive Industries, vol. 46, no. 6, Feb. 9, 1922, pp. 274–276. Results of experiments in heat treatment of finished forgings; outlines five definite conclusions arrived at. Author states that there are seven possibilities of difference between drop forgings that are apparently identical.

E

ELASTICITY

Theory. Recent Progress in Theory of Elasticity (Neuere Fortschritte der technischen Elastizitätstheorie), L. Föppl. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 466–481. Review of literature of past decade on calculation of plates and cylindrical and spherical shells.

ELECTRIC DRIVE

Wire Mills. Electric Drives For Wire Mills. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 64–67, 7 figs. General description of modern electric drives recently installed in Alabama City works of Gulf States Steel Co.

ELECTRIC FURNACES

Counterflow-Car-Type. Counterflow Car Type Electric Furnace, Horace Drever. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 47–49, 5 figs. Describes in detail a furnace annealing gray cast iron, using the recuperative principle. Will anneal 20 tons of stock per 24-hr. day at 1450 deg. Fahr.; high thermal efficiency.

Heroult Steel. New 7-Ton Heroult Furnace. Iron Age, vol. 109, no. 5, Feb. 2, 1922, p. 325, 1 fig. Details of design capable of employing mechanical instead of hand charging.

Steel. The Present Status of Electric Furnaces in Steel Making, Harry Etchells. West of Scotland Iron & Steel Inst. Jl., vol. 29, Part 2, Nov., Session 1921–1922, pp. 2–7 and (discussion) 7–11, 1 fig. on supp. plate. Discusses various types of electric furnaces, especially the arc, and advantages of electric steel.

ELECTRIC LOCOMOTIVES

Lentz Hydraulic Drive. The Lentz Hydraulic Drive in Electric Locomotives (Das Flüssigkeitsgetriebe von Lentz in der elektrischen Lokomotive), H. Wittfeld. Elektrische Kraftbetriebe u. Bahnen, vol. 20, no. 1, Jan. 10, 1922, pp. 1–2. It is shown that possibility exists of improving electric locomotives with simple alternating current by installing a Lentz hydraulic driving gear between driver and driving axle, and that existing driver could be replaced by a synchronous driver.

Steam vs. Railway Electrification, Vincent Raven. Ry. Gaz., vol. 36, no. 1, Jan. 6, 1922, pp. 11–14, 3 figs. Some advantages which may result from substitution of electric for steam locomotive operation. Describes design of various classes of electric locomotives. Abstract of paper read before North-East Coast Instn. Engrs. & Shipbuilders. See also Engineering, vol. 113, nos. 2923 and 2924, Jan. 6 and 13, 1922, pp. 25–26 and 39–43, 13 figs. partly on supp. plate and on p. 48, and Electrician, vol. 88, no. 2277, Jan. 6, 1922, pp. 10–11, 1 fig.

Storage-Battery. Accumulator Locomotives for Steel Works. Iron & Coal Trades Rev., vol. 104, no. 2811, Jan. 13, 1922, pp. 43–44, 3 figs. Describes electric apparatus built by Sanderson Bibby Co.

ELECTRIC RAILWAYS

Insurance for. Insurance for Electric Railways. Elec. Ry. Jl., vol. 59, no. 2, Jan. 14, 1922, pp. 73–78. Discusses types of insurance applicable to railway organizations; an efficient aid in handling labor; affords opportunity for operating economies; suggestions for executive action.

ELECTRIC WELDING, ARC

Car-Wheel Flanges. Three Years Experience in Welding Worn Flanges, E. B. Gunn. Elec. Ry. Jl., vol. 59, no. 5, Feb. 4, 1922, p. 196. Satisfactory results have been obtained; wheel mileage has been increased greatly at small cost and with no bad results from a safety standpoint. Paper read before Central Elec. Ry. Assn.

Cast Iron. Arc-welding of Cast Iron, A. R. Allard. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 461–464, 6 figs. Use and application of methods for welding of cast iron by electric arc.

Increasing Welding Speed. Increasing Welding Speed, H. R. Pennington. Welding Engr., vol. 7, no. 1, Jan. 1922, pp. 24–25. Speed of electric arc welding can be increased by increasing electrode diameter and coating electrodes. Paper read before Am. Welding Soc.

Steel Structures. Electric Arc Welding in Steel Structures, James Caldwell. Engineering, vol. 113, no. 2925, Jan. 20, 1922, pp. 88–90, 4 figs. Gives examples of work done, and summary of test results to date, giving some idea of extent to which welds in steel structures can be relied upon. (Abstract.) Paper read before British Instn. Mech. Engrs.

ELEVATORS

Evolution of. Evolution of Mechanical Handling Devices of the Continuous Type. Eng. World, vol. 20, no. 2, Feb. 1922, pp. 90–91, 11 figs. Described in illustrations dating from 1560 B. C.

Power Application to. Electric Power Application to Passenger and Freight Elevators, Harrison P.

Reed. Am. Inst. Elec. Engrs Jl., vol. 41, nos. 1 and 2, Jan and Feb. 1922, pp 57–67 and 152–164, 23 figs. Notes on history and service requirements; types of elevator machines and limitation of each; characteristics and limitations of d.c. and a.c. motors, elevator controllers; brakes and other safety accessories, power consumption. Paper prepared under auspices of Subcommittee on Elevators of Indus. & Domestic Power Committee.

EMPLOYEES, TRAINING OF

Foundry Workers. Industrial Training for Foundry Workers, Thos Vickers. Foundry Trade Jl., vol. 25, nos 283 and 284, Jan. 19 and 26, 1922, pp. 42–44 and 63–65, Jan. 19. Gives historical review. Discusses the Worshipful Company of Founders; improvements necessary in modern foundry conditions; effort of Cast Iron Research Assn. to modernize foundry production; etc. Jan. 26: American system and a German scheme.

EMPLOYMENT MANAGEMENT

Analyses of Working Force. How to Analyze the Working Force, Eugene J. Benge. Management Eng., vol. 2, no. 2, Feb. 1922, pp. 79–84, 8 figs. Notes on securing facts to establish labor policies and proper working conditions.

ENGINEERING SCHOOLS

Newark Technical School. College of Engineering of the Newark Technical School. Chem. Age (N. Y.), vol. 30, no. 1, Jan. 1922, pp. 11–14, 3 figs. Discusses origin and administration of college, coöperation with industry, chemical-engineering instruction, etc.

ENGINEERS

Coöperation of Chemists and. The Coöperation of the Engineer and Chemist in the Control of Plants and Processes, G. M. Gill. Gas Jl., vol. 157, no. 3061, Jan. 11, 1922, pp. 82–86 and (discussion) 86–89, 8 figs. Deals with coal and refractory materials and outlines system which has been applied with object of standardizing quality of gas. Paper read at joint meeting of (British) Instn. Mech Engrs. and Soc. Chem. Industry. See also Engineering, vol. 113, no. 2924, Jan. 13, 1922, pp. 57–59, 8 figs.

EVAPORATORS

Liquor Concentration. The Concentration of Liquors by Evaporation, James Holmes. Chem. Trade Jl. & Chem. Engr., vol. 70, no. 1807, Jan. 6, 1922, pp. 1–3. Notes on heat losses in evaporation; typical quadruple-effect performances; improvements in design of evaporators.

EXHAUST STEAM

Utilization. The Utilization of Exhaust Steam. Engineer, vol. 133, no. 3448, Jan. 27, 1922, pp. 109–110. Outline of two papers read before joint meeting of Instn. Elec. Engrs. and Instn. Heating & Ventilating Engrs., namely, Utilisation of Exhaust Steam from Electric Generating Stations and Coal Economy, by Ingham Haden; and Utilisation of Waste Heat from Electric Generating Stations, by F._N. Whysall.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FANS

Low-Pressure. Low-Pressure Fans (Niederdruck-Ventilatoren), H. Hüttig. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1342–1344, 4 figs. Discusses different types, uses, and problems of drive.

Measuring Delivery. Standardized Method of Measuring Fan Delivery, E. N. Fales. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 1, Jan. 1922, pp. 1–10, 7 figs. Discusses the method as applicable not only to cooling fans, but also to larger-type propeller fans where flow is not enclosed.

FERROSILICON

Additions to Pig Iron. Ferrosilicon for the Improvement of Cast Iron (Ferro-Silizium). Zeit. für die gesamte Giessereipraxis, vol. 42, no. 53, Dec. 31, 1921, pp. 697–698. Writer gives results of his practical experiences with additions of silicon to charge, and points out that Fe Si in the form of E. K. packages is a very good medium for drawing of pig iron, and can be of great value when combined with other media.

FIRE PROTECTION

Rural Districts. Water Supply to Rural Districts for Fire-Extinguishing Purposes (Löschwasserbeschäffung in ländlichen Ortschaften), Bernard Peill. Feuerwehrtechnische Zeit., vol. 9, no. 11, Nov. 20, 1921, pp. 171–173, 2 figs. Discusses use of fire-brigade trucks with water tanks, water-scooping machines for supply of conduit or pipe systems, etc.

FLIGHT

Soaring. The Problem of Soaring Flight, A. P. Herff Aviation, vol. 12, no. 6, Feb. 6, 1922, p. 167, 3 figs. New theory based on observations of the turkey buzzard; requirements for reproducing soaring flight with airplanes.

FLOW OF FLUIDS

Commercial Pipe Lines. The Flow of Fluids through Commercial Pipe Lines, Robert E. Wilson, W. H. McAdams and M. Seltzer. Jl. Indus. & Eng. Chem., vol 14, no 2, Feb. 1922, pp. 105–119, 18 figs. Describes experimental work to fill in gaps in existing data on flow of fluids in pipes of commercial size and roughness, especially for very viscous liquids and in critical region between viscous and turbulent flow; and to determine correction factors for pressure drop around bends.

Turbulence. Experimental Investigations of Problem of Turbulence (Experimentelle Untersuchung zum Turbulenzproblem), L. Schiller. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 436–444, 7 figs. Study of conditions of stability of laminary and turbulent flow in smooth pipes.

The Origin of Turbulence (Bemerkungen über die Entstehung der Turbulenz), L. Prandtl. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 431–436, 3 figs. Results of investigations carried out by author on an open conduit, 6.5 m. long, with rectangular cross-section.

FLOW OF LIQUIDS

Viscous. The Flow of Viscous Liquids Through Slightly Conical Tubes, A. S. Hemmy. Physical Soc. of Lond. Proc., vol. 34, Part 1, Dec. 15, 1921, pp. 22–25 and (discussion) 25–26. Formula is obtained by neglecting terms containing the square of the obliquity.

FLOW OF WATER

Channels. The Discharge of Water in Raft Canals and Similar Channels (Der Wasserabfluss in Flossgassen u. ähnlichen Gerinnen), Ludwig Freytag. Forschungsarbeiten, no. 235, 1921, 85 pp., 15 figs. Contribution to theory of non-uniform movement of water.

The Movement of Water in Artificial and Natural Channels (Ueber die Bewegung des Wassers in künstlichen und naturlichen Gerinnen), Josef Putzinger. Zeit. des Oesterr. Ingenieur-u. Architekten-Vereines, vol. 74, no. 1–2, Jan. 6, 1922, pp. 4–8, 3 figs. Rules for flow of water in pipes, open channels and natural river beds, are developed which, it is believed, should be helpful in solving problem of distribution of velocity in flowing water.

Kutter's Formula. Kutter's Formula Simplified, H. E. Babbitt. Eng. & Contracting, vol. 57, no. 6, Feb. 8, 1922, p. 128. It is shown that apparent discrepancies introduced by use of modified form of formula for solution of problems ordinarily met are less than discrepancies introduced by difference of 0.001 in determination of value of n.

Pipes. Flow of Water through Spiral Riveted Steel Pipe, F. W. Greve and R. R. Martin. Purdue University Publications of Eng. Depts., vol. 5, no. 2, July 1921, 32 pp., 11 figs. Data and results of investigation upon flow of water through 4, 6, 8 and 10-in. galvanized spiral riveted steel pipes, in which effort was made to determine (1) variation of friction loss with velocity, for flow both with and against laps; (2) variation in accuracy of four types of piezometer rings; (3) comparison of friction loss with that in cast iron pipes for like conditions of diameter and velocity.

Prandtl Limit-Stream Theory. Problems of Flow and Transmission of Heat (Strömungs- und Wärmeübergangsprobleme), Max Jacob. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 53, Dec. 31, 1921, pp. 1374–1375, 1 fig. Refers to a number of articles published in Zeit. für angewandte Mathematik u. Mechanik (no. 4, 1921), most of which are based on so-called limit-layer theory of Prandtl, which is here discussed without mathematics in a manner intelligible to pratical engineers.

FLUIDS

Viscous, Motion of. The Two-dimensional Slow Motion of Vicous Fluids, L. Bairstow, B. M. Cave and E. D. Lang. Roy. Soc. Proc., vol. 100, no. A 705, Jan. 2, 1922, pp. 394–413, 7 figs. Discusses problems which require a solution of differential equation $\delta \psi = 0$.

FORGE PLANTS

Steam and Board Hammers. Comparison of Steam and Board Hammers, R. C. Jennings. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 28–29. Advocates board hammer for forging of light and medium heavy parts and steam hammer where considerable drawing or heavy forging is to be done.

Upset Forging. New Upset Forging Plant in Chicago, William E. Crocombe. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 20–22, 5 figs. Describes plant of Amforge Company, touching briefly on forge shop, die-sinking department, and inspection department.

Plant Makes Upset Forgings Exclusively. Iron Age, vol. 109, no. 6, Feb. 9, 1922, pp 401–404, 5 figs. New shop of Amforge Co. is said to be unique because of its equipment, layout and methods of stores keeping, ventilating system, etc.

FORGES

Gas Forges. Use of Gas Forges in Repair Shops, J. L. Springer. Gas Age-Rec., vol. 49, no. 5, Feb 4, 1922, pp. 133–134. Deals with temperature regulation, combustion gases, sulphur in burning gases, and bench forges.

FOUNDRIES

Gray-Iron. Complete Huge Wisconsin Foundry. Foundry, vol. 50, no. 3, Feb. 1, 1922, pp. 89–98, 15 figs. Describes new plant of Fairbanks, Morse & Co., with capacity of 500 tons per day of gray-iron castings varying in weight from 1 lb. to 15 tons.

FUELS

Bagasse, Calorific Value of. The Calorific Value of Bagasse, P. H. Parr. Int. Sugar Jl., vol. 24, no. 277, Jan. 1922, pp. 13–18. Determines heating value for bagasse, its composition, etc. Gives some comparative figures for wood.

Economy. A Session on Fuel Economy. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 112–113 and 118. Discussion of four papers at A.S.M.E. meeting, namely, Boiler Plant Efficiency, by Victor J. Azbe; Boiler and Furnace Economy, D. S. Jacobus; Fuel Saving in Relation to Capital Necessary, Joseph Harrington; and Fuel Saving in Modern Gas Producers and Industrial Furnaces, W. B. Chapman. Brings out many experiences in economic boiler and furnace operation, leading to great fuel savings.

Low-Grade. Recent Fuel Investigations. Power Plant Eng., vol. 26, no. 3, Feb. 1, 1922, pp. 162–164. Experiments conducted to determine feasibility of utilizing lower-grade fuels for steaming purposes.

[See also OIL FUEL; PULVERIZED COAL.]

FURNACES

Combination Welding and Preheating. Combination Welding—Preheating Furnace, F. M. Gloyd. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 84–85 and 89, 7 figs. Methods at plant of A. A. Simonds & Sons Co., Dayton, Ohio, using stoker-fired furnace for preheating and welding. Special tongs and metric clock increase production materially.

FURNACES, BOILER

Low-Grade Fuels. Step Grates, Semi-Producer-Type Furnaces, Forced Draft, and Coal Burned per Unit Grate Area (Treppenroste, Halbgasfeuerungen, Unterwind und Rostbelastung), H. Pradel. Braunkohle, vol. 20, no. 41, Jan. 14, 1922, pp. 641–648, 11 figs. Discusses efficiency of and gives results of tests with the Topf high-capacity and the Bergmann semi-producer furnaces, Pluto stoker, etc., for utilization of low-grade fuel.

FURNACES, HEATING

Forgings. Heating Furnaces For Forgings, C. Fischer. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 94–95, 3 figs. Discusses utilization of waste gases from heating furnaces, including direct preheating of steel by waste gases.

FUSION WELDING

Castings. Utilizing Fusion Welding on Castings, H. S. Rawdon. Iron Trade Rev., vol. 70, no. 4, Jan. 26, 1922, pp. 274–276. Includes table summarizing mechanical properties of low-carbon cast steel prepared by thermit process, and by arc-fusion. Discussion of paper entitled Fusion Welding, by S. W. Miller, presented at Am. Iron & Steel Inst.

G

GAGES

Adjustable Limit. The Wickman Adjustable Limit Gauge for Taps. Engineering, vol. 113, no. 2926, Jan. 27, 1922, op. 100–102, 13 figs. Describes adjustable thread caliper gage which enables screws and externally threaded part to be controlled within any desired limits of accuracy in pitch, effective diameter, etc. Its use for tap inspection.

Error of Contact. Tests to Determine Error of Contact (Versuche zur Bestimmung des Berührungfehlers), Eugen Simon. Werkstattstechnik, vol. 16, no. 1, Jan. 1, 1922, pp. 6–8. Results of tests conducted by sub-committee on gage allowances of German Industries Committee on Standards (NDI), to determine error occurring in measurement of same hole with different gages brought about by giving to all gages the same diameter without regard to influence of varying sizes of their measuring surfaces.

Multiple-Spline, Grinding. Grinding Multiple Spline Gauges. Machinery (Lond.), vol. 19, no. 485, Jan. 12, 1922, pp. 449–450, 3 figs. Describes method of grinding multiple-spline gages having six or more splines, which has proved successful in practice.

Snap, Setting Machine for. Snap Gauge Setting Machine. Machinery (Lond.), vol. 19, no. 485, Jan. 12, 1922, pp. 439–440, 3 figs. Range of machine covers settings from 1/2 up to 10 in., and the sensitiveness is to 0.0001-in.

GAS

Straw. Gas Made by Carbonizing Straw, Harry E. Roethe. Gas Age-Rec., vol. 49, no. 3, Jan. 21, 1922, pp. 75–76, 2 figs. Discusses destructive distillation of straw and similar material, and the gas producing plant on the government farms at Arlington, Va., for experimental work.

GAS ANALYSIS

Stack and Fuel. Graphical Treatment of Stack Gas Analysis and Fuel Gas Analysis, W. Trinks. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 50–58, 5 figs. Gives most important phases of work regarding charts introduced by Wa. Ostwald and laid out in book called "Beiträge zur graphischen Feurungstechnik," on calculation for stack gas analysis for producer gas, natural gas, by-product tar, coke-oven gas, and for coal.

GAS PRODUCERS

German Bamag. Improvements and Operating Experiences with Gas-Producer Plants for Large Variety of Fuels (Neuerungen und Betriebsergebnisse von Gasgeneratoranlagen für die verschiedensten Brennstoffarten), H. Lichte. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 48 and 49, Dec. 2 and 9, 1921, pp. 385–387 and 390–399, 15 figs. Describes Bamag producers in the following constructions: revolving-grate producer with and without water-cooling jacket; high-pressure revolving-grate producer; and grateless producer.

Hot-Blast Application. Using Hot Air in Gas Producers for Fusing Ash (L'Emploi du vent chaud dans les gazogènes à fusion des cendres), A. Dessemond. Le Genie Civil, vol. 79, no. 26, Dec. 24, 1921, pp. 561-564, 1 fig. Describes installation of Société des Houillères de St. Etienne, showing success of system with fuel containing up to 60 per cent ash, as well as with heterogeneous fuels.

GASES

Cleaning. A New Process of Cleaning Gases and Vapors (Ein neues Verfahren zur Reinigung von Gasen und Dämpfen), E. Stach. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 49, Dec. 3, 1921, pp. 1265-1267, 7 figs. Points out that for removal from gases and vapors of dust, tar, oil, etc., according to the Freytag-Metzler rotary-filter process, a much greater degree of cleanliness is achieved than with methods heretofore in use. Writer recommends further development of process for removal of oil from vapor and air filtration.

Rotary-Type Gas Filter. Mech. Eng., vol. 44, no. 2, Feb. 1922, p. 126, 1 fig. Describes process intended to be used for removing dust, tar, oil and similar impurities from gases and vapors, developed by Freytag-Metzler and tested by E. Stach and Dr. Alexi. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 49, Dec. 3, 1921, pp. 1265-1267, 7 figs.

Compressed, Steel Containers for. Explosions of Steel Flasks (Stahlflaschen-Explosionen). Zeit. fur komprimierte u. flüssige Gase, vol. 21, nos. 9 and 11, 1920-21, pp. 104-105 and 128-129. Account of series of serious accidents which have occurred in the last years in the handling of compressed and liquid gases, and results of investigations.

Oxy-Hydrogen, Ignition Point of. Investigations of the Ignition Point of Oxy-Hydrogen Gas (Untersuchungen über den Entzündungpunkt des Knallgases), Alexander Mitscherlich. Zeit. für komprimierte u. flüssige Gase, vol. 21, nos. 8, 9 and 10, 1920-21, pp. 89-93, 101-103 and 125-128, 6 figs. Account and results of tests and description of testing apparatus. Article was published during war in Zeit. für anorganische Chemie, vol. 98, from which above is reprinted.

GEAR CUTTING

Fixing and Releasing of Blanks. Rapid Holding and Releasing of Gear Blanks, Fred Horner. Can. Machy., vol. 27, no. 5, Feb. 2, 1922, pp. 40-41 and 46, 10 figs. Holding with spring collets of external or internal type; use of draw-back rod; etc.

Worm-Gear Machine. A New Worm Gear Generating Machine. Engineer, vol. 133, no. 3447, Jan. 20, 1922, pp. 78-79, 9 figs. New machine by Smith & Coventry, Ltd., Manchester, England, of tangent feed pattern, more particularly adapted to generation of single wheels or wheels in small numbers by means of less expensive fly cutter.

GEARS

Automobile, Machining. Cost-reducing Tooling Equipments, Ralph E. Flanders. Machinery (Lond.), vol. 19, no. 485, Jan. 12, 1922, pp. 441-444, 10 figs. Machines and tooling equipments used for performing turning, boring, facing, and recessing operations on automobile gears.

Tooling Equipment for Automobile Gears and Ball Races, Ralph E. Flanders. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 447-451, 14 figs. Describes jobs performed on Fay automatic lathes and operations on double-spindle flat turret lathes and Hartness automatic lathes.

Grinding Hardened Teeth. Grinding Hardened Gear Teeth. Eng. Production, vol. 4, no. 67, Jan. 12, 1922, pp. 42-44, 6 figs. Describes machine for finish grinding spur gear teeth to within definite limits of accuracy, and without producing scrap.

High-Carbon, Reclaiming. Reclaiming High Carbon Gears, R. L. Dowdell. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 320-322, 8 figs. Describes method by which these gears could be reclaimed by heat treatment which would give them a tough core with a hard case by varying the internal structures without altering carbon content.

Involute. Gear Tooth Shapes, E. W. Miller. Am. Mach., vol. 56, nos. 4 and 5, Jan. 26 and Feb. 2, 1922, pp. 129-132 and 168-172, 26 figs. Study of fundamentals in principles of involute gearing in endeavor to find a suitable standard form and pressure angle.

The Evolution of the Involute Gear Tooth—XI, A. Fisher. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 513-517, 6 figs. Involute pitch and pressure-angle permutability.

Spur, Inspection of. Inspection of Spur Gears, D. Vaughn Waters. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 465-466, 4 figs. Describes practice of Gould & Eberhardt, Newark, N. J., in inspecting spur gears, with particular reference to uniformity of tooth spacing and concentricity of pitch circle relative to axis of gear.

Transmission. Transmission (Les Transmissions), Legrand-Ribet. L'Outillage, vol. 241, no. 1, Jan. 7, 1922, pp. 8-17, 44 figs. Discusses dimensions, speed of transmissions, bearings, brakes, pulleys, etc.

Variable-Speed. Gears and Mechanisms at Variable Speed (Les embrayages et les mécanismes en mouvement varié), H. Meuris. Annales des Travaux Publics de Belgique, vol. 22, Dec. 1921, pp. 993-1006, 4 figs. Distinguishes between those where starting and stopping occurs rarely, and where it occurs frequently, and studies useful work and lost work mathematically.

GRINDING MACHINES

Practice. Grinding Machines and Practice—II-VII. Mech. World, vols. 70 and 71, nos. 1812, 1816, 1819, 1821, 1824 and 1829, Sept. 23, Oct. 21, Nov. 11, 25, Dec. 16, 1921 and Jan. 20, 1922, pp. 238-239, 318-320, 378-379, 418-419, p. 478 and pp. 42-43, 32 figs. Sept. 23: Discusses grain and grade, bonds used for vitrified silicate, elastic and other wheels, and natural and artificial abrasives. Oct. 21: Selection of wheels for a given job; hardness, speeds, dressing and truing wheels, etc. Nov. 11 and 25: Design of wheel mountings. Dec. 16: Discusses the question of protection hoods and the production of sparks. Jan. 20: Cylindrical grinding machines, and wheel-spindle mounting for plain grinding machines. (To be continued.)

Wheel-Truing Attachment for Thread. Wheel-Truing Attachment for Screw-Thread Grinding. Engineering, vol. 113, no. 2925, Jan. 20, 1922, p. 76, 4 figs. on p. 78. Describes new attachment brought out by Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., primarily intended for use with maker's multi-graduated precision thread grinder.

H

HARDNESS

Testing. Ball Hardness Testing of Semi-Steel (L'Essai de Dureté à la bille sur la Fonte aciérée), M. Portevin. Fonderie Moderne, no. 11, Nov. 1921, pp. 318-321, 2 figs. Establishes empiric formulas and gives advantages of Brinell test.

Hardness Testing (Beitrag zur Härteprüfung), F. Waizenegger. Forschungsarbeiten, no. 238, 1921, 32 pp., 13 figs. Notes on the Brinell test; effect of load, ball diameter and duration of load on coefficient hardness; calculation of maximum coefficient of hardness; comparison of different materials by means of maximum hardness coefficient. Tests of A. Kürth to determine relation between maximum hardness coefficient and (a) tensile strength, (b) yield point and (c) temperature.

Some Brinell Hardness Measurements on Small Specimens, E. D. Campbell. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 269-273, 1 fig. Describes attachment for the standard Alpha Brinell machine which enables hardness measurments to be made on small bars with almost as much ease and accuracy as can be done on larger specimens.

HEAT TREATING

Electric. Economics of Electric Heat Treating, E. F. Collins. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 76-81, 5 figs. Method of electric heat transmission and delivery to charge; importance of insulation in various types of furnaces.

HEAT TRANSMISSION

Liquid to Liquid. Numerical Law of Heat Transmission Between Liquids in Industrial Heat Exchangers (Lois numériques de la Transmission de la Chaleur entre les fluides dans les Echangeurs Industriels), H. Dieterlen. Chaleur et Industrie, vol. 2, nos. 17, 18 and 19, Sept., Oct. and Nov. 1921, pp. 570-579, 649-652 and 736-746, 16 figs. Sept.: The coefficient of transmission through walls. Oct.: Formulas used. Nov.: Construction of economisers of the Kablitz type.

HEATING

Direct-Indirect. The Weak Spots in Direct-Indirect Heating, E. Vernon Hill. Heat. & Vent. Mag., vol. 19, no. 1, Jan. 1922, pp. 29-32, 5 figs. Results of test of air conditions in Greentown (Ind.) High School, made at request of Ind. State Board of Health, which has not approved use of direct-indirect heating systems.

HEATING, ELECTRIC

Residences. Electric Heating of Residences, Edgar Allan Loew. University Wash. Eng. Experiment Station Bul., no. 15, Dec. 1921, 44 pp., 8 figs. Experiments and reports on electric house heating. Experiences with domestic heating in Tacoma, Wash., and conclusions reached. Comparison of heating electrically and by means of coal; and possibilities in use of surplus, off-peak and seasonal power.

Thermal Processes. Electric Heat for Thermal Processes, E. F. Collins. Jl. Indus. & Eng. Chem., vol. 14, no. 2, Feb. 1922, pp. 101-104, 6 figs. Discusses heat generation and heat transmission, and gives examples of the various installations applying electric heat industrially.

HEATING, FACTORY

Analysis. An Analysis of Factory Heating, M. C. W. Tomilson. Factory, vol. 28, no. 2, Feb. 1922, pp. 162-164, 4 figs. Twelve ways to get more heat from less coal.

HELICOPTERS

Design. Theoretical Discussion of the Problem of Helicopters (Theoretische Bemerkungen zur Frage des Schraubenfliegers), Th. v. Kàrmàn. Zeit. fur Flutechnik u. Motorluftschiffahrt, vol. 12, no. 24, Dec. 31, 1921, pp. 345-354, 8 figs. Discusses the three theoretical problems governing design of helicopters. It is believed that difficulties encountered in construction of a serviceable helicopter are greater than is generally supposed, though not insurmountable. Modern types of helicopters are described by same author in same journal (pp. 360-361, 4 figs.)

HOISTS

Electric. Factors Affecting Installation of Electric Motors for Hoisting, Gordon Fox. Elec. World, vol. 79, no. 4, Jan. 28, 1922, pp. 171-173, 1 fig. Methods of determining size of motors required. Various types of skip hoists and their use. Advantages and disadvantages of a.c. and d.c. drives for skip hoists.

HYDROELECTRIC DEVELOPMENTS

Upper Rhone, France. Improvements in the Upper Rhone (L'Amenagement du Haut Rhône), Leon Perrier. Annales de l'Energie, vol. 1, no. 2, Mar.-Apr. 1921, pp. 49-57, 1 fig. Technical data and principal projects for making use of water power and navigating the French Upper Rhone.

Western U. S. Projects. Some Western Hydroelectric Projects Under Way in 1921 or Definitely Scheduled for 1922. Jl. Electricity & Western Industry, vol. 48, no. 2, Jan. 15, 1922, pp. 60-61. List giving essential data in tabular form.

HYDROELECTRIC PLANTS

Barcelona, Spain. Power Transmission by the Catalan Gas and Electric Co. (La transmission d'énergie Seira-Barcelone de la Societé catalane du Gaz et l'Électricité à Barcelone), J. Reyval. Revue Genérale de l'Électricite, vol. 11, no. 1, Jan. 7, 1922, pp. 11-31, 31 figs. Describes control of water power, the hydroelectric plant and its equipment at Seira, transmission lines, substations, transformers, etc.

Bathurst, N. B. Hydro-Electric Developments Near Bathurst, N. B., James Dick. Can. Engr., vol. 42, no. 5, Jan. 31, 1922, pp. 181-185, 10 figs. Construction details of plant at Grand Falls, Nepisiguit River. 15 mi. of standard-gage railway laid to work. Power house and dam of reinforced concrete. Transmission line is 19 mi. long.

Design. Hydro-Electric Developments, W. M. White. Denki Gakkwai Zasshi (Jl. Inst. Elec. Engrs. Japan), no. 402, Jan. 1922, pp. 21-31, 6 figs. Deals with design of power house and dam, tunnels, canals, pipe lines, turbines, draft tubes and tail race.

Increasing Capacity. Increasing Capacity of Parnahyba Plant, H. P. Quick. Power, vol. 55, no. 5, Feb. 7, 1922, pp. 212-213, 3 figs. Describes how a hydroelectric plant in Brazil, originally laid out for 16,000 hp. was modified to develop double this capacity.

Pit River, California. The Pit River Hydroelectric Power Project, Charles W. Geiger. Power Plant Eng., vol. 26, no. 2, Jan. 15, 1922, pp. 105-111, 8 figs. Describes first two plants of Pacific Gas & Elec. Co. on its Pit River system in Shasta county where unusual geological formation makes possible operation of a system without necessity of artificial storage capacity.

Queenston-Chippawa. First Unit for Queenston-Chippawa Water Power Plant Opened. Eng. News-Rec., vol. 88, no. 3, Jan. 19, 1922, pp. 110-111. Includes views of completed hydroelectric development around Niagara Falls in Ontario.

South Africa. Description of the Hydroelectric Power Plant Installed at Howick Falls, H. W. Miller. So. African Instn. of Engrs. Jl., vol. 20, no. 4, Nov. 1921, pp. 62-71, 6 figs. Describes work connected with construction of concrete diversion weir, a pipe line of some 600 ft. in length with upper section 34 in. diameter by 200 ft. long, the power house and machinery, etc. See also So. African Eng., vol. 32, no. 12, Dec. 31, 1921, pp. 242-243.

Trash-Rack Rake. Mechanical Trash-Rack Rake, I. W. Jones. Power, vol. 55, no. 4, Jan. 24, 1922, pp. 131-132, 3 figs. Describes rack rake developed by author, consisting of motor-operated car mounted on wheels designed to travel on rails inlaid in rack platform. Rake is supported by light structural-steel framework and operated by four steel cables.

Wales. Hydro-Electric Installation at Denbigh Asylum. Engineer, vol. 133, no. 3446, Jan. 13, 1922, p. 50, 8 figs. Describes erection of dam 160 ft. long to give fall of 15 ft., a fish pass, and generating station in which are installed a water turbine, electric generator and switchgear.

HYDRAULIC TURBINES

Governors. Hydraulic Turbine Governors, W. R. Kepler. Elec. Jl., vol. 19, no. 2, Feb. 1922, pp. 60-68, 12 figs. Discusses limitation of speed to suit conditions demanded by character of load. Governing element may be grouped into three sections, (1) flyballs, valve and compensating device, (2) pressure system and (3) mechanism for applying energy of pressure system to change amount of water through turbine.

Kaplan. The Brake Horsepower Guarantees of the Kaplan Turbine Concern in the Storek Turbine Experimental Station in Brünn (Austria) (Die Garantiebremsungen des Kaplanturbinenkonzerns in der Turbinenversuchsanstalt der Firma Storek in Brünn), J. Slavik and P. Walther. Elektrotechnik u. Maschinenbau, vol. 40, no. 2, Jan. 8, 1922, pp. 13-15, 4 figs. Results of brake tests carried out under supervision of Dr. Kaplan and his assistants and members of Kaplan Turbine Concern, not only achieved, but greatly exceeded guaranteed efficiency.

I

ICE MANUFACTURE

Hoisting System. Economical Ice Harvesting, Otto Luhr. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, pp. 16-17. Describes a multiple ice-hoisting system, hoisting a whole row of cans at a time by putting cans in a framework and attaching air-agitating device onto framework so that only one air connection need be made. Paper read before Nat. Assn. Pratical Refrig. Engrs.

Refrigerating Process. Voorhees' Refrigerating Economies, Gardner T. Voorhees. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, p. 22, 2 figs. Discusses the

multiple-effect receiver, multiple-effect compressor, compressed exhaust-steam process, double-freezing can ice process, and the non-cracked ice and fore-cooler process. Paper read before Nat. Assn. Pratical Refrig. Engrs.

ILLUMINATION

Committee Reports. Illumination Items by the Lighting and Illumination Committee. Am. Inst Elec. Engrs. Jl., vol. 41, no. 2, Feb. 1922, pp. 149 151, 4 figs. Notes on preliminary report by P. W. Cobb on influence of illumination levels upon speed of vision; electric sign lighting; and report of Committee on Elimination of Waste in Industry of Am. Eng. Council on accidents due to eye defects.

IMPACT

Bars, Duration of. Duration of Impact of Bars, Erwin W. Tschudi. Physical Rev., vol. 18, no. 6, Dec. 1921, pp. 423-430, 4 figs. Experiments show that duration of impact is not a linear function of length of colliding bars, a fact directly contrary to compressional wave theory.

INDICATORS

Steam-Engine. The Steam-Engine Indicator Power, vol. 55, nos. 4, 5 and 6, Jan. 24, 31 and Feb. 7, 1922, pp. 142–144, 6 figs., 182–184, 10 figs. and 224, 3 figs. Jan. 24: What a reducing rig is and how it is made. Jan. 31: Reducing rigs on modern engines, and reducing wheels and cylinder connections. Feb. 7: Checking reducing rig for errors.

INDUSTRIAL MANAGEMENT

Job Analysis. Job Analysis as a Factor in Cost Reduction, Richard S. Uhrbrock. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 100–102. Qualifications of the analyst and methods of approach.

Overhead Distribution. Lightening the Factory Burden, Clinton W. Bennett. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 103–106, 5 figs. Distribution of overhead for analysis and control.

Production Control. Production Control by Graphics. Machinery (Lond.), vol. 19, no. 484, Jan. 5, 1922, pp. 405–412, 13 figs. Describes system employing graphic charts for controlling shop operations in plant making cotton looms and automatic attachments for looms.

Production Planning. Production Planning at the Dennison Plant. Factory, vol. 28, no. 2, Feb. 1922, pp. 159–162, 4 figs. Describes system which controls made-to-order goods almost entirely, where each order requires special attention. Its main object and accomplishment is to coördinate all departments to secure most satisfactory ultimate results.

Small Shop Overhead. Minimum Shop Operation Without Loss, D. S. Cole. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 96–97, 1 fig. Describes how small industrial plant operated plant during period of curtailed manufacturing operations, without allowing overhead or fixed expense to force losses.

[See also TIME STUDY.]

INDUSTRIAL ORGANIZATION

Drafting Rooms. The Organisation of a Jig and Tool Drawing Office, H. Varley. Eng. & Indus. Management, vol. 7, no. 5, Feb. 2, 1922, pp. 123–126, 4 figs. Development and scope of tool office; size of tool drawing office; duties of jig and tool office, relationship with productive departments; layout of office organization; and division of work.

Knitting Mills. The Organization of Knitting Mills Carle M. Bigelow. Management Eng., vol. 2, no. 2, Feb. 1922, pp. 111–116, 10 figs. Standardizing work of planning department.

INDUSTRIAL RELATIONS

Alliance of Employers and Employees. Association of Employers and Employees. Iron Age, vol. 109, no. 6, Feb. 9, 1922, p. 407. Unique institution in Cleveland in which better understanding is brought about. Educational and other features.

INJECTORS

Exhaust-Steam, Locomotive. An Improved Exhaust Injector For Locomotives. Ry. Engr., vol. 43, no. 504, Jan. 1922, pp. 9–10 and 12, 3 figs. Describes advantages of new F type injector made by Davies & Metcalfe, Romiley.

Metcalf's Exhaust Steam Injector. Engineering, vol. 113, no. 2925, Jan. 20, 1922, pp. 71–72, 4 figs. New pattern, constructed by Davies & Metcalfe, Ltd., Romiley, England, is capable of delivering water against pressure of 150 lb. per sq. in., with 1 lb. exhaust pressure, thus greatly reducing amount of live steam necessary to get up to normal working pressures in locomotive pratice.

INSTRUMENTS

Control. The Organization of Instrument Control in Industrial Plants, Frederick J. Schlink. Management Eng., vol. 2, no. 2, Feb. 1922, pp. 67 72, 4 figs. Deals with factors in instrument control and describes some typical installations Qualifications and duties of inspectors. Calibration and tagging of instruments Installation, repair and maintenance.

INTERNAL-COMBUSTION ENGINES

Lubricating Oils. Lubricating Oil, W. R. G. Atkins. Automobile Engr., vol. 11, no. 158, Dec. 1921, pp. 450 452. Factors affecting its consumption in internal-combustion engines.

Research Recent Research Work on the Internal Combustion Engine, Harry R. Ricardo Automotive Industries, vol. 46, no. 3, Jan. 19, 1922, pp. 126 133, 15 figs. Discusses effect of latent heat of vaporization, mean volatility, temperature, pressure, dilution, mixture strength, stratification and other factors upon combustion, and especially the detonation, of various fuels. Condensed from paper read before Soc. Automotive Engrs.

Semi-Ideal Gases for. Semi-Ideal Gases and Efficiency of Internal-Combustion Engines (Halbideale Gase und Wirkungsgrad der Verbrennungsmaschinen), M. Seiliger. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 1, Jan. 7, 1922, pp. 8–10, 1 fig. It is claimed that gases of internal-combustion engines are not ideal, but semi-ideal. Their adiabatics cannot be expressed by a polytropic curve. Equations of adiabatics and isodiabatics for semi-ideal gases are developed. Based on these equations and with regard to volume reduction and change of specific heat in combustion, the efficiency of a general working process is determined

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Charcoal, Manufacture of. Manufacture of Charcoal Iron and Charcoal Iron Boiler Tubes, W. H. S. Bateman. Southern & Southwestern Ry. Club, vol. 16, no. 6, Nov. 17, 1921, pp. 10–17 and (discussion) 17–21. Describes processes of manufacture and method of rolling skelp for tubes.

IRON ALLOYS

Silicon-Iron. Silico-Thermy and Its Practical Application, C. A. Heise. Iron Age, vol. 109, no. 5, Feb. 2, 1922, pp. 337–338, 5 figs. German iron-silicon castings of "thermisilid" made by thermal reactions. Silicides which are formed. Properties of new alloy. Paper read by Richard Walter before German Met. Soc.

IRON, PIG

Pig-Breaking Machine. A New Pig-Breaking Machine. Foundry Trade Jl., vol. 24, no. 280, Dec. 29, 1921, p. 519, 2 figs. Describes patent of E. Roper & Co., of Keighley, made either for belt or direct motor drive.

Synthetic. Recarburising Steel for Iron Foundry Use. Foundry Trade Jl., vol. 25, no. 282, Jan. 12, 1922, pp. 29–30. Describes series of trials made at Rombach, and gives analyses of cupola-melted steel scrap, billets and slags, also typical analyses of recarburized Bessemer steel and Bessemer steel recarburized with charcoal. From Stahl u. Eisen.

Synthetic Iron (Considérations sur les Fontes synthétiques), A. Keller. Fonderie Moderne, no. 11, Nov. 1921, pp. 327–336, 10 figs. Discusses process of making synthetic iron from scrap in the electric furnace, and its application for various purposes.

The Production of Synthetic Pig Iron By the Oehler & Cie. Iron & Steel Works, Inc., Aarau (Switzerland) [Ueber die Herstellung von synthetischem Roheisen bei den Eisen- und Stahlwerken Oehler & Cie., A.-G., Aarau (Schweiz)], K. Dornhecker. Stahl u. Eisen, vol. 41, no. 52, Dec. 29, 1921, pp. 1881–1889, 14 figs. partly on supp. plate. Notes on general aspects of production of pig iron from scrap and fundamentals of different processes; advantages of production in electric furnace with extensive carburization in the solid state. Details of the Aarau plant and planned enlargement.

L

LABORATORIES

Engineering Works. An Engineering Works Laboratory. Engineering, vol. 113, no. 2924, Jan. 13, 1922, pp. 34–36, 4 figs. Describes laboratory and equipment of W. H. Allen Sons & Co., Ltd., Bedford, England, manufacturers of high-speed engines, turbines, oil engines, electrical machinery, etc.

LATHES

Scroll-Forming. Lathe Formers, V. Gartside. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 505-507, 7 figs. Discusses scroll-turning lathes.

Turret. Turret Lathe Tooling. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 500-501, 4 figs. Equipment for machining differential gear housings on turret lathes.

Wheel. A New 48-In. Wheel Lathe Ry. Gaz., vol. 35, no. 22, Nov. 25, 1921, pp. 815-816, 2 figs. Describes a modern wheel lathe characterized by abundance of driving power, rigidity, efficient operating facilities, and high output, made by Noble & Lund, Ltd., Felling-on-Tyne.

LEATHER INDUSTRY

Research. Research in Leather Manufacture, Arthur W. Thomas. Mech. Eng., vol. 44, no. 2, Feb. 1922, p 116. Describes work which has been done and points out that there is a great field in tanning industry, by prosecution of scientific research, to eliminate unnecessary wastes due to lack of knowledge of reactions.

LIGHTHOUSES

Aerial. Aerial Lighthouses. Flight, vol. 14, no. 4, Jan. 26, 1922, pp. 52-54, 3 figs. Describes the 1,000,000,000-c.p. lighthouse which is being erected at Dijon for aerial routes between Paris and Algiers, Italy and Switzerland, made by Barbier, Bernard and Turenne, of Paris.

LIQUIDS

Emulsified, Pumping. Pumping Liquids and Light Bodies by Emulsifying (Pompage des liquides et des corps légers par émulsion), Henry Béduwé. Révue Universelle des Mines, vol. 11, nos. 1 and 2, Oct. 1 and 15, 1921, pp. 57 64 and 155 160, 7 figs. Oct. 1 Describes application and operation of air lift pump, and experiments made by Westinghouse Air Brake Co. Oct. 15: Discusses industrial applications of emulsion pump, pumping by compressed air, etc.

LOCOMOTIVE BOILERS

Pulverized-Coal-Fired. Pioneer Boilers fired With Pulverized Coal, F. P. Coffin. Combustion, vol. 6, no. 2, Feb. 1922, pp. 74–77 and 95, 2 figs. Describes the Bettington boiler, designed for firing with powdered coal or coal dust; the Erie City Iron Works boiler, designed by Aero Pulverizer Co; and the American Locomotive Works boiler. (Abstract.)

Tube Fractures. Notes on Fractures in Locomotive Boiler Tubes, Henry Fowler. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 82–90, 11 figs. Results of investigation of large tubes of boiler on Midland Railway showing brittleness and fractures.

LOCOMOTIVES

Adhesion and Rack. Adhesion and Rack Locomotive for Sumatra, S. Abt. Ry. Age, vol. 72, no. 4, Jan. 28, 1922, pp. 263–266, 7 figs. Describes 0-10-0 type superheater four-cylinder compound locomotive of Dutch State Railways; tractive effort 30,865 lb.

British Types, 1921. Locomotives in 1921. Engineer, vol. 133, no. 3445, Jan. 6, 1922, pp. 10–12, 17 figs. partly on supp. plates and p. 14. Data on locomotives built for different British roads.

Electric. See ELECTRIC LOCOMOTIVES.

Fireless. The Explosion of a Fireless Locomotive in the German Works in Dachau (Zerknall einer feuerlosen Lokomotive in den Deutschen Werken in Dachau). Zeit des Bayerischen Revisions-Vereins, vol. 25, nos. 23 and 24, Dec. 15 and 31, 1921, pp. 191–193 and 200-204, 14 figs. Account of explosion of locomotive for operating pressure of 13 atmos., equipped with simple cylindrical, 4-meter-long steam boiler with diam. of 1690 mm. Results of investigation lead to conclusions that explosion was due to disadvantageous shape of boiler head; inferior quality of boiler plate; and to deficient heat treatment in construction of head.

Freight. Geared Locomotive for Freight Service. Ry. Jl., vol. 28, no. 2, Feb. 1922, p. 12, 1 fig. Particulars of 150-ton Shay geared three-truck type locomotive for freight service in mountainous regions. Tractive power, 59,740 lb. Built by Lima Locomotive Works, Inc., for Greenbriar, Cheat & Elk Railroad.

Gasoline. A Practical and Powerful Gasoline Switch Locomotive, L. C. Josephs, Jr. Ry. Rev., vol. 70, no. 3, Jan. 21, 1922, pp. 82–84, 4 figs. Describes the Mack gasoline locomotive by which smoke and fire risks are eliminated.

New Castle Mfg. Co. The New Castle Manufacturing Company, J. Snowden Bell. Ry. & Locomotive Eng., vol. 35, no. 1, Jan. 1922, pp. 1–4, 3 figs. Describes first locomotive built by Stephenson and locomotive "America" built by New Castle Mfg. Co.

Rebuilt. Rebuilt Locomotives, London & South Western Railway. Ry. Gaz., vol. 36, no. 1, Jan. 6, 1922, pp. 21–23, 6 figs. By rebuilding, tractive effort is raised from 21,620 to 23,500 lb. for freight engines, and from 16,900 to 20,240 lb. for tank engines.

Stokers. An Everyday Run With the New Hanna Type H-2 Stoker. Ry. Rev., vol. 70, no. 2, Jan. 14, 1922, pp. 51-53, 2 figs. Describes performance on Norfolk & Western mountain-type locomotive; tractive effort, 57,200 lb.

Three-Cylinder. Three-Cylinder Locomotive for Spanish Railways. Engineer, vol. 133, no. 3449, Feb. 3, 1922, pp. 134-136, 8 figs. partly on supp plate. Describes 8-coupled locomotive of 4-8-0 type, with double bogie tender, built by Yorkshire Engine Co., Ltd., Sheffield, England. Gives characteristics of engine and tender.

Truck Arrangement. On the Question of Bogies (Trucks), Axles and Springs of Locomotives, M. Bochet. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 193-250, 20 figs. Report No. 2 (All countries, except those using English language, Belgium and Scandinavian countries). Best arrangement of truck, axles and springs of locomotive for high speeds, with long wheelbases, so as to facilitate running round curves and to insure proper stability of engines.

LUBRICATING OILS

Treatment of Distillates. The Treatment of Refined Oil Distillate, C. D. Dean. Can. Machy., vol. 27, no. 5, Feb. 2, 1922, pp. 42–44 and 46. Removing wax by cooling; treating lubricating oils; pitches and paving asphalts; distillation under pressure; storage; etc.

M

MACHINE DESIGN

Kinematics; Use in. Graphic Kinematics in Machine-Tool Design (Zeichnende Kinematik im Werkzeugmaschinenbau), Ferdinand Wittenbauer. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 2 and 3, Jan. 14 and 21, 1922, pp. 25–30 and 60-62, 45 figs. Notes on transmission and gears used in machine-tool construction; speed and acceleration of crank gear; slotting machines with quick return of tool; guidance of needles in Wanzer sewing machine; carriage guide for turning pulleys; drive of a high-speed planing machine; oscillating drives by eccentric wheels; oscillating motion of a slot-mortising machine; crank gear with quick-return stroke; oscillating crank guide; steel spring hammers, etc.

MACHINE SHOPS

British. Famous British Works. Eng. Production, vol. 4, nos. 67 and 69, Jan. 12 and 26, 1922, pp.

26-28, 5 figs., and 74-76, 6 figs Jan 12 Describes works of Fielding & Platt, Ltd. Gloucester, for manufacture of hydraulic machinery and gas and oil engines. Jan 26 Works of Geo Richards & Co., Ltd., near Manchester.

Department Layout. Department Layout in the Colburn Shop, Fred H. Colvin Am Mach vol 56, No. 7, Feb. 16, 1922, pp 259-261, 12 figs Arrangements for machining, erecting, and testing units and complete machines. Toolroom arrangement and heat-treating department. Lavatory and coatroom

MACHINE TOOLS

Economical Drives. Efficiency and Fuel Consumption of Factory Installations (Wirkungsgrad und Brennstoffverbrauch von Fabrikanlagen), Karl Meller Zeit fur Dampfkessel u Maschinenbetrieb, vol 44, no 46, Nov 18 pp 369 372, 8 figs Investigation of efficiency of existing installations and how it can be improved with view to saving of coal.

MACHINES

Running Speed and Efficiency. Effect of Acceleration of Running Speed on Increase of Output in Factory Machines (Einfluss der Laufgeschwindigkeit auf die Leistungsteigerung bei Fabrikationsmaschinen), S. Ledermann. Werkstattstechnik, vol 16, no 1, Jan 1, 1922 pp 3-4, 2 figs It is shown that acceleration of speed of machines does not always bring about an increase in performance, but that it is necessary to determine the work time factor.

MAGNESIUM ALLOYS

Electron Metal. Elektron Metal, Adolph Bregman Metal Industry (N. Y.), vol. 20, no. 1, Jan. 1922, pp. 1-3, 9 figs. Discusses composition; physical, chemical and electrical characteristics; fabrication, working soldering and welding; melting and casting, principal uses advantages and disadvantages.

MAGNETOS

Elements. The Functioning of Magnetos (Contribution a l'etude du fonctionnement des magnetos d'allumage), L. Canaby. Arts et Métiers, vol. 74, no. 12, Sept. 1921, pp. 273-281, 13 figs. Discusses the various elements and their influence on working of magneto, gives formulas and curves.

MARINE BOILERS

Economical Operation. Coal Economy at Sea by Improved Methods of Steam Generation, David Brownlie. Shipbuilder, vol. 26, no. 137, 1922 (New Year Number), pp. 49-54, 5 figs Performance of stationary and marine boiler plants; coal weighing; boiler feedwater meters; saving effected by continuous analysis of flue gases.

MECHANICS

Modern Theories. Modern Theories in Mechanics (Les théories modernes de la mécanique), F. Blondel. Révue de l'Industrie Minérale, no. 25, Jan. 1, 1922, pp. 1-21, 12 figs. Discusses Einstein's theory of relativity and experiments leading up to it.

Present Crisis. The Present Crisis in Mechanics (Ueber die gegenwärtige Krise der Mechanik), R. v. Mises. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 425-431. Notes on mechanics of the relativity theory. Development of main problem, namely: Can it be assumed that all the phenomena of motion and equilibrium observable in visible bodies can be explained by the Newton and related laws? Development of a scheme of mechanical statistics.

Rigid Frames, Calculation of. Simplified Calculation of Rigid Frames, H. Marx. Mech. Eng., vol. 44, no. 2, Feb. 1922, p. 125, 1 fig. Describes new process devised by H. Bronneck for calculatiog most complicated frame shapes directly and without use of tables. Translated from Dinglers Polytechnisches Jl., vol. 336, no. 21, Oct. 22, 1921, pp. 301-302, 2 figs.

METALS

Cleaning. Industrial Methods of Metal Cleaning, F. MacDonald. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 66-70, 6 figs. Cleaning material; equipment for cleaning metal parts; methods.

Failure under Stress. Chemical Influences in the Failure of Metals under Stress, Cecil H. Desch. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 17-21. Investigation of such instances of intercrystalline rupture as may be attributed to action of chemical reagents.

The Mechanism of Failure of Metals from Internal Stress, W. H. Hatfield. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 36-46, 7 figs. Discusses influence of cold work, and chemical and corrosive attack. Notes on relative properties of amorphous and crystalline phases of metals, dealing with physical properties (hardness, elasticity, and capacity for plastic deformation) and chemical properties.

Fatigue Failure. Remarks on Fatigue Failure of Metal Parts, their Cause and Prevention, Horace C. Knerr. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 40-42, 4 figs. Factors upon which fatigue failure depends are: Number or repetitions; range of stress; presence of points at which stress may be localized. Gives example of fatigue failure.

Hardening. The Slip Interference Theory of the Hardening of Metals, Zay Jefferies and R. S. Archer. Chem. & Met. Eng., vol. 26, no. 6, Feb. 8, 1922, pp. 249-252. General reply to questions raised by various commentators, including condition of iron and carbon in and grain size of martensite.

Internal Stresses. Internal Stresses in Relation to Microstructure, J. C. W. Humfrey. Faraday Soc. Trans., vol. 17, part I, no. 49, Dec. 1921, pp. 47-51, 3 figs. Author offers suggestions, and draws attention to factor in strength of materials which does not appear adequately to have been studied.

Polishing. Motion Study in Metal Polishing Metal Industry (Lond.), vol 20, no 2, Jan 13, 1922, pp 30-33, 3 figs Describes experiment with a wattmeter on the process of roughing.

Season Cracking. The Failure of Metals under Internal and Prolonged Stress, W Rosenhain Faraday Soc Trans., vol. 17, part 1, no. 49, Dec 1921, pp 2-16, 2 figs. Discussion of phenomenon known as season cracking, and consideration of the various explanations therefor.

METRIC SYSTEM

English or Mixed. English, Metric or a Mixed Measurement System. Machinery (Lond.), vol 19, no. 484 Jan 5, 1922, pp. 428-430. Considers relative values of each system in various aspects

MOLDING MACHINES

Air and Electric. Develops Air and Electric Machine Foundry, vol 50, no. 2, Jan. 15, 1922, pp 75 76, 1 fig Air used for ramming sand into molds; but electricity has been adapted for rolling flask and afterward drawing pattern.

Design. The Present Status of Molding-Machine Construction (Der heutige Stand des Formmaschinenbanes), U. Lohse. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 1, Jan. 7, 1922, pp 4-7, 12 figs Deals with power molding machines, including molding presses and hydraulic molding machines

Equipment and Use. Molding Machine Practice Is Successful, Paul R. Ramp. Iron Age, vol 109, nos 6 and 7, Feb. 9 and 16, 1922, pp. 397-399 and 462-464, 13 figs. Points out that even without castings recurring in large numbers, method may be made to pay. Details of equipment and its use. Marked gain in efficiency in making cylinder and piston molds.

Improvements. Recent Progress in Machine Molding (Neuere Fortschritte in der Maschinenformerei), U. Lohse. Giesserei-Zeitung, vol. 19, nos. 1 and 2, Jan 3 and 10, 1922, pp. 8-12 and 29-32, 9 figs. Describes new arrangements and methods which tend to increase economy of machine molding.

Jarring. Jarring Molding Machines (Étude sur les Machines à mouler à secousses), M. Grospierre. Fonderie Moderne, no. 11, Nov. 1921, pp. 309-316, 5 figs. Discusses principles of machine and describes the Thomas electrically controlled machine working on gravity-magnetic principle. Discussion of paper by M Ronceray, pp. 316-318.

MOLDING METHODS

Gray-Iron Castings. Mold Intricate Gray-Iron Castings, H. E. Diller. Foundry, vol. 50, no. 2, Jan. 15, 1922, pp. 45-51, 11 figs. Describes methods used for molding gas-meter castings and automobile parts, such as flywheels, transmission housings and piston rings.

MOTOR BUSES

Connecticut. The Bus is Finding Its Sphere in Connecticut. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 5-13, 2 figs. Gives statistical summary of bus transportation services in state of Connecticut.

Design. Motor Bus and Its Relation to Electric Railways, Ralph M. Sparks. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 36-38. Discusses design of motor buses so as to give reliability of service and comfort to passengers, low maintenance cost, and high operating efficiency.

Some Factors Which Must Be Considered in Bus Transportation, Ezra W. Clark. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 14-16, 4 figs. Discusses future of bus and its proper design for safety, comfort and efficiency, from standpoints of manufacturing and operating.

Development. Evolution of the Motor Vehicle for Goods and Passenger Service, Percy Frost Smith. Inst. of Transport Jl., vol. 3, no. 1, Nov. 1921, pp. 35-44 and (discussion) pp. 44-47. History of development, and discussion of four principal types, namely, battery, steam, petrol gear-driven and petrol-electric transmission vehicles.

Double-Deck. Details of Equipment and Cost of Operation of Double-Deck Buses in Chicago. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 31-36, 11 figs. Describes bus of Chicago Motor Bus Co.; seating capacity, 60; inclosed upper deck.

Overhauling Depot. An Omnibus Overhauling Depot. Engineer, vol. 133, no. 3449, Feb. 3, 1922, pp. 121-124, 19 figs. partly on pp. 130 and 137. Details of large works recently erected by London Gen. Omnibus Co., Ltd., with object of concentrating work of overhauling its vast fleet of motor buses in one building. At least 15 omnibuses are pulled to pieces and re-erected daily. See also Engineering, vol. 113, no. 2927, Feb. 3, 1922, pp. 145-147, 5 figs. partly on p. 140.

MOTOR PLOWS

German Types. Tendencies in German Motor-Plow Construction (Die auf der DLG-Ausstellung sichtbaren Richtlinien des Motorpflugbaues), H. Martiny. Wirtschaftsmotor, nos. 8 and 9, Aug. 10 and Sept. 10, 1921, pp. 29-32 and 31-35, 13 figs. Notes on development and progress, based on observations at exhibition of German Agricultural Soc.

MOTOR TRUCKS

Berliet Chassis. The 25-30 cwt. Berliet Chassis. Motor Transport, vol. 34, no. 880, Jan. 9, 1922, pp. 45-47, 7 figs. Describes French machine designed for heavy work on pneumatic tires which successfully passed very severe French army tests; horsepower rating, 20.1 on R. A. C. formula.

Buying Parts. Buying Parts for a Big Fleet—How a Big Company Economizes Commercial Vehicle, vol 26, no. 1, Feb 1, 1922, pp. 8 9, 3 figs. Describes organization of Consumers Co. of Chicago, which has recently acquired equipment of Cook County Supply Co and its ten subsidiary organizations

German. The German Motor Truck Industry (Die deutsche Kraft Nutzfahrzeug-Industrie), Wirtschaftsmotor, no 8, Aug 10, 1921, pp. 6 19, 47 figs Status and development of German and Austrian motor truck construction. Details and illustrations are given of numerous types of trucks and buses.

Parts Design. Features of Recent Development in Truck Parts Design, P. M. Heldt. Automotive Industries, vol. 46, no 1, Jan. 5, 1922, pp 12 18, 12 figs. Discusses recent developments in engine, clutch, transmission, universal joint, rear axle and wheel design.

Six-Wheeled. Flexible Six-wheelers. Motor Transport, vol. 31, no. 882, Jan 23, 1922, pp. 95 97, 14 figs. Underlying principles of these vehicles, the different types available, and their advantages and possibilities.

MOTORCYCLES

German Types. German Motor Cycles (Deutsche Krafträder und Einbaumotoren), Kurt Bernhard Wirtschaftsmotor, no. 9a, Sept. 25, 1921, pp. 6 11, 61 figs. Details of numerous types, including high-power motor cycles with side carriages; medium- and low-power motor cylces; motor scooters, motor cycles with small non-detachable motors; and non-detachable motors.

N

NICKEL STEEL

Determination of Nickel. The Determination of Nickel in Steel (Nickelbestimmung in verschiedenen Stahlsorten), Hans Rubricius. Chemiker-Zeitung, vol. 46, no. 3, Jan. 7, 1922, p. 26. As result of numerous tests with steels of varying nickel content, it is shown that a complete precipitation of nickel from the ammonia solution can be effected with alcoholic dimethylglyoxim liquid.

Low-Carbon and Chromium. Low-Carbon Nickel and Nickel-Chromium Steels. Iron & Coal Trades Rev., vol. 104, no. 2812, Jan. 20, 1922, p. 77. Summaries of paper on the constitution and properties of low-carbon nickel steels, by J. N. Greenwood, and paper on nickel-chromium steels, by J. S. Dickenson.

O

OIL ENGINES

Solid-Injection. The Solid Injection Oil Engine, C. McTaminey. Mar. Eng. of Can., vol. 12, no. 1, Jan. 1922, pp. 11-14. Describes experiments made on oil tank of the Trefoil, main engines of which are of the four-stroke cross-head type.

OIL FUELS

Ceramic Kilns. Using Liquid Fuel in the Hoffmann Furnaces (L'Emploi des combustibles liquides dans les fours Hoffmann), L. Mascard. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 9, Nov. 1921, pp. 1192-1195, 2 figs. Discusses application of heavy oils and tars in ceramic furnaces.

Heavy Oils. Receiving Heavy Fuel Oils (Reception des combustibles liquids lourds), M. Denier. Bulletin Technique du Bureau Veritas, vol. 3, nos. 8, 9, and 10, Aug., Sept. and Oct. 1921, pp. 194-199, 221-227 and 245-251, 28 figs. Aug.: Discusses difficulties of "taking delivery" of mazout, etc., due to various methods of analysis and to its varying composition. Sept.: Discusses laboratory tests, specific gravity, water content, impurities, acidity, cold test flash point, fire point, etc. Oct.: Describes processes and apparatus for various tests, including ignition point, fluidity and viscosity.

OIL PUMPS

Quimby Screw. The Quimby Screw Pump. Shipbldg. & Shipg. Rec., vol. 19, no. 3, Jan. 19, 1922, p. 73. Data on this pump which has been employed in the American naval service as a high-pressure fuel-oil service pump.

OPEN-HEARTH FURNACES

Gun-Steel Manufacture. Acid Open-hearth Process for Manufacture of Gun Steels and Fine Steels, W. P. Barba and Henry M. Howe. Am. Inst. Min & Metallurgical Engrs. Trans., no. 1114-S, 1922, 39 pp., 8 figs., and (in abstract) Min. & Metallurgy, no. 181, Jan. 1922, pp. 32-34. Report of committee appointed during war by Engineering Division of Nat. Research Council to study steel melting and ingot production for guidance of wartime manufacturers. Precautions are given for making the ingots of proper and uniform composition; of proper macro- and micro-structure; sound, that is, free from pipes, blowholes, cracks and roughness; and to prolong life of furnace.

Talbot. The Talbot Process in Comparison with Other Open-Hearth Processes (Das Talbotverfahren im Vergleich mit anderen Herdfrischverfahren), J. Puppe. Stahl u. Eisen, vol. 42, nos. 1 and 2, Jan. 5 and 12, 1922, pp. 1-10 and 46-54, 9 figs. Describes steel works, gas-producer and mixing plants in Witkowitz. Operating conditions of Talbot, Wellmann and ordinary open-hearth furnaces. Technical and economic results obtained with processes carried out in these three furnace types.

OXY-ACETYLENE CUTTING

Cutting Machines. The Godfrey Universal Oxygen-Jet Cutting Machine. Automobile Engr., vol. 11, no. 158, Dec. 1921, pp. 446–447, 4 figs. Built by Godfrey Eng. Works, Lond. Design and operation. Special attention has been given to blowpipe.

OXY-ACETYLENE WELDING

Pipe. Autogenous Pipe Welding, H. B. Iglehart. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 173–174, 4 figs. Account of pratical demonstrations of welded pipe joints made under direction of writer at W. K. Mitchell Co. shops. (Abstract.) Paper read before Int. Acetylene Assn.

Rods for. Welding Rods for Oxy-Acetylene Welding, J. R. Dawson. Iron Age, vol. 109, no. 7, Feb. 16, 1922, pp. 468–472, 17 figs. Also Welding Engr., (vol. 7, no. 1, Jan. 1922, pp. 32, 37 and 40, 17 figs.) under title: Oxy-Acetylene Welding Rods. Their selection and composition as factor in successful results on steel. Welding cast iron. Copper and brass welding. Paper before International Acetylene Assn.

P

PACKING

Transit and Storage. Packing and Wrapping-Up for Transit and Storage (including Baling). Abridgments of Specifications, Period—A.D. 1909-15, class 94 (i), 1921, 221 pp. Patents for inventions.

PAPER MANUFACTURE

Chemical Hydration of Pulp. Chemical Hydration of Pulp, Alfred MacKay. Paper, vol. 29, no. 16, Dec. 21, 1921, pp. 7–10. Discusses hydration of stock by chemical treatment to replace hydration by beating, and gives results of tests carried out showing advatages of chemical hydration.

Fibers for. New Sources of Paper Fibers. Paper, vol. 29, no. 15, Dec. 14, 1921, pp. 20–23. Describes possibilities afforded by giant grasses of India and Africa.

Nigerian Grasses for Paper Making. Imperial Inst. Bul., vol. 19, no. 3, 1921, pp. 271–282. Account of investigation of two series of dried grasses, belonging to ten different species, received by Imperial Inst. from Nigeria in order that their suitability for manufacture of paper might be ascertained.

Laid and Wove Molds. Laid and Wove, Dard Hunter. Paper, vol. 29, no. 16, Dec. 21, 1921, pp. 12–18, 7 figs. Origin of the terms described and their early use set forth.

PAPER MILLS

Construction. Paper Mill Construction, H. S. Taylor. Paper, vol. 29, no. 15, Dec. 14, 1921, pp. 9–11. Discusses engineering as related to pulp and paper industry, plant development, efficiency in operations, organization, etc.

PIPE, STEEL

Centrifugally Cast. Steel Pipe by the Centrifugal Process, L. Cammen. Iron Age, vol. 109, no. 6, Feb. 9, 1922, pp. 405–406. Methods and cost of Cammen process for making seamless pipe at low cost. Competition with welded pipe.

PIPE, WOOD-STAVE

Redwood vs. Fir. Wood-Stave Water Pipe. Pub. Works, vol. 52, no. 1, Jan. 7, 1922, p. 5. Summary of results obtained by its use in U. S. Reclamation projects during past 20 years. Comparison of fir and redwood, buried and above ground.

60-in. Pipe Line. 60-Inch Wood Stave Pipe Line for Hydroelectric Plant, W. A. Scott. Eng. World, vol. 20, no. 2, Feb. 1922, pp. 69–70, 2 figs. New pipe line, 912 ft. long, was built upon a regraded bed and is supported by 166 concrete cradles, each 6 in. thick above ground, with concrete bases 12 in. thick. Staves were creosoted by vacuum process.

POWER PLANTS

Remodeling. Remodeled Naval Proving Grounds Power Plant, P. J. Searles. Power, vol. 55, no. 4, Jan. 21, 1922, pp. 133–134, 2 figs. Describes changes that were made, and gives total cost figures for new boiler, stoker, generator, electrical and auxiliary equipment, etc. Plant was kept in operation while work of remodeling was going on. Explains how difficulty arising in supporting steam pipes was overcome.

POWER TRANSMISSION

Friction Losses. The Problem of Efficient Power Transmission, G. C. V. Hewson. Can. Machy., vol. 27, no. 3, Jan. 19, 1922, pp. 23–26, 8 figs. Friction causes largest percentage of loss; charts and tables showing different conditions.

Industrial Plants. Power Transmission in Industrial Plants, Kenneth M. Raynor. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 1, Jan. 1922, pp. 1–10 and (discussion) 10–21, 5 figs. Discusses construction, operation and some operating results obtained from a 6600-volt, 25-cycle, three-phase balanced-current overhead power transmission loop system operating in a modern steel-mill plant.

PRESSES

Punch, Guard for. Eliminating Cold Trim Press Accidents, G. A. Kuechenmeister. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 71–72, 2 figs. After experimenting with various kinds of "two-handed" mechanical tripping devices an electrical guard was installed. Production has not suffered and accidents are eliminated.

Lignite, Preparation of. The Pulverization of Rhenish Lignite (Die Aufbereitung rheinischer Braunkohle zu Staub), H. Weiss and H. Haering. Braunkohle, vol. 20, no. 40, Jan. 7, 1922, pp. 625–631, 4 figs. Describes drying and pulverizing process of the Büttner Works, Inc., Uerdingen on the Rhine; and use of pulverized coal for heating of a recuperative furnace.

Preparing and Distributing System. Preparing and Distributing Powdered Coal, E. C. Greisen. Iron Age, vol. 109, no 5, Feb. 2, 1922, pp. 326–329, 8 figs. Modern seamless steel-tube plant adopts pulverized coal as fuel. Details of system in use for furnaces and boilers.

PUMPS

Boiler-Feed, Governor for. Thermofeed Differential Feed-Pump Governor. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 184–185, 4 figs. Describes device which, when attached to steam supply of pump, will not only cause pump to stop when any predetermined pressure has been attained, but will start pump again as soon as any predetermined drop in pressure has taken place in feed pipe.

PUMPS, CENTRIFUGAL

Corrosive Liquids. The Flexala and Resilene Pumps. Engineering, vol. 113, no. 2925, Jan. 20, 1922, pp. 74–75, 8 figs. Describes centrifugal pumps manufactured by Metal Powders, Ltd., London, feature of which is a flexibility and resilience in certain parts which tend to reduce erosion and corrosion when dealing with acids or liquids holding solids or fibrous matters in suspension.

High- and Low-Lift. The Applications of High- and Low-Lift Centrifugal Pumps. Mech. World, vol. 71, nos. 1829 and 1830, Jan. 20 and 27, 1922, pp. 46–48 and 67–68, 9 figs. Jan. 20: Characteristics of a centrifugal pump; advantages of centrifugal over reciprocating type. Describes De Laval single-stage centrifugal pump having capacity of 10,000 gal. per min. against 150 ft. head. Jan. 27: Discusses boiler feeding and electrically driven centrifugal boiler-feed pumps; circulating pumps for surface condensers barometric and jet condensers.

PYROMETERS

Maintenance Costs. Maintenance Costs of Pyrometric Systems, R. W. Newcomb and G. V. Nightingale. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 50–51. Lack of appreciation of sensitivity of pyrometric instruments; thermocouples as high factor in maintenance cost; better protection tubes and care in selection.

Radiation. A New Radiation Pyrometer (Ein neues Strahlungspyrometer). Chemiker-Zeitung, vol. 46, no. 2, Jan. 5, 1922, pp. 20–21, 2 figs. Describes new pyrometer in the shape of a small telescope for use of works engineer in measurement of furnace temperature.

Thermoelectric and Optical. Electrical Instruments for Industrial Measurements, Ezer Griffiths. Beama, vol. 10, no. 1, Jan. 1922, pp. 18–27, 9 figs. Thermoelectric pyrometry and optical pyrometry. Discusses temperature indicators of millivoltmeter type; recording pyrometers; recording potentiometer; automatic temperature control; disappearing filament-type optical pyrometer; and laboratory standard optical pyrometer.

R

RAILS

Basic Bessemer Steel. Basic Bessemer Steel Rails, Cecil J. Allen. Ry. Engr., vol. 43, no. 504, Jan. 1922, pp. 5–8 and 35, 2 figs. Details of modern methods employed in Europe in production of rails by basic bessemer process, including reaction in basic converter, graphic method of estimating additions, comparison of analysis and test results, reliability of basic bessemer steel.

Corrugation. The Corrugation of Tramway Rails. Engineer, vol. 133, no. 3447, Jan. 20, 1922, p. 66, 1 fig. Abstract of report presented to Mun. Tramways Assn. by Rail Corrugation Sub-committee appointed to investigate corrugation of tramway rails, with particular reference to vibration of rails and foundations as cause thereof.

Girder, Rolling. Rolling Girder Rails, R. C. Cram. Elec. Ry. Jl., vol. 59, no 3, Jan. 21, 1922, pp. 102–106, 16 figs Describes the various rolling-mill processes incidental to rolling girder rails; essential difference in rolling T-rails and girder rails; recent developments.

Joint Welding. Reclaiming Joints in Indianapolis, T. H. David. Elec. Ry. Jl., vol. 59, no. 5, Feb. 4, 1922, pp. 199–201. Discusses experience with Lorain weld joints, arc welding on old tracks, and thermit welding. (Abstract.) Paper read before Central Elec. Ry. Assn.

Manufacture. Improvement in the Manufacture of Rails. Ry. & Locomotive Eng., vol. 35, no. 1, Jan. 1922, pp. 6–7. Describes tests made with Hadfield sink-head ingots rolled by Maryland Steel Co., showing that after removal of top discard of 13 per cent, the Hadfield ingot is free from piping and undue segregation.

Standard 7-in. Standard Rails Reduce Costs, R. C. Cram. Aera, vol. 10, no. 7, Feb. 1922, pp. 581–583, 2 figs. Advocates use of Association standard seven-inch girder grooved rail.

RAILWAY CONSTRUCTION

Program. Real Program of Railroad Construction Needed, Herbert Hoover. Ry. Age, vol. 72, no. 6, Feb. 11, 1922, pp. 379–382. Tremendous losses suffered because of lack of foresight and antagonism to railroads.

RAILWAY ELECTRIFICATION

England. The Electrification of English Main Line Railways. Engineering, vol. 113, no. 2926, Jan. 27, 1922, pp. 102–104. Account of discussion held at joint meeting of Instn. Mech. Engrs., Instn. Civ. Engrs. and Instn. Elect. Engrs.

St. Gothard Ry., Switzerland. The Electrification of the St. Gothard Railway. Engineer, vol. 133, no. 3447, Jan. 20, 1922, pp. 68–70, 15 figs. partly on p. 72. Details of electrical equipment of Ritom and Amsteg power stations, locomotive types, etc.

RAILWAY MOTOR CARS

New Haven Branch Lines. New Haven Using Motor Cars on Branch Lines. Ry. Age, vol. 72, no. 5, Feb. 4, 1922, pp. 315–317, 4 figs. Advantages of new passenger-equipment car, including flexibility and low operating cost.

RAILWAY OPERATION

British Railway Speeds. Tables of British Railway Speeds in 1921. Engineer, vol. 133, no. 3449, Feb. 3, 1922, pp. 120–121. Annual statistics.

Train Control. The Control of Trains. Ry. Gaz., vol. 36, no. 3, Jan. 20, 1922, pp. 91–92, 1 fig. Discusses the problem of deceleration and considers brake power in relation to increased weight and speed of trains, combined with reduced headway. Summary of paper read before Instn. Civil Engrs.

RAILWAY REPAIR SHOPS

Freight-Car. Community Hospitals for Disabled Foreign Freight Cars, J. J. Tatum. Ry. Rev., vol. 70, no. 3, Jan. 21, 1922, pp. 73–76, 2 figs. Advocates adequate car facilities at important interchange points on coöperative basis.

RAILWAY SHOPS

Electric Drive for. Electric Drives in Railroad Shops, Bertram S. Pero. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 477–481, 10 figs. Selection and types of motors, and application on different kinds of machine tools.

RAILWAY SIGNALING

Interlocking. Interlocking Practice of the Interborough Rapid Transit Ry., W. A. Bartley. Ry. Rev., vol. 70, no. 4, Jan. 28, 1922, pp. 113–115. Describes electropneumatic power interlocking plant and their equipment; traffic density and control, etc. From paper read before N. Y. Sectional Committee.

Light. The Light Signal Committee's Report. Ry. Gaz., vol. 36, no. 3, Jan. 20, 1922, pp. 80–81. Discusses report of departmental committee to Ministry of Transport, who have been inquiring into the potentialities of light signals. Committee favors color light as against position light.

Track Circuits. Testing of D. C. Track Circuits to Insure Safety and Efficiency, F. B. Weigel. Ry. Signal Engr., vol. 15, no. 1, Jan. 1922, pp. 7–9, 2 figs. Discusses limiting resistance at battery; bonding wires; track ballast; track relay and housing. Simple tests should be made periodically. Paper read before A. R. A.

RAILWAY STATIONS

Freight. On the Question of Goods (Freight) Stations, Edilio Ehrenfreund. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 5–24, 11 figs. Report No. 2 (Italy). Organization of receiving and delivering stations, so as to accelerate their business. Arrangement of building and tracks so as to simplify shunting (switching) operations and handling. Mechanical appliances.

On the Question of Good (Freight) Stations, M. Jullien and M. Moutier. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 151–192, 12 figs. Report No. 1 (All countries, except Italy and those using English language.) Organization of receiving and delivering stations, so as to accelerate their business. Arrangement of buildings and tracks so as to simplify shunting (switching) operations and handling, particularly as regards goods in bulk. Mechanical appliances.

RAILWAY TIES

Specifications. Procurement of Railway Ties Under Federal Control, G. G. Yeomans. Ry. Rev., vol. 70, nos. 1 and 2, Jan. 7 and 14, 1922, pp. 20–22 and 55–57. Work of the Forest Products Section. Standard tie specification most notable achievement. Describes control and distribution of all wood preservatives, together with work involved in procurement of lumber required for construction of Railroad Administration freight cars.

Treatment. Wood Preservers Discuss Economics of Ties. Ry. Age, vol. 72, no. 4, Jan. 28, 1922, pp. 269–271, 1 fig. Factors affecting cost of treated cross ties. Economics of tie renewals. Papers read before Am. Wood-Preservers' Assn.

RAILWAY TRACK

Maintenance. On the Question of the Maintenance and Supervision of the Track, Joseph Barbierint. I. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 139–150. Report No. 4 (All countries, except Great Britain and America.) Measures to be taken to provide an economic organization for maintenance and supervision of track, taking into consideration increase of traffic and speed as well as rise in wages and in cost of materials. Use of mechanical appliances.

Relocation. Costly Railroad Re-location. Cement & Eng. News, vol. 34, no. 2, Feb. 1922, pp. 23–24, 2 figs. Shifting 15 miles of double-track railroad around Huffmann dam, Miami Conservancy District, required excavating 657,000 yd., mostly rock in one cut 120 ft. deep, placing 390,000 yd. embankment. Cost more than $3,237,000.

Relocation on the South African Government Railways. Eng. News-Rec., vol. 88, no. 3, Jan. 19, 1922, pp. 116-118, 4 figs. A 70-mi. relocation in rough country, reducing curvature 50 per cent and maximum grades from 3.3 to 1.5 per cent, is being carried out on S. A. Government Railways to meet requirements of increasing traffic.

Roadbed Construction. On the Question of the Construction of the Road Bed and of the Track, M. Henry and M. Candelier. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 251-270, 11 figs. Supp. to Report No. 2 (Oct. 1920, p. 639) (All countries, except Denmark, Sweden, Norway, Great Britain and America.) Arrangements to be adopted, in view of increase in locomotive weight and speed of trains.

RAILWAY YARDS

Terminals and. Report of Committee XIV—On Yard and Terminals. Am. Ry. Eng. Assn. Bul., vol. 23, no. 239, Sept. 1921, pp. 65-84. Warehouses in connection with L. C. L. freight houses. Classification yards, including methods of switching from classification to departure yards.

RAILWAYS

Light. Development of Light Railways in Great Britain. Eng. News-Rec., vol. 88, no. 5, Feb. 2, 1922, p. 205. Standard gage preferable; or 30-in. for isolated lines. Light rail and load; economic operation; road motors.

Net Cost of Transportation. On the Question of the Net Cost, Rates, Samuel O. Dunn. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 123-138. Report No. 3 (America). Determination of net cost of carriage (passengers and goods), taking capital charges into consideration. Relation to rates charged.

REFRIGERATING MACHINES

Modern Types. The Present Status of Design of Refrigerating Machines (Der heutige Stand des Kältemaschinenbaues), Martin Krause. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1349-1355, 25 figs. Notes on working process of superheated compressor in ammonia machines. Present design of compressors and condensers. Improvement of carbonic-acid machines using hot cooling water by increasing liquid pressure. Steam refrigerating machines for low brine temperatures and high refrigerating capacities.

REFRIGERATING PLANTS

Ammonia Condensers. Types and Constructions of Ammonia Condensers. Power, vol. 55, no. 6, Feb. 7, 1922, pp. 208-210, 7 figs. Discusses principles of operation of several condensers in general use.

Economy in. Refrigerating Plant Economy Standards and Records, Victor J. Azbe. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, pp. 19-21. Discusses basic requirements of an efficient plant, including, lowest possible condenser pressure and highest possible back pressure, highest possible CO_2 and lowest possible flue-gas temperature, etc. Paper read before Nat. Assn. Practical Refrig. Engrs.

REFRIGERATION

Carbonic-Dioxide Refrigerating Cycle. The Carbonic Refrigerating Cycle, H. J. Macintire. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 175-177, 2 figs. Presents latest table on properties of saturated carbon dioxide, which is said to be great improvement over previous tables, and diagram known as total-heat diagram, showing effect of condensation or liquefaction of carbon dioxide and condition of substance.

Forecooling Liquid Ammonia. Forecooling of Liquid Ammonia, H. T. Whyte. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, p. 15. Discusses different methods. Paper read before Nat. Assn. Practical Refrig. Engrs.

Wet vs. Dry Compression. Wet vs. Dry Compression, Van. R. H. Greene. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, pp. 10-11. Objection to wet compression; maximum output for minimum of power; etc. Paper read before Nat. Assn. Practical Refrig. Engrs.

RIVETING

High-Speed Hammers. Cutting Costs with Riveting Hammers, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 474-476, 6 figs. Several examples of cold-heading and rivet-setting operations performed on high-speed riveting hammers made by the High Speed Hammer Co., Inc., Rochester, N. Y., are illustrated.

ROLLING MILLS

Cross. Cross-Rolling Mills. Eng. Progress, vol. 3, no. 1, Jan. 1922, pp. 4-6, 12 figs. Discusses mode of action and field of application, and describes the Friemel cross-rolling mill.

Sheet Mills. Sheet Mill of the Otis Steel Company. Iron Age, vol. 109, no. 4, Jan. 26, 1922, pp. 259-263, 6 figs. Features include staggered arrangement of furnaces. Powdered coal used. Plant notable for its applications of modern equipment and design.

Strip-Rolling Calculations. Cold Rolled Strip Steel Calculations, S. T. Hilliard. Iron Age, vol. 109, no. 4, Jan. 26, 1922, pp. 267-268. Formulas for determining pounds output and piece-work rates in manufacture of cold rolled strip steel.

RUBBER

Energy-Absorbing Capacity. Energy Absorbing Capacity of Vulcanized Rubber, H. P. Gurney and C. H. Tavener. Jl. Indus. & Eng. Chem., vol. 14, no. 2, Feb. 1922, pp. 134-139, 36 figs. Discusses relations which exist between capacity of vulcanized rubber to absorb or store up in a potential form and partially to transform or degrade kinetic energy into heat when subjected to single or repeatedly applied stresses.

S

SAND, MOLDING

Origin and Uses. Moulding Sands: Their Origin and Uses, Alexander Scott. Mech. World, vol. 71, no. 1830, Jan. 27, 1922, pp. 71-72. Discusses uses of sands as abrasives, for casting molds and surface linings, building purposes, an ingredient of soap, and as a filtering medium in connection with water supplies. From paper read before Stoke Assn. of Engrs.

SCALES

Precision Tests. The Precision Test of Large Capacity Scales. Scale Jl., vol. 8, no. 4, Jan. 10, 1922, p. 6, 1 fig. Gives extract from Technologic Paper 199 of Bur. of Standards, which outlines procedure for accurate test.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCRAP

Non-Ferrous, Smelting. The Smelting of Scrap Metal (Einschmelzen von Metallabfällen), F. Reinboth. Metall-Technik, vol. 47, no. 4, Mar. 9, 1921, pp. 21-23. Suggestions for smelting of aluminum, copper, brass, nickel, zinc and rare-metal scrap.

SEAPLANES

Fairey Long-Distance. The New Fairey Long-Distance Seaplane. Flight, vol. 14, no. 3, Jan. 19, 1922, pp. 35-36, 3 figs. Top speed developed was 95 m.p.h. with a power load of over 19 lb. per hp., and a wing loading of over 10 lb. per sq. ft. Rolls-Royce "Eagle" engine.

SEMI-DIESEL ENGINES

Peugeot. The Peugeot Semi-Diesel Engine. Motor Transport, vol. 34, no. 882, Jan. 23, 1922, pp. 99-102, 12 figs. Describes two-cylinder two-stroke motor of original design which is being put into service in Paris by General Omnibus Co.

Vickers-Petter Manufacturing Methods. Semi-Diesel Engine Construction. Eng. Production, vol. 7, nos. 66 and 67, Jan. 5 and 12, 1922, pp. 13-19 and 37-41, 29 figs. Describes works practice of Vickers-Petters, Ltd.

SEMI-STEEL

Elongation and Compression. Elastic Limits of Elongation and Compression of Semi-Steel (Limites élastiques a la Traction et a la Compression de la Fonte aciérée), M. Portevin. Fonderie Moderne, no. 11, Nov. 1921, pp. 321-324, 5 figs. Gives results of tests from which curves are plotted and formula developed.

SHAPERS

Vertical. Production Work on Vertical Shapers, Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 483-485, 5 figs. Operations advantageously performed on shapers of vertical type.

SILICA BRICK

Breakage Factor in Manufacture. Breakage Factors in Silica Brick Manufacture, Philip H. Jung. Chem. & Met. Eng., vol. 25, no. 5, Feb. 1, 1922, pp. 214-217. Critical discussion of those factors in manufacture of silica brick which determine breakage records; properties of silica rock; grinding; effect of bats; workmanship; drying; setting in kiln; burning; methods of firing.

South Wales Silica. The Refractory Silica Materials of South Wales, W. R. D. Jones. Colliery Guardian, vol. 123, no. 3181, Jan. 6, 1922, p. 11. Discusses importance of texture and correct grading of materials employed in silica brick manufacture; also refractoriness.

SPRINGS

Helical, Calculation of. Practical Helical Spring Calculation, Alex Taub. Am. Mach., vol. 56, no. 5, Feb. 2, 1922, pp. 179-183, 2 figs. Essentials of spring design. Analyzing spring troubles mathematically.

STANDARDIZATION

Basic Standards. Development and Construction of Standard Parts Making Use of Basic Standards (Entwicklung und Aufbau von Normteilen unter Benutzung von Grundnormen), R. Koch. Betrieb, vol. 4, no. 7, Jan. 14, 1922, pp. 83-89, 21 figs. It is shown on two definitely established standard parts that even the simplest standard part is composed of different individual standards, and on screwed pipe joints and plug cocks that a systematic development of suitable basic standards is of great advantage in standardization. Report of German Industry Committee on Standards (NDI).

Germany. Industrial Standardization in Germany. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 136-137. Describes program being carried out in Germany. Organization and methods of work; work in special industries; system of "preferred numbers."

Importance. Significance of Standardization, A. A. Stevenson. Am. Mach., vol. 56, no. 4, Jan. 26, 1922, pp. 138-139. Points out need for coöperation between industry and Federal Government. Work of committees in harmonizing conflicting standards and formulating new ones. (Abstract.) Paper presented before Am. Eng. Standards Committee.

STANDARDS

German N. D. I. Report. Report of the German Industry Committee on Standards (Normenausschuss der Deutschen Industrie). Betrieb, vol. 4, no. 6, Dec. 24, 1921, pp. 73-77, 4 figs. Proposed standards for fastening of belt pulleys on transmission shafts, and for ball hand cranks. Problems of the working committee for screws.

STEAM

Generation and Utilization. Fuel Economy by the Adoption of Scientific Management in Steam Generation and Utilisation, David Brownlie. Eng. & Indus. Management, vol. 7, nos. 2, 4 and 5, Jan. 12, 26 and Feb. 2, 1922, pp. 39-41, 6 figs., 117-120, 9 figs. and 131-132, 2 figs. Jan. 12: Boiler and pipe coverings. Jan. 26 and Feb. 2: Steam traps.

STEAM ENGINES

Compound Drop-Valve. Compound Drop-valve Mill Engine. Mech. World, vol. 71, no. 1827, Jan. 6, 1922, pp. 11-12, 3 figs. Describes cross-compound jet-condensing type of engine, having cylinders 27 in. and 55 in., with a 5-ft. stroke, built by Hick, Hargreaves & Co., Bolton. Develops 1580 i.hp. at 65 r.p.m.; boiler pressure, 160 lb.

Schmidt High-Pressure. Schmidt Steam Engine More Efficient Than Largest Turbine, O. H. Hartman. Power, vol. 55, no. 6, Feb. 7, 1922, pp. 217-219, 2 figs. Results of tests indicate that it is feasible to generate and utilize steam at pressure of 800 lb. per sq. in. and over in reciprocating engines with probable gain of 20 per cent in efficiency as compared to best present-day turbine practice. Steam consumption of 5.12 lb. per i.hp. was obtained with 150-hp. engine. Translated from Zeit. des Vereines deutscher Ingenieure.

Uniflow. Modern Development of Uniflow Steam Engines (Die neuere Entwicklung der Gleichstromdampfmaschine), H. Bonin. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 46, Nov. 18, 1921, pp. 372-374, 4 figs. Describes various working losses occurring in a reciprocating steam engine, and shows how these losses can be greatly reduced in a uniflow engine. Report of new edition of book entitled, Uniflow Steam Engines, by J. Stumpf.

300-HP. Uniflow Engine. Engineering, vol. 113, no. 2927, Feb. 3, 1922, p. 136, 7 figs. partly on p. 137. Describes engine recently constructed under John Davidson's patents by Clayton, Goodfellow and Co., Ltd., Blackburn, England. It has a single-cylinder, 24-in. diam. by 30-in. stroke, and operates with steam at 160 lb. per sq. in. and 150 deg. fahr. superheat.

STEAM METERS

Kent-Hodgson. The Kent-Hodgson Steam Meters, J. L. Hodgson. So. African Eng., vol. 32, no. 12, Dec. 31, 1921, pp. 243-245, 5 figs. Describes steam meter developed by the author and his firm (George Kent, Ltd., Lond.). Used in power stations and paper mills, collieries and cement works, due works and pumping stations, on locomotives and on ship board.

STEAM PIPES

Economical Diameter. The Most Economical Pipe Diameter for Steam Piping (Der billigste Rohrdurchmesser für Kraftdampfleitungen), O. Denecke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 49, Dec. 9, 1921, pp. 394-396, 1 fig. Determination of diameter taking only pipe friction into consideration; and taking the separate resistances into consideration; the cheapest diameters. Numerical example with high-pressure saturated-steam turbine.

STEAM POWER PLANTS

Auxiliary Drives. Driving Power-House Auxiliaries, W. H. Smith. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 166-169, 3 figs. Types of auxiliary drives; heat-balance considerations that influence selection of drives; a.c. versus d.c. motors; suitable voltage for auxiliary motors; selection of motors for various drives.

Birmingham, Ala. Sloss-Sheffield Steel and Iron Company's Steam Generating Stations, M. M. Argo and H. Maulshagen. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 83-88, 14 figs. Describes their modern steam-generating plants at North Birmingham, Ala., including feedwater system and by-product power house.

STEAM TURBINES

Blade Proportioning. The Proportioning of Steam Turbine Blading, Harold Medway Martin. Engineering, vol. 113, nos. 2923, 2924, 2925, 2926 and 2927, Jan. 6, 13, 20, 27 and Feb. 3, 1922, pp. 1-3, 33-34, 66-70, 96-98 and 128-130, 14 figs. Determination of effective thermodynamic head and general dimensions of a compound turbine to operate with given indicated hydraulic efficiency; also relation between thermodynamic head and specific volume.

Increasing Efficiency. Possibilities of the Turbine, P. F. Coffin. Power, vol. 55, no. 4, Jan. 24, 1922, pp. 136-137, 1 fig. Points out that efficiency limitations reached in steam turbines may be overcome by using two vapors in series, such as mercury and steam. A 1000-kw. experimental unit has operated under conditions equivalent to producing 1 kw-hr. on about 11,300 B.t.u. (Abstract.) Author's contribution, "Utilization of Coal on a Multiple-Products Basis," to R. F. Bacon's and W. A. Hamor's forthcoming book, "American Fuels."

STEEL

Alloy. See ALLOY STEELS.

Boiler-Tube. Occurrence of Oxides and Nitrides in Boiler Tube Steel, A. E. White and J. S. Vanick. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 323-330, 8 figs. Discusses examination of boiler tube which has been overoxidized, or allowed to absorb and retain an excess of oxygen and nitrogen.

Casting Ingots. Leaves from a Steel Melter's Note Book, Henry D. Hibbard. Iron Age, vol. 109, no. 7, Feb. 16, 1922, pp. 465-467. Experiences in casting

1860-1922

In our sixty-two years of bearing service to the railroads, power plants, industrial plants and manufacturers of America not one pound of anything but the finest procurable virgin material has ever been permitted to enter our metals. We have never used, and will not use, reclaimed or scrap metal of any kind.

During this sixty-two years we have not, to our knowledge, lost a single customer because of failure of our metal or for lack of uniformity. Three of the largest corporations in the United States have been our customers continuously for more than fifty years, several for more than thirty years, many for more than ten years.

For the past thirty years our metals have been alloyed by the process developed by the late A. W. Cadman. This process, by ensuring perfect distribution of the hardening medium, greatly increases the life of the bearing and removes the common causes of bearing trouble.

We cannot afford to ignore for one instant the traditions which make the name Cadman on a bearing metal a guarantee of perfect bearing service.

Can you?

(Clip the coupon or simply enclose your card in an envelope)

A.W.
Cadman
Manufacturing Co.
Pittsburgh
Pa.

Master Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletin M-1, samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:..**Position:**........................

Company Name:..

Address:...

steel ingots in cans How cracks were prevented Causes of hard spots in forging ingots.

Chrome. See CHROME STEEL.

Chrome-Nickel. See CHROME-NICKEL STEEL.

Fracture. Intercrystalline Fracture in Steel, D Hanson. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 91–101, 13 figs. Discusses cases of failure which occur only under certain circumstances, in material of normal quality, when time during which stress is applied is prolonged.

Internal Service Strains. Internal Service-Strains in Steel, James E. Howard. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 117 122. Deals particularly with original properties and characteristics of steels, and means by which these original properties are modified.

Nickel. See NICKEL STEEL.

Nitrogen in. The Determination of Nitrogen in Steel, Frederik Hurum and Henry Fay. Chem. & Met. Eng., vol. 25, no. 5, Feb. 1, 1922, pp. 218–222, 2 figs. Review of literature on the subject. Describes reagents and apparatus recommended for determination of nitride nitrogen.

STEEL, HEAT TREATMENT OF

Cost Analysis. Over-all Cost of Heat-Treated Parts, C. I. Ipsen. Iron Age, vol. 109, no. 7, Feb. 16, 1922, pp. 459–462, 6 figs. Electric current or fuel cost is only a portion of total cost. Percentage of rejection important. Cost of subsequent operations an item.

Effect on Properties. The Effect of Heat Treatment on the Properties of Steel, G. L. Thirkell. Commonwealth Engr., vol. 9, nos. 3 and 4, Oct. 1, and Nov. 1, 1921, pp. 69–74 and 109–114, 28 figs. Describes the iron-iron-carbide diagram. Notes on heating and cooling curves, effect of carbon on the change points, effect of heat on grain size, hardening and tempering.

Medium-Carbon Steel. Effect of Time in Reheating Quenched Medium-carbon Steel Below the Critical Range, Carle R. Hayward, Daniel M. MacNeil and Raymond L. Presbrey. Am. Inst. Min. & Metallurgical Engrs. Trans., no. 1111-S, 1922, 5 pp., 2 figs., and (in abstract) Min. & Metallurgy, no. 181, Jan. 1922, pp. 34–35. Results of investigation show that even 5 min. heating at 300 deg. cent. lowers considerably the strength and hardness and increases ductility; there is marked increase in ductility in passing from 400-deg. to 500-deg. treatment without equivalent lowering of strength; specimens reheated to 600 deg. cent. are nearly as ductile as annealed specimens, but have an elastic limit about 60 per cent greater.

Ordnance Purposes. Heat Treatment of Steel for Ordnance Purposes, H. F. Leary. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 288–295. Discusses specification requirements for gun forgings so far as heat treatment is concerned.

STEEL, HIGH-SPEED

American Manufacture. American Practice in High-Speed Steel Manufacture, A. H. d'Arcambal. Chem. & Met. Eng., vol. 25, no. 24, Dec. 14, 1921, pp. 1097–1099, 3 figs. Impressions received on trip of inspection covering several plants. Importance of pure raw materials and metallurgical control of all steps in process is emphasized.

STEEL WORKS

Holland. Royal Dutch Blast-Furnaces and Steel Works in Course of Construction (De in aanbouw zijnde werken ven de Koninklijke Nederl. Hoogovens en Staalfabrieken), A. H. Ingen Housz and A. H. Van Rood. Ingenieur, vol. 37, no. 1, Jan. 7, 1922, pp. 1–12, 12 figs. Discusses work of committee for installation of a plant comprising blast furnaces, steel works and rolling mills, and describes construction of works at Kaaimuur.

STOKERS

Underfeed, Operation of. The Practical Operation of an Underfeed Stoker. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 179–180, 3 figs. Article, based on actual experience with type AA 4 Taylor stoker, covers following subjects: Starting up; regulating draft and stoker speed; proper thickness and contour of fire; use and misuse of long stroke of lower ram; getting rid of troublesome clinkers; dumping ash; keeping lower ram from binding.

STREET RAILWAYS

Track Paving. The Pavement of Tracks in Street Railways Laid in Asphalt Roads (Befestigung der Gleisstreifen bei Strassenbahnen in Asphaltfahrstrassen), H. Henneking. Verkehrstechnik, vol. 39, no. 1, Jan. 6, 1922, pp. 4–6, 7 figs. Describes paving of track in Magdeburg, Germany. Roadbed between outside rails is covered with copper slag bricks on gravel base, and on either side of outside rail is a 50-cm. strip paved with copper slag bricks on concrete base with asphalt grouting of joints.

STRESSES

Concentrations Due to Notches. Stress Concentrations Due to Notches and Like Discontinuities, E. G. Coker and Paul Heymans. Engineering, vol. 113, no. 2923, Jan. 6, 1922, pp. 26–28, 6 figs. Brief account of experimental investigations made on discontinuities by photoelastic methods described in previous report, whereby stress distributions have been determined sufficiently completely to allow of fairly accurate value being assigned to maximum stresses experienced under given loads. (Abstract.) Report on Complex Stress Distribution, read before British Assn. at Edinburgh.

STRUCTURAL STEEL

Joints of Rigid Members. Tests on Joints of Rigid Members (Versuche mit Anschlüssen steifer Stäbe). H. Rudeloff. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 3, Jan. 21, 1922, pp. 68–69, 1 fig. Results of tests conducted at the State Material-Testing Bureau, Berlin-Dahlem, on rigid bars of angle and channel iron. (Abstract.) Berichte des Ausschusses fur Versuche im Eisenbau des deutschen Eisenbauverbandes, no. 3.

SUBSTITUTE MATERIALS

Germany. The Utilization and Improvement of German Raw Materials (Ausnutzung und Veredlung deutscher Rohstoffe), H. Schulz Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 2, Jan. 14, 1922, pp. 37–42. Review of Prof. Kessner's book with above title, giving his experiences during war in use of German raw materials, with discussion of future utilization of these experiences. Deals with use of substitute materials for overhead lines, cables, insulated wirings, motors and transformers, etc.; substitute materials in general machine construction; fiber materials, graphite, lubricants, etc.

T

TEMPERATURE MEASUREMENT

Ardometer. The Ardometer, a New Measuring Instrument for High Temperatures (Ein neues Messgerät für hohe Temperaturen: das "Ardometer"), G. Quaink. Dinglers polytechnisches Jl., vol. 336, no. 23, Nov. 19, 1921, pp. 323–325, 5 figs. Describes new instrument by Siemens & Halske, which is said to combine advantages of the thermoelectric and the light-radiation pyrometers, and is especially adapted to measurment of internal temperatures of furnaces.

Ultra-Micrometer. The Application of the Ultra-Micrometer to the Measurement of Small Increments of Temperature, W. Sucksmith. Lond. Edinburgh and Dublin Philosophical Mag. & Jl. Sci., vol. 43, no. 253, Jan. 1922, pp. 223–226, 2 figs. Method used was to attach a metal bar to one of two opposite condenser plates and measure change in temperature by change in note produced in telephone.

TEXTILE MACHINERY

Flax-Stripping Machine. The Feuillette Flax Stripping Machine (Machine, système Feuillette, pour le teillage industriel du lin), E. Weiss. Le Génie Civil, vol. 79, no. 27, Dec. 31, 1921, pp. 590–591, 6 figs. Describes machine and its operation, and the process of stripping.

Manufacture. Building Textile Machinery. Eng. Production, vol. 4, no. 70, Feb. 2, 1922, pp. 109–114, 14 figs. Manufacturing methods and equipment of The British Northrop Loom Co., Ltd., Blackburn.

THERMIT WELDING

Joining Bars. Joining Bars by Thermit Welding, L. I. Grinnell. Am. Mach., vol. 56, no. 4, Jan. 26, 1922, pp. 132–133, 6 figs. Long bars needed for making lead screws of rifling machines; aligning the sections; making mold and weld.

TUBES

Brass, Internal Stresses in. Internal Stresses in Brass Tubes, H. N. Vaudrey and W. E. Ballard. Faraday Soc. Trans., vol 17, part 1, no. 49, Dec. 1921, pp. 52–57, 7 figs. Deals exclusively with brass tubes of circular section containing about 70 per cent of copper.

Elliptic, Thickness of. Thickness of Elliptic Tubes (Épaisseur d'un tube elliptique), Gay Georges and Gay Albert. Annales de l'Énergie, vol. 1, no. 6, Nov.-Dec. 1921, pp. 217–219. Calculation based on resistance of materials.

U

UNEMPLOYMENT

Causes and Remedies. The Unemployment Problem. Nat. Indus. Conference Board, research report no. 43, Nov. 1921, 91 pp., 9 figs. Deals with extent, causes and suggested remedies for unemployment.

Insurance Scheme. Unemployment Insurance With Special Reference to Individual Firms and Industries, Henry Lesser. Jl. Indus. Administration, vol. 1, no. 8, Dec. 1921, pp. 227–239. Discusses a scheme for administration of unemployment insurance in individual firms, with ultimate object of its expansion and application to each organized industry as a separate, self supporting entity. (Abstract.) Paper read before Inst. Indus. Administration.

V

VALVE GEARS

Governor-Controlled. The Most Favorable Motion of Governor-Controlled Valve Gear (Ueber die günstigste Bewegung zwangläufig gesteurter Ventile), W. Borth. Wirtschaftsmotor, no. 7, July 1921, pp. 15–19, 10 figs. Writer discusses theoretical conditions for the best valve motion and seeks to establish most favorable lift curve.

Reversing. Reversing Gears (Ueber Umsteuerungen) W. Jung. Zeit. fur angewandte Mathematik u. Mechanik, vol. 1, no 6, Dec. 1921, pp. 455–463, 17 figs. Discusses different types of reversing gear, including the Stephenson gear favored in rolling-mill engines, and a more recent American reversing gear, the Baker Pilliod.

VALVES

Gate, Loss of Head in. Experiments Show Measurement of Valve Loss Dependent on Piezometer Location, Charles I. Corp. Wis. Engr., vol. 26, no. 4, Jan. 1922, pp. 61–62, 4 figs. Describes experiments carried out to determine loss of head due to flow to water.

Johnson-Boving. The Johnson-Boving Valve. Engineering, vol. 113, no. 2923, Jan. 6, 1922, p. 24, 4 figs. Describes large valves constructed by Glenfield & Kennedy, Ltd., Kilmarnock, England, consisting of a cylinder which, when valve is closed, rests against a seating in the main, and, when valve is open, is telescoped back into a casing so as to have a large free waterway.

VENTILATION

Katathermometers. Ventilation and Human Efficiency, Leonard Hill. Mech. World, vol. 71, no. 1830, Jan. 27, 1922, p. 69. Better health due to attention to good ventilation, and increase in efficiency and output due to cooling power adjusted to severity of work. Notes on electric and recording katathermometers. From paper read before Instn. Min. & Met.

W

WAGES

Piece-Price Systems. Should Piece-Price Systems Be Abandoned? James H. Delany. Factory, vol. 28, no. 2, Feb. 1922, pp. 175–176, 2 figs. Writer tells why he believes that piece-price systems should be scrapped and how scrapping will bring lower wages without cutting piece rates.

WASTE ELIMINATION

Research and. Elimination of Waste in Industry Through Research, F. A. Wardenburg. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 115–116. Outlines plan of a large corporation. Suggests coöperative plan. (Abstract.)

WASTE HEAT

Utilization. Heat Utilization and Economy in Steam Power Plants (Wärmeausnutzung und Wirtschaftlichkeit in Dampfkraftanlagen), W. Graulich. Chemiker-Zeitung, vol. 45, no. 153, Dec. 22, 1921, pp. 1233–1238. Study of waste-heat utilization Notes on volume of heat required for generation of steam; arrangements for utilization of waste-heat energy; purpose and limitations of waste-heat utilization.

The Utilisation of Waste Heat in Generating Stations. Electrician, vol. 88, no. 2280, Jan. 27, 1922, pp. 94–95, 2 figs. Abstract of paper by Ingham Haden suggesting combination of heat distribution in form of steam or hot water with electrical generation so as to utilize our fuel resources to better advantage, effected by converting generating stations, which would otherwise be discarded, into heat stations, and of paper by F. H. Whysall dealing with practical and economic difficulties of such a scheme. Read before joint meeting of Instn. Elec. Engrs. and Instn. Heat. & Vent. Engrs. See also editorial on pp. 90–91.

Utilization of Waste Heat. Eng. & Indus. Management, vol. 7, no. 4, Jan. 26, 1922, pp. 102–105, 2 figs. Suggests combination of heat distribution with generation of electric current as possible means of using coal to better advantage. Based on paper presented before (British) Instn. Elec. Engrs. by V. Ingham Haden.

WELDING

Locomotive Boilers. Locomotive Boiler Welding. Welding Engr., vol. 7, no. 1, Jan. 1922, pp. 26–28, 19 figs. Special committee of Master Boiler Makers' Assn. reports best methods of reconditioning boilers. To be presented before Master Boiler Makers' Assn. convention.

Wire Specifications. Welding Wire Specifications and Folios. Am. Welding Soc., Bul. no. 1, Dec. 1921, 16 pp. Report of committee.

[See also ELECTRIC WELDING, ARC; FUSION WELDING; OXY-ACETYLENE WELDING; THERMIT WELDING.]

WELDS

Test Standards. Committee Recommends Standards for Tests of Welds. Automotive Industries, vol. 46, no. 1, Jan. 5, 1922, pp. 19–20, 6 figs. Describes the shop, commercial and research standards of tests which Am. Bur. of Welding committee finds are desirable.

Standards for Testing Welds. Am. Welding Soc., Bul. no. 1, June 1921, 16 pp., 14 figs. Report of committee.

WINCHES

Pneumatic. Comparative Tests on Pneumatic Winches (Vergleichende Versuche an Presslufthaspeln), M. Schimpf. Glückauf, vol. 57, no. 51, Dec. 17, 1921, pp. 1245–1249, 9 figs. Results of tests on described machines are numerically and graphically compared. Points to necessary dewatering of compressed air underground and shows that through increasing temperature of compressed air at point of consumption, great savings can be effected.

WIND TUNNELS

Design and Equipment. The New Four-Foot Wind Tunnel at the Massachusetts Institute of Technology, William H. Miller and John R. Markham. Aerial Age Weekly, vol. 14, no. 20, Jan. 23, 1922, pp. 472–473, 4 figs. Describes construction and equipment of two new tunnels, one having a 4-ft. and the other a 7 $^1/_2$-ft. diameter.

Motor Regulators and Manometer. Langley Field Wind Tunnel Apparatus, D. L. Bacon. Aerial Age Weekly, vol. 14, no. 22, Feb. 6, 1922, pp. 518–519, 2 figs. Deals with regulators for speed of wind-tunnel drive motor; and a Vernier manometer with adjustable sensitivity. Technical Note, Nat. Advisory Committee for Aeronautics.

MECHANICAL ENGINEERING

Volume 44 May, 1922 Number 5

Power Development in the Southeast

Utilized and Undeveloped Water-Power Resources of Five Southern States Discussed—Present State of Muscle Shoals Project and Future Possibilities Described

By CHAS. G. ADSIT,[1] ATLANTA, GA.

In considering the power development in the Southeast, it is perhaps in order to give a brief history of the development and use of hydroelectric power since this form of energy predominates in this section.

It has been found that some form of water wheel was in use with primitive peoples as far back as any record is available, the first ones raising water for irrigation and for grinding grain. Water wheels have gone slowly through the various steps of development from these early times, but it was not until their application to driving electric generators that improvement of design and efficiency began. Since that time, they have grown from a few horsepower to 50,000-hp. units. The serious construction involved in the application to hydroelectric power, began in the early 90's, but at that time its use was still restricted by the limitation of transmission. In 1897, the highest voltage of transmission was 20,000; in 1900 this had grown to 40,000; in 1903, to 60,000; in 1908 to 100,000; in 1913 to 150,000; and today there are two lines being built in California whose operating voltage will be 220,000. One of these lines is approximately 250 miles long, the other something more than 300 miles.

The increase in voltage has made available many hydroelectric developments which in former years were too far from the center of application for the power to be transmitted, since the location of hydroelectric possibilities are not usually in sections which lend themselves to a large growth of population.

As the use of electric power became more and more general, and was not confined merely to lighting, the improvement and increase in size of generators became rapid, and the ease with which electric current could be applied to lighting and power purposes, made its application imperative throughout a very wide field, at present embracing some 3000 distinct uses.

It has been said that the growth of any community—large or small—depends largely on two factors, transportation and available power. It is therefore of the greatest benefit to any community to do everything possible to promote power developments and to show its public utility companies the greatest consideration.

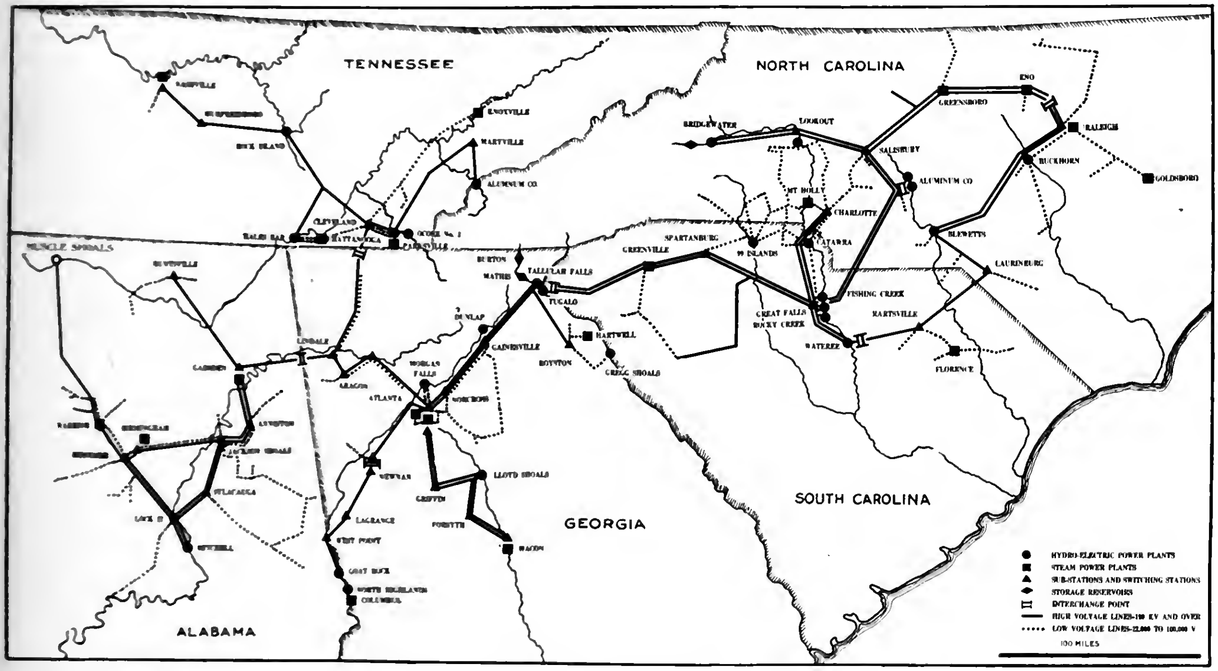


Fig. 1 Five-State Transmission System

Power Resources of the Southeast

The southeastern section is traversed by the great Appalachian Mountain Range, which rises to an altitude of from one to seven thousand feet above sea level, and enjoys an average annual precipitation greater than that of any section of the United States, the average ranging from 50 in. to 85 in. per annum. In the foothills of this mountain range are many streams and rivers which have a fall, as a rule, too great for them to be navigable and so lend

---

[1] Director and Executive Engineer, Georgia Railway & Power Co.

For presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. Copies may be obtained gratis upon request. All papers are subject to revision.

themselves admirably to economical development. This region also enjoys a climate of even temperature not subject to severe winters or ice conditions. The mean annual temperature varies from 55 deg. at an elevation of 2000 ft. above sea level to about 60 deg. at 500 ft. elevation.

The region is somewhat heavily timbered, especially on the head waters of the streams, and this to a large extent prevents a sudden run-off or great floods except during periods of extraordinary precipitation.

Five-State Development

It is intended to deal herein largely with the water-power and steam-generating stations that are now connected to the transmission system covering the five states of Alabama, Tennessee, Georgia, and North and South Carolina. The transmission system as shown in the accompanying map, Fig. 1, includes the five states mentioned, forming a trunk line some 900 miles long with several thousand miles of main line connected. It is operated at 110,000 volts, 3-phase, and at 60-cycle frequency. All of the large water-power and steam-generating stations in this territory are connected to this transmission system, making it possible to transfer power from one locality to another. This relieves power shortages due to periods of drought at water-power stations, or shortage of coal at steam plants or any other unforeseen circumstances which may interfere with the power supply in the different sections. In several instances, every power station connected to this system has been operated in parallel at the same time and with marked success. During the month of October, 1921, a part of Georgia and a part of North Carolina suffered a severe shortage in water due largely to the fact that the precipitation for the preceding six months was considerably below normal, but by means of the existing transmission system, both the affected areas were fully supplied with power from other parts of the system. Had this great transmission system not been in service, and interconnected, the industrial load in these two localities would have been necessarily dropped, since the power companies could not have supplied a larger amount of power than that required by the municipalities which they also serve. However, the other power companies by lending their assistance prevented any shutdown whatsoever in the industrial plants and the consequent unemployment of many thousand operators.

The table under Fig. 2 gives the installed capacity of the various power developments which are connected to the system under discussion. From this table it will be noted that the total installed capacity is 1,010,355 hp. The total output of the system during 1921 was approximately two billion kilowatt-hours.

New developments are constantly being made by the various power companies comprising this system, and there is now under construction an additional 310,000 hp. capacity in generating equipment. This does not include 90,000 hp. which will also be installed as an addition to one of the new plants at a later date, nor the much-discussed Muscle Shoals hydroelectric development, mention of which will be made later.

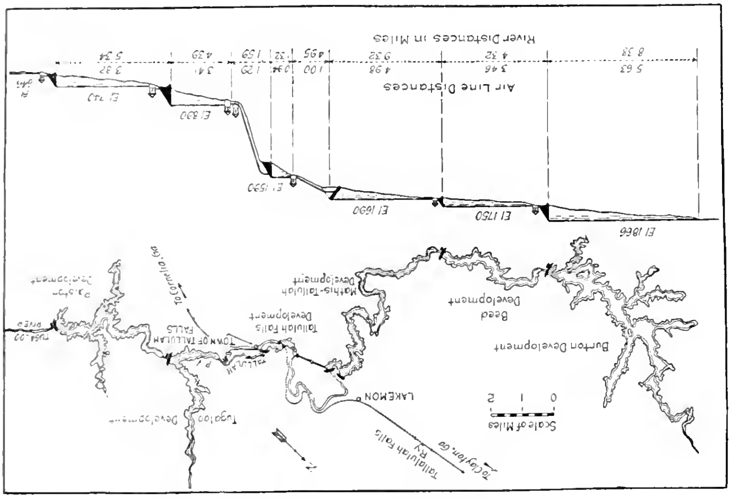


Fig. 2 Scheme for Complete Development of Tallulah River

Power-Generating Stations of the Power Companies of the Southeastern Section

Hydroelectric Stations			Steam Stations
	Alabama Power Co.		
	KW.		KW.
Lock 12	72,000	Warrior	60,000
		Gadsden	10,000
		Birmingham	10,000
	Tennessee Power Co.		
	KW.		KW.
Parksville	15,000	Parksville	6,125
Hales Bar	37,100	Nashville	15,500
Great Falls	7,800	Knoxville	6,125
Ocoee No. 2	10,500	Chattanooga	3,000
	Georgia Railway & Power Co.		
	KW.		KW.
Tallulah Falls	72,000	Atlanta No. 1	11,000
Morgan Falls	10,500	Atlanta No. 2	10,500
Dunlap	2,200		
Chestatee	1,100		
Gregg Shoals	1,200		
	Columbus Power Co.		
	KW.		KW.
Goat Rock	11,000	Columbus, Ga.	9,000
North Highlands	6,900		
	Central Georgia Power Co.		
	KW.		KW.
Lloyd Shoals	14,400	Macon Nos. 1 and 2, each	1,500
	Southern Power Co.		
	KW.		KW.
Bridgewater	20,000	Eno	10,000
Lookout	18,000	Greensboro	6,800
Catawba	4,800	Mount Holly	6,800
Fishing Creek	30,000	Greenville	6,800
Great Falls	24,000		
Rocky Creek	24,000		
Wateree	56,000		
99 Islands	18,000		
	Carolina Power & Light Co.		KW.
	KW.	Florence	1,500
Buckhorn	2,900	Raleigh	3,720
Blewetts	33,100	Goldsboro	1,200
Total kw.	492,500	Total kw.	181,070
Total hp.	738,750	Total hp.	271,605
Total developed horsepower, hydroelectric and steam			1,010,355

Water-Power Reserves

The steam generating stations of the Southeast, generally speaking, are used for the purpose of supplementing the water-power production. Many of the water-power plants are, however, also backed by large storage reservoirs, making their annual output practically continuous regardless of dry months or dry years. On the head waters of the Catawba River, the Southern Power Company has constructed a very large storage reservoir at Bridgewater, N. C., which has a capacity of 13,500,000,000 cu. ft., representing 90,000,000 kw-hr. under present conditions at the various water-power plants already constructed below. The Georgia Railway & Power Company has two storage reservoirs on the Tallulah River, one at Burton containing 5,280,000,000 cu. ft. and one at Mathis containing 1,369,000,000 cu. ft. This total storage on the Tallulah River represents approximately 70,000,000 kw-hr. at the present developments and makes available for use in power production at the plants below, about 95 per cent of the annual stream flow. This storage will later be equivalent to 125,000,000 kw-hr., when other developments contemplated and under construction are completed.

The diagrams given in Fig. 2 show the scheme for the complete development of the Tallulah River with reservoirs and power plants. These developments when completed will have an average annual output of 535,000,000 kw-hr., the reservoir capacity falling through 1220 ft. head. In this section the average annual precipitation is about 65 in., and the average annual run-off about 40 in.

The entire section of the Southeast is fortunate in having water power available which can be depended upon so completely due to the fact that great droughts seldom occur. There is no section of the United States with the exception of that adjacent to Niagara Falls, or in sections where the streams are fed from perpetual snows, where the flow of the streams and rivers can be so thoroughly depended upon. This insures a continuous supply of power to the various industries located in this section, with very little secondary power available or desired.

It may be interesting in passing to note that the power connected to the transmission system under discussion represents 17.75 per cent of the total water-power development in the United States.

Undeveloped Resources

While the Southeast has enjoyed extensive hydroelectric development already, it still has many sources of potential water power available for development as rapidly as the demand for electric power increases, and it will be many years before the entire possibilities of the streams in this section are exhausted. There are many industries not supplied at present with hydroelectric power which are depending upon the cheapness of fuel in the section where they are operating, and which in time will turn to electrical energy for their power needs. The electrification of the railroads of the South, which cannot be put off for many more years, will also provide an outlet for a large block of electric power, many of the trunk trail lines being already paralleled by transmission lines of sufficient capacity to meet their requirements.

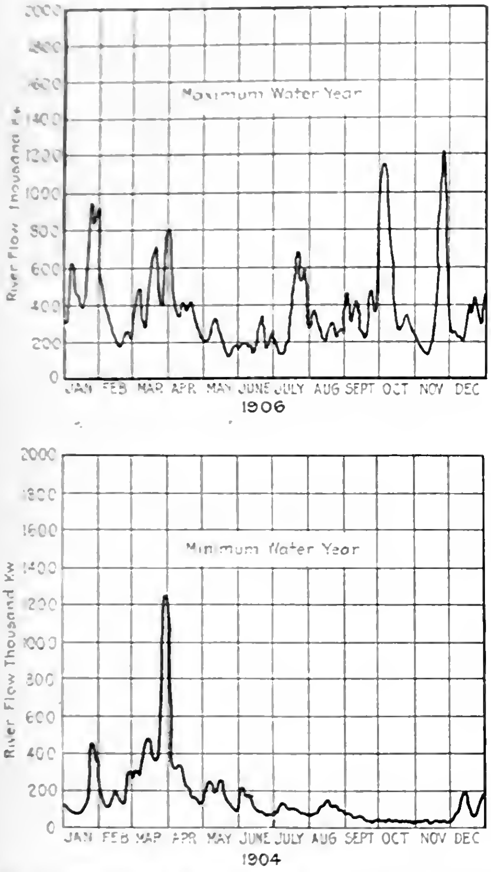


Fig. 3 Hydrographs of the Tennessee River at Florence, Ala., for 1904 and 1906

It has been found in communities where electric power is available and generally used, that the consumption amounts to approximately 500 kw-hr. per inhabitant per annum. As stated above, the total output per year of the various power companies connected to the system under discussion now amounts to 2,000,000,000 kw-hr. while the population of the territory served by this system is approximately 11,819,585, showing that there is only 34 per cent saturation in this territory, based on the consumption of electric power in communities where it is in more general use.

Muscle Shoals Conditions

Anything that is said or written about the power developments in the Southeast cannot pass without some reference to the Muscle Shoals hydroelectric development, especially that part of this development known as the Wilson Dam or Dam No. 2.

The Muscle Shoals section of the Tennessee River is the name applied to the fifty-mile stretch between the railroad bridge south of Florence, Ala., and Brown's Island, near Decatur, Ala., which is not now navigable during periods of low water comprising approximately six months of each year. The Shoals are located approximately 150 miles southwest of Chattanooga, Tenn., and are about 125 miles northwest of Birmingham, and a similar distance from Memphis, Tenn. They are about 200 miles in an air line from Atlanta.

Sometime prior to 1890 the effort of various individuals and organizations to do something with Muscle Shoals was begun, and the matter has been more or less active ever since that time. Every effort until recently has been in the nature of forcing the Federal Government to develop Muscle Shoals for the ostensible purpose of improving the navigation of the Tennessee River, with which very little navigation has ever existed, with the secondary object of producing hydroelectric power.

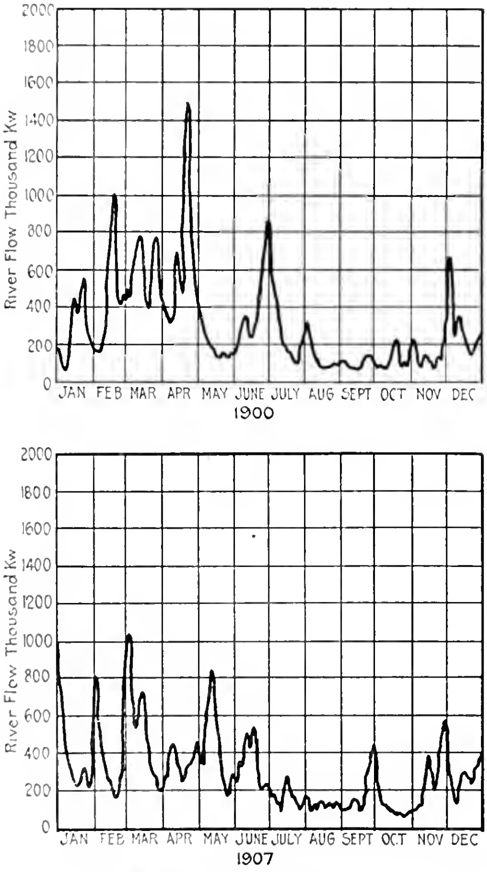


Fig. 4 Hydrographs of the Tennessee River at Florence, Ala., for 1900 and 1907

In the year 1890 a canal was cut around the Shoals by the Federal Government for the purpose of improving the navigation at this point, and this constituted the first step in the Government's activities at this location. Since that time, various bills have been introduced in Congress for the continued improvement of the river, but all plans have carried with them the idea of developing the hydroelectric power.

As soon as it became apparent that the United States would be ultimately drawn into the European war, it was brought to the attention of the Government that an interference with the supply of Chilean nitrates (sodium nitrate, $NaNO_3$) would seriously cripple the ability of the United States to supply ammunition for itself and associated nations in the war. So a clause was inserted in the National Defense Act of 1917, which appropriated twenty million dollars for the purpose of investigating the advisability of, and taking the necessary preliminary steps toward, the erection of a plant for the fixation of atmospheric nitrogen, the idea being that such a plant should be erected at or near some water-power site, remote from the sea coast, where the large amount of electric power required by the process would be cheaply available. The authority for this investigation and action was vested in the President, and he in turn selected a committee to carry out the intention of the Act.

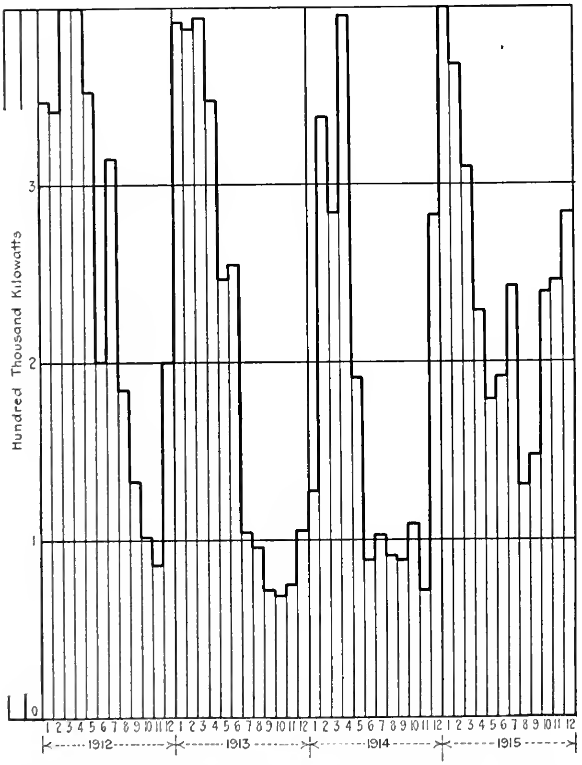


Fig. 5 Powergraph of Tennessee River from 1912 to 1915

Present Development

An early investigation of the water-power situation at Muscle Shoals indicated that the hydroelectric power plant could not be built in time for service during the war in connection with the nitrate plant, and as a consequence a steam plant was constructed at Nitrate Plant No. 2, with a capacity of 60,000 kw. in one three-part turbo-generator unit, room being provided in the plant for the later installation of a second unit of 30,000 kw. It is a modern, up-to-date plant, well designed and thoroughly efficient. The construction of this plant was carried out by the Government and cost approximately thirteen million dollars.

In addition, a steam unit of 30,000 kw. capacity was installed by the Government at the Warrior River steam plant of the Alabama Power Company, 90 miles from Sheffield, Ala., and connected with the nitrate plant by a 110,000-volt transmission line, the total cost of this improvement being approximately five million dollars. Also, a limestone quarry was purchased and opened at Waco, Ala., for the purpose of supplying the nitrate plant with the lime necessary in the production of calcium carbide.

To get back to the subject of the Muscle Shoals hydroelectric development: It was decided early in 1918 to call the dam the Wilson Dam, since the decision as to its construction was originally vested in President Wilson and it was he who directed that the project be carried out. At the time it was decided to proceed with the development, the property was more or less completely in the hands of the Muscle Shoals Hydroelectric Power Company. This company did not desire to stand in the way of any improvement which would further the prosecution of the war, and therefor surrendered all of its holdings, including dam sites, water right and plans to the Government for "one dollar and other considerations." As a consequence of these earlier negotiations, actual construction work on the project was begun during the spring of 1918.

The plans call for a dam about 100 ft. high and almost one mile in length, and include two locks for navigation requirements on the northern end of the dam with two 50-ft. lifts, said to be the highest-lift locks anywhere now contemplated. The dam is to be fitted with crest gates 18 ft. high for flood control, the gates to be counterweighted and operated by electric motors. The dam is to be of liberal gravity section, and will be constructed with a downstream apron which extends approximately 100 ft. below the toe of the dam, to protect the river bottom from the overfall. There is to be a highway bridge across the top of the dam above the gates. The dam will contain 1,250,000 cu. yd. of concrete. The power house is to be constructed on the southern end of the structure and built integral with the dam. It will contain a total of eighteen units, four of which have already been contracted for and built. They will be of the usual vertical type with 30,000-hp. water wheels, directly connected to 22,500-kw. generators, together with all the usual auxiliary equipment. It is now contemplated that the fourteen remaining units will be built with 36,000-hp. water wheels, and 27,500-kw. generators, making the total capacity of the plant in generating equipment approximately 400,000 kw. The power house is being constructed at this time for the full ultimate installation.

The Government has prosecuted this work somewhat intermittently since it was started, and has completed, up to the present time, a four-track bridge below the dam across the river for construction purposes, and the excavation for the power house. Two hundred and fifty thousand cubic yards of concrete have been laid in the dam structure on the north end, a portion of the excavation for the locks has been completed, and about 60 per cent of the excavation for the dam, of which there is a total of 620,000 cu. yd.

All of the work done on this project to date has cost approximately seventeen million dollars, and estimates covering the work necessary to complete the project vary from twenty to thirty-five million dollars. The work today is about 20 per cent complete and has been entirely shut down for more than a year.

Much has been said from time to time about the foundations at this dam site. A thorough investigation has been made by both diamond drills and well drills, and the records of these operations indicate that the foundations under the main part of the dam are satisfactory. There is, however, a seam appearing in the southern abutment which extends for a long distance into the surrounding country, and this is now being investigated by tunneling to see if it is or can be made watertight.

Possibilities

Volumes have been written in the Government records and in the press regarding the hydroelectric-power possibilities of Muscle Shoals. It is distinctly a run-of-river proposition, as no storage is created by the dam except that required to control the daily flow of the river. The Government at the present time has a requirement in existence for the benefit of navigation below, which will not allow the control of river flow under 10,000 cu. ft. per sec.

(Continued on page 300)

Boiler-Room Performance and Practice of the Colfax Station, Duquesne Light Company

By C. W. E. Clarke,[1] New York, N. Y.

IT IS the purpose of this paper to describe in some detail the operation of the boiler plant in the Colfax Station of the Duquesne Light Co., located at Cheswick, Pa. Fig. 1 is a cross-section of the boiler house and part of the turbine room of this plant. The Colfax Station at present contains one three-element-compound Westinghouse turbine of 60,000 kw. capacity and an additional similar machine will be installed this summer. The present plans for this station contemplate an ultimate capacity of 360,000 kw. The boiler plant contains seven boilers, 18 tubes high by 51 wide, each containing 20,867 sq. ft. of heating surface; and four additional boilers, 20 tubes high by 51 wide, each containing 22,914 sq. ft. of heating surface, are being installed this summer. The station is designed for base-load operation. Under present conditions it is possible to maintain a load in excess of 50,000 kw. for most of the day. For the night periods, from about midnight until seven or eight in the morning, the load may fall as low as 30,000 kw.

The boiler room was designed with a view to securing the highest ultimate efficiency in point of fuel, labor and fixed charges. It will be noted that the labor per horsepower is very small. The area covered by the boiler house per boiler horsepower is only 1.37 sq. ft.

Fuel and Fuel Handling

Coal is brought to the station on a standard-gage railway in 50-ton hopper-bottom cars from the Harwick Mine, which is owned by the Duquesne Light Company and located about a mile and a half from the power station. A space about 1000 by 400 ft. just north of the power station is provided for coal storage and is large enough for the storing of about 150,000 tons of coal. A rope-operated gantry bridge is now being erected for handling coal into and out of this storage.

At the plant, coal is dumped into receiving hoppers under the tracks. Crushers are located below the hoppers and the crushed coal is raised by two pivoted bucket elevators to distributing belt conveyors over the bunkers. As the coal goes to the crushers, water is added to help keep down the dust, and as an aid to combustion.

A representative sample of each day's coal is secured by taking individual samples of about 75 lb. from each carload as the cars are dumped. These are placed in airtight cans and so kept until they are to be used. The whole day's samples are then run through an automatic crushing and sampling machine which extracts a 3 to 4 per cent sample, amounting at the present time to about 40 lb. This 40-lb. sample is quartered on a clean floor and two 3-lb. samples are taken out and put in sealed containers. One of these is sent to the laboratory for analysis and the other is held at the plant until satisfactory analysis of the laboratory sample has been completed.

To secure samples of the coal as fired, a sample of about 1000 lb. is also taken from the stoker hoppers at 7 a.m. daily. This sample is treated in the manner described above. Table 1 shows the average of a number of proximate analyses of the fuel and Table 2 a representative ultimate analysis.

The coal bunker is of reinforced concrete and has a capacity of about 240 tons per boiler. Coal is not permitted to remain in the bunker longer than about three days, which practically eliminates any possibility of spontaneous combustion in the bunkers. Distribution of the fuel to the individual stoker hoppers is by means of two weighing larries each having a capacity of 10 tons. A number of openings in the bottom of the bunker are provided with short cast-iron spouts equipped with chain-operated gates and permit coal to be taken from any part of the bunker.

Stokers and Clinker Grinders

Each stoker is provided with an extension hopper, the capacity of the grate and hopper together being about 25,000 lb. The stokers are of the Westinghouse underfeed type and have 17 retorts of 20 tuyeres each. The projected grate area of each stoker is approximately 403 sq. ft.

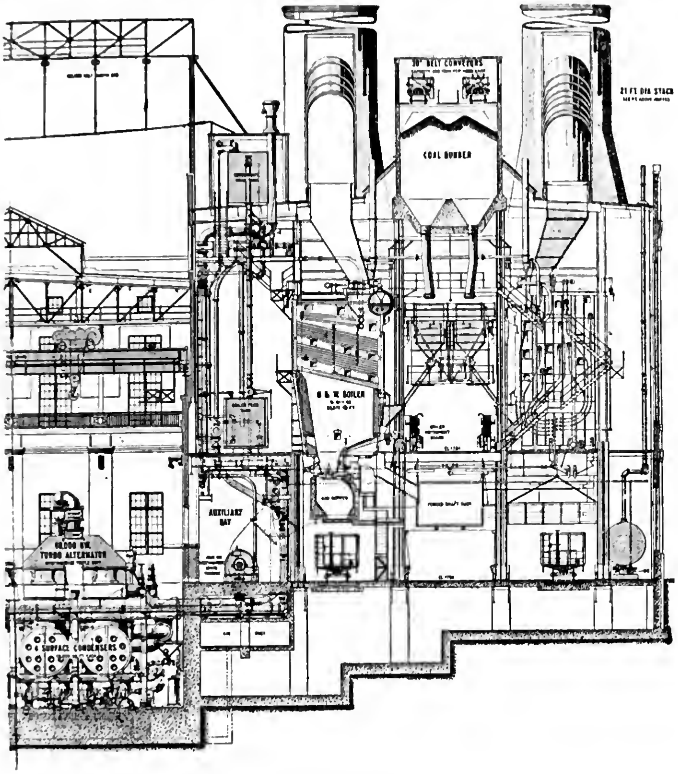


Fig. 1 Cross-Section of Boiler House and Part of Turbine Room

TABLE 1 PROXIMATE COAL ANALYSES

	As Received		Moisture-Free	
	As Unloaded	As Fired	As Unloaded	As Fired
No. of samples	25	30	25	30
Moisture, per cent	2.9	4.1	...	...
Volatile matter, per cent	34.5	34.1	35.5	35.6
Fixed carbon, per cent	53.0	52.5	54.6	54.8
Ash, per cent	9.6	9.3	9.9	9.6
Total, per cent	100.0	100.0	100.0	100.0
Sulphur, per cent	1.0	1.1	1.1	1.2
Calorific value, B.t.u. per lb.	13,351	13,237	13,758	13,895

The difference in moisture between the coal as unloaded and as fired is due to the addition of water at the crushers mentioned above.

TABLE 2 REPRESENTATIVE ULTIMATE ANALYSIS OF FUEL

	As Received	Dry Coal	Moisture-and Ash-Free
Ash, per cent	8.88	9.30	.....
Sulphur, per cent	1.09	1.14	1.26
Carbon, per cent	72.92	76.40	84.23
Hydrogen, per cent	5.39	5.12	5.64
Nitrogen, per cent	1.49	1.56	1.72
Oxygen, per cent	10.23	6.48	7.15
Total, per cent	100.00	100.00	100.00
B.t.u. per lb. by calorimeter	13,202	13,832	15,251
B.t.u. per lb. by analysis	13,199	13,828	15,246

---

[1] Dwight P. Robinson & Co. Mem. Am.Soc.M.E.

Abstract of a paper to be presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

Each stoker is driven by a 15-hp. variable-speed direct-current motor, equipped with both armature and field control. Current for these motors and for the clinker-grinder motors is supplied by two 2200-kw. 440-volt a.c. to 125-volt d.c. motor-generator sets located in the auxiliary bay of the turbine room.

The stoker operator is guided entirely by observation of the fires and of the wind-box pressure. The forced-draft-fan speed and consequent wind-box pressure are automatically controlled by variations of the steam pressure in the main header. Wind-box pressure is for this reason somewhat of an indication of load condition. The pressure over the fire is maintained at from 0 to minus 0.1 in. of water by means of balanced-draft damper controllers.

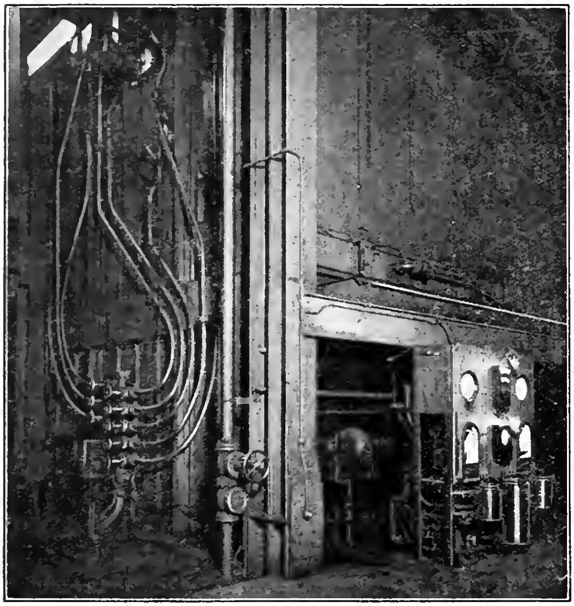


Fig. 2 General View of Boiler

In this type of stoker the upper and lower rams are linked together, but the movement of the lower rams is made much less than that of the upper through lost motion in the linkage. In case the fire piles up on the lower end of the grate this lost motion may be taken out by means of U-links which are left on until the fire is in proper condition. The stoker drive is capable of very close speed regulation and with ordinary care and the occasional use of the U-links, an even fuel bed suitable to the load may be maintained.

Each boiler is provided with an individual instrument and control board shown at the right in Fig. 2. At the top are two pressure gages connected to either end of the boiler drum. Between them is a three-in-one draft gage which indicates the pressure in the wind box, over the fire, and in the boiler uptake. Below the draft gage is a combined CO_2 and furnace-pressure recorder. Each of the two boiler-feed lines is provided with a Simplex venturi meter, the recorders for which are at the bottoms of the two side panels. Each of these meters has a capacity sufficient to feed the boiler at over 250 per cent of rating. The stoker and clinker-grinder motor controllers are bolted to the frame below the board, with the stoker-motor controller in the center and the clinker-grinder controllers at either side. This places practically the entire control for each boiler at one point so that but one stoker operator is required for 4175 nominal boiler horsepower, which is over 9000 developed boiler horsepower at 220 per cent rating, the normal daytime condition. No centralized control is provided as such a system is of doubtful advantage. The management of stokers, aside from that which can be made automatic, must be almost entirely through visual observation of the fuel bed. There are few factors of stoker control that can be centralized in such a way as to save either labor or fuel. Fig. 2 shows the general arrangement of the boiler, gage board, etc.

When this installation was first put in operation some difficulty was encountered with clinkering. After considerable experimenting it was definitely determined that this was due in part to periods when there was pressure over the fires and in part to improper water distribution in the clinker pits. Particular care is now taken to maintain a furnace pressure below atmosphere at all times, and the water distribution has been improved as described below with the result that clinker trouble has been practically eliminated.

Some trouble was at first experienced due to burning out of the lower front-feed wedges. This trouble has been largely eliminated by allowing air to blow through from the wind box, thus keeping the wedges cool. To facilitate replacement, the air-box tops and grinder-pit aprons have been made sectional instead of as in the original design.

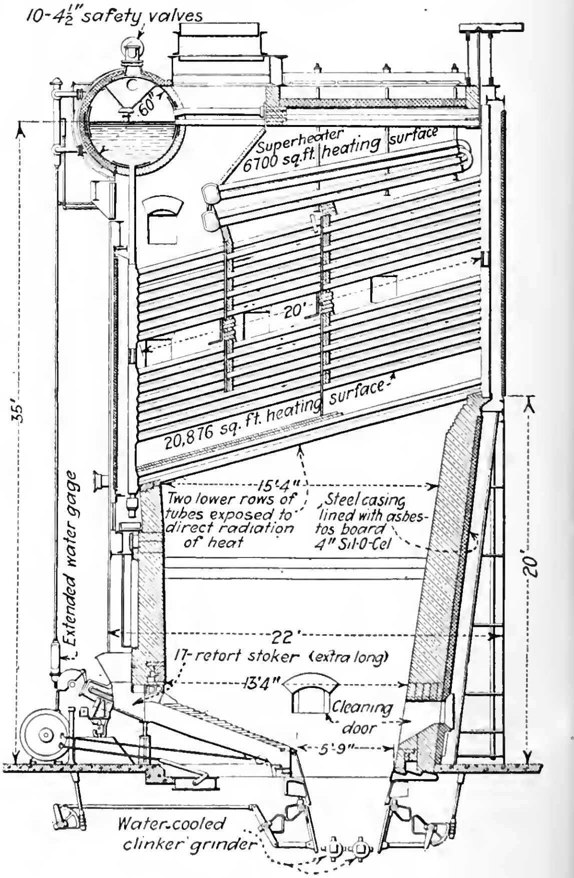


Fig. 3 Cross-Section of Boiler and Setting

The stokers are provided with double-roll clinker grinders, divided in the center, with the rolls turning toward each other. The two halves are driven by separate motors, separately regulated, giving individual control over the two halves of the grinder. The rolls are driven through reciprocating pawls and ratchets which may be disengaged on either roll. It has not been found desirable to operate the rolls continuously. Under normal operating conditions the rear rolls are operated rarely, the front rolls being run for periods of from two to five minutes in every twenty minutes, which means from six to eight revolutions in one hour. Grinder operation is governed entirely by observation of the ashpit. The top of the ash bed is kept above the top of the rear wall air boxes.

To prevent the formation of clinker masses in the ashpit and to cool the clinker rolls, water is introduced above the rolls. Upper-grate box tops having a down-turned projecting lip are installed,

under which lip is placed a horizontal spray pipe perforated with quarter-inch holes six inches apart. This pipe introduces the water high up in the ashpit and quite effectually prevents the formation of hard clinker masses. The introduction of water high up in the ashpit tends to quench the ash before combustion is as complete as could be desired, thus increasing the amount of combustible in the ash. At the present time this seems to be the lesser of two evils. The sprinkling system requires about fifty gallons per minute for each boiler.

Ash Handling and Sampling

The clinker grinders discharge into firebrick-lined reinforced-concrete ash hoppers with an approximate capacity of 60 cu. yd. These hoppers will hold the refuse of from one and a half to two days' normal operation. It is the regular practice, however, to remove the refuse from all working boilers twice a day.

A sample of ash from each boiler is taken every other day. A gross quantity of about 400 lb. is taken from the total 24-hr. dump from each boiler, the sample being taken from six different points in the pile, at a depth of about three feet below the surface of the pile. The whole sample is then hand-crushed and quartered until about three pounds remain, which is sealed in a container and sent to the laboratory to be analyzed for combustible. The method of analysis is in accordance with the specifications of the American Society for Testing Materials.

Boilers

There are at present seven boilers of the Babcock & Wilcox cross-drum type, 18 tubes high by 51 wide, with 20,876 sq. ft. of heating surface and with the so-called "Alert" baffling. There are 918 tubes in each boiler proper and 102 circulating tubes connecting the uptake headers with the drum, making 1020 tubes in all. Fig. 3 is a cross-section of the boiler and setting. It will be noted that the combustion space is large. The present settings contain 0.345 cu. ft. of combustion space per square foot of heating surface and those to be installed this summer will be the same.

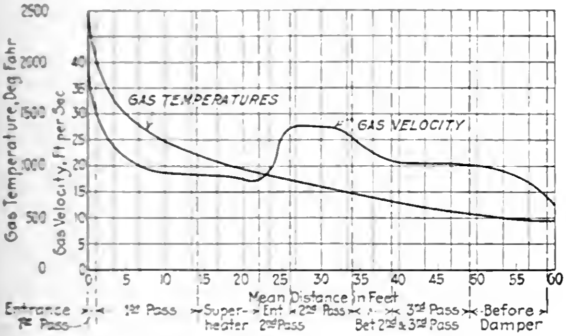


Fig. 4 Variation of Temperature and Velocity of Flue Gas Throughout the Boiler

Each boiler has two water columns with high- and low-water alarm whistles. When one of these alarms sounds the operator examines the feed regulators for possible sticking, and if necessary cuts it out and uses hand control until repairs can be made. If the regulator is found to be all right he checks up the feed pressure and if necessary starts another pump or puts on the auxiliary feed.

Furnace temperatures vary from 2500 to 2800 deg. fahr.; at the top of the first pass this approximates 1000 deg. fahr., between the second and third passes it is 530 deg. fahr., and the exit gas temperature varies from 450 to 480, usually being about 470 deg. fahr. Fig. 4 is a chart showing the temperature range and gas velocities through the boiler. Typical temperature and CO_2 traverses are given in tabular form in the complete paper.

Slagging on the boiler tubes is slight and has never been sufficient to cause trouble. The use of distilled make-up water eliminates trouble from scale and consequent tube renewals. The total commercial operation of the seven boilers now installed has been approximately 39,922 boiler-hours up to February 1, an average of 5703 hr. per boiler and but two tubes have been replaced.

Each boiler is equipped with eighteen soot-blower elements, nine on each side. These soot blowers are operated three times a day with the dampers opened wide.

In the past boilers have been taken off for cleaning and repairs after 30 to 45 days of service, but it is expected that in the future service periods will be from 90 to 100 days. This increase is due to some slight modification of the settings and increased knowledge of the performance of the equipment. The work of inspection and repair ordinarily takes from 10 to 11 days. Full efficiency is not reached until from four to seven days after the boiler is put on the line.

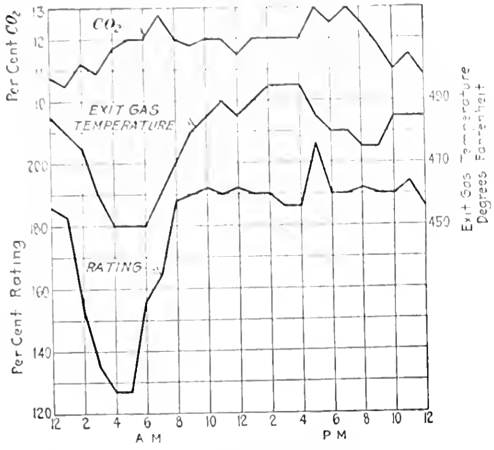


Fig. 5 Hourly Variation in Rating, Gas Temperature and CO_2 for Typical 24-Hr. Day

The settings are of firebrick throughout, the brick walls being 18 in. thick. Sil-O-Cel and asbestos millboard fill the $4^1/_4$-in. space between the firebrick and the steel casing. Deterioration of the setting is very slight.

The formation of clinker on the furnace walls is prevented by air cooling, Bernitz and Drake blocks being used. These blocks did not altogether prevent clinkering on the side walls and side-wall tuyeres have been installed, which have practically eliminated it.

The superheaters are located over the tube banks between the first and second pass. Considerable trouble has been experienced because of insufficient superheat. The normal superheat should be 180 deg., but 145 deg. has seldom been exceeded. The boilers to be installed this summer will have the superheaters located above the sixth row of tubes, and with this arrangement no trouble from deficient superheat is anticipated.

There is one forced-draft fan for every four boilers. The fans are of the radial-flow type, and have a capacity of 250,000 cu. ft. of free air per minute at a maximum static pressure of 6 in. of water. The fans are driven through reduction gears by 420-hp. turbines. Each fan turbine is provided with a speed controller actuated by variations of steam pressure in the main header. Ordinarily no control of the stoker air other than that provided by the automatic, forced-draft-fan speed control is used, although individual wind-box dampers are provided that may be used in case of emergency. There is one main forced-draft duct, 9 ft. 6 in. by 15 ft., running beneath the firing-aisle floor, from which all stokers are supplied. This duct is provided with sectionalizing dampers located midway between the fan inlets. At each boiler a branch duct runs from the main duct to the stoker wind boxes. The duct system is of $^3/_{16}$-in. sheet steel made practically airtight without welding.

The generator-cooling-air discharge is carried to the main air-supply duct from which the fans take part of their supply. In addition to this, large openings are provided at the tops of the fan chambers through which air may be drawn from the top of the auxiliary bay. In winter the openings between the fan chambers and the boiler-room basement are closed. This is done to prevent freezing of piping due to drawing large quantities of air from outdoors through the boiler-room basement.

Fig. 5 shows the hourly variation in boiler-room operation over a typical 24-hr. period. Fig. 6 shows the average efficiency, rating and gas temperature for all boilers for the period from July, 1921 to February, 1922. This clearly shows the steady increase in efficiency as conditions were improved and as the operating force became more familiar with the equipment. The low point at the beginning of December was due to a period during which there was considerable trouble with clinker.

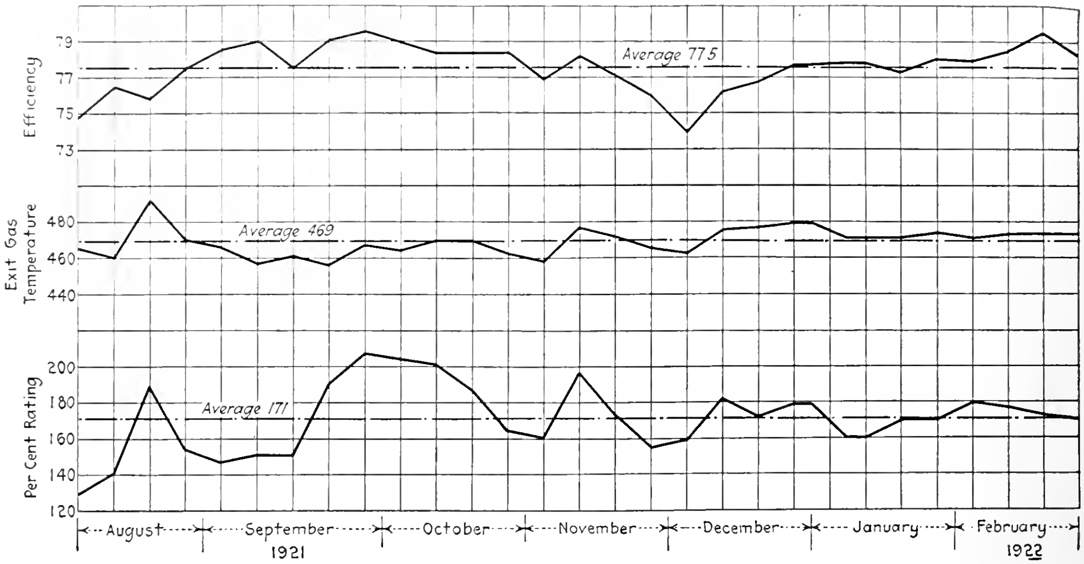


Fig. 6 Average Weekly Boiler Performance for All Boilers

Note—The points on this curve are the weighted averages of the average weekly efficiencies for the individual boilers, hence the variations at some points.

Piping System

The piping system for boiler feeding consists of a main and auxiliary header. The main header runs below the firing-aisle floor and between it and the forced-draft duct. A feed line is carried up each side of the boiler (these boilers are provided with feed connections at both ends of the drums) and is controlled by globe valves at the boiler-room floor level. Automatic boiler-feed regulators are provided on the feed lines at the boiler drums, part being Stets and part Copes regulators. The auxiliary header runs over and at the rear of the boilers. The auxiliary feed line on one side of each boiler is provided with a by-pass through the automatic controller, that on the other side being provided with hand control only. The boiler-feed system in general is described below.

The piping system was installed in accordance with the general piping specification given in the complete paper.

Feedwater System

The feedwater cycle is shown diagrammatically in Fig. 7. All water in the system is distilled. Make-up water is provided by two evaporators of the double-effect, dry-tube type. Water from the evaporators is pumped directly to the head tanks, above the barometric condensers, which serve as feedwater heaters. The average make-up required is about 1.9 per cent of the total amount flowing in the system. The tail pipe of the barometric condenser is sealed in the boiler-feed tank from which the feed pumps take their suction. Two V-notch meters are provided in this tank; one measures the water going to the feed pump and the other the overflow. All overflow from the system is piped to the boiler-feed tank so that it is recorded by this meter. Overflow from the boiler-feed tank flows to the main storage tank mentioned below. There is some variation between the water quantities recorded by the venturi and V-notch meters, but it is the venturi-meter readings which have been used as a basis for all results given in this paper.

There are three 4-stage 1500-g.p.m. turbine-driven centrifugal boiler-feed pumps, regulated to maintain a pressure in the feed system of 350 lb. per sq. in. One pump is sufficient to supply the total feedwater for a load of about 60,000 kw.

Condensate from the main unit goes first to a surface heater where its temperature is raised about 4.5 deg. fahr. by the transformer- and turbine-oil cooling water. It then goes to the evaporator condenser serving there as a circulating medium, and its temperature is increased about 32 deg. fahr. From the evaporator condenser it goes to the head tank and then through the barometric condenser. The exhaust from the house turbine and that part of the exhaust from the auxiliaries which is not used in the evapora-

TABLE 3 OBSERVATION OF DISSOLVED OXYGEN IN BOILER FEEDWATER, PARTS PER 1000 BY VOLUME

Head Tank			Boiler-Feed Tank		
Temp., Deg Fahr	Actual Dissolved Oxygen	Theoretical Dissolved Oxygen	Temp. Deg. Fahr	Actual Dissolved	Theoretical Dissolved Oxygen
100	(6) 1.93	4.7	(1) 185	1.21	1.55
101	(10) 2.10	4.65	(2) 186	1.2	1.50
102	(1) 2.15	4.6	(1) 187	1.31	1.45
103	(2) 2.05	4.55	(1) 188	1.11	1.40
104	(5) 2.43	4.5	(1) 189	0.81	1.35
105	No data	4.45	(3) 190	0.88	1.30
106	(3) 1.91	4.4	(2) 191	0.895	1.25
107	(1) 1.99	4.35	(1) 192	1.08	1.20
Mean 102	(32) 2.11	4.6	(0) 193		1.15
			(5) 194	0.75	1.00
			(8) 195	0.65	1.06
			(3) 196	0.70	0.95
			(0) 197		0.90
			(3) 198	0.506	0.85
			(0) 199		0.80
			(2) 200	0.43	0.75
			(0) 201		0.70
			(0) 202		0.60
			(0) 203		0.55
			(1) 204	0.21	0.50
			Mean 193	(34) 0.766	1.15

Figures in parentheses indicate number of observations at given temperature.

TABLE 4 OPERATING FORCE FOR THREE EIGHT HOUR SHIFTS

Title	No required per shift 1 unit	 2 units	Duties
Boiler engineer[1]	1	1	Responsible for the proper operation and maintenance of all boiler room apparatus and coal- and ash handling systems.
Boiler operator	1	1	In general charge of boiler operation during his shift. Reports to boiler engineer
Stoker operator	3	6	Each operates two boilers, including stokers, clinker grinders, dampers, etc.
Soot blower operator	1	1	Operates soot blowers on each boiler once during the shift.
Larry operator.	1	1	Weighs and distributes coal to stoker hoppers keeping all active boilers supplied In order to provide a consistent record for daily heat balance, hoppers on all active boilers are filled full between 11.30 and midnight.

---

[1] Day shift only

TABLE 5 COAL- AND ASH-HANDLING FORCE, ONE TEN HOUR SHIFT ONLY

Title	No. required 1 unit	 2 units	Duties
Coal Handling			
Coal foreman	1	1	In charge of coal handling to bunker.
Coal-conveyer operators	2	2	Operate crushers and conveyor system.
Coal laborers....	2	2	Dump coal cars.
Ash Handling			
Crane operator	1	1	Operates locomotive crane in assisting to distribute ash; part time only.
Locomotive operator	1	1	Operates dinky locomotive in shunting coal cars; part time only.
Laborers	2	3	Load ashes to cars
Miscellaneous			
Coal and ash sampler	1	1	Takes and mixes samples, etc.
Boiler Maintenance			
Boiler-repair man	2	3	Repair leaks, clean inside of tubes, etc.
Boiler-repair-man helper.	1	2	
Stoker-repair man	2	2	Repair and overhaul stokers.
Stoker-repair-man helper	2	2	
Bricklayer	1	1	Repair brickwork
Bricklayer helper	1	2	
Furnace cleaners	2	2	Clean slag from tubes, etc.
Soot-Blower Maintenance			
Pipe-fitter.......	1	1	Repair soot blowers.
Pipe-fitter helper	1	1	

TABLE 6 SUMMARY OF BOILER DATA — DECEMBER, 1921 — COLFAX POWER STATION

Boiler No.	Lb. Water Evaporated	Lb. Coal Consumed	Hours Active	Efficiency, per cent	Rating, per cent	Exit Gas Temp., deg. fahr.	CO_2 per cent	Combust. in Refuse, per cent
1	60,020,000	6,638,060	559	76.6	172	489	9.9	26.67
2	55,291,000	6,089,230	480	76.9	185	482	12.0	26.89
3	75,435,000	8,319,030	696	76.7	174	460	10.3	28.60
4	75,542,000	8,324,290	691	76.8	175	481	11.9	25.71
5	32,242,000	3,519,710	285	77.5	183	—	11.5	29.55
6	73,474,000	8,138,360	688	76.5	171	479	11.7	26.88
8	70,546,000	7,761,900	640	77.0	171	481	11.0	27.18
Total	442,550,000	48,790,580	4038	76.8	176	478	11.2	26.99

Average superheat, 132 deg. fahr.
Average feed temperature, 193 deg. fahr.
Average B.t.u. in coal, 13,283 per lb.

TABLE 7 SIX MONTHS' SUMMARY OF BOILER DATA — COLFAX POWER STATION AUGUST, 1921, TO JANUARY, 1922, INCLUSIVE

	August	September	October	November	December	January	Average
Total water evaporated, lb..........	272,779,000	265,373,000	292,355,000	248,858,000	442,550,000	313,703,500	305,936,417
Total coal consumed, lb................	30,085,600	28,023,100	31,690,300	27,109,300	48,790,600	35,911,530	33,601,738
Total active service, hours............	2,782	2,193	2,474	2,361	4,038	2,894	2,840
Average feed temp., deg. fahr...........	208	210	203	204	193	204	204
Average superheat, deg. fahr.......... ...	124	120	127	127	132	136	128
Average B.t.u. in coal per lb......... ...	13,093	13,180	13,159	13,198	13,283	13,177	13,182
Average efficiency, per cent........	76.4	78.9	78.0	77.2	76.8	77.6	77.5
Average rating, per cent................	154	167	187	167	176	168	170
Average exit gas temp., deg. fahr	466	460	465	467	478	471	468
Average CO_2, per cent.........	9.2	9.3	9.6	10.3	11.2	11.1	10.1

tors is here condensed, bringing the temperature of the mixture to about 205 deg. fahr.

The storage tank employed has a capacity of 200,000 gal. and serves to take up fluctuations in the demand for feedwater and to provide a reserve supply for emergencies.

The evaporators have in general given satisfactory service. They are so connected that either river or deep-well water may be used. The river water, although very dirty, was found to contain less scale-forming salts than that from the wells, and is therefore generally used. The effects are reversed every four hours, thus minimizing scale formation. The thermal efficiency of the evaporators is practically 100 per cent, and with the modifications now being made it is thought they will give no trouble.

Water qualities throughout the cycle are closely watched. A multiple-point, indicating conductivity meter with cells located at various points is used to observe the water purity continuously. This instrument immediately indicates leakage of circulating water into the condenser and permits a close check in the quality of the distillate from the evaporators. No condenser leakage has as yet been detected, but much useful information on the performance of the evaporators has been obtained.

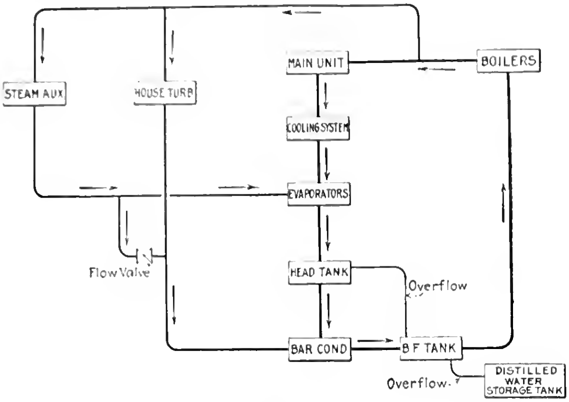


Fig. 7 Diagram of Steam and Feedwater Cycle

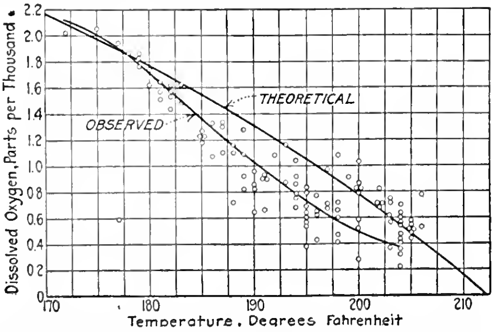


Fig. 8 Comparison of Actual Dissolved Oxygen in Colfax Boiler Feedwater with Theoretical Solubility at Varying Temperatures.

It has been found that dissolved oxygen in the feedwater tends to pit the boiler drums. It has also been determined that this pitting takes place during banked periods, there being practically

none when the boiler is active. In order to decrease the quantity of dissolved oxygen to the lowest possible point, all parts of the feed cycle are effectually sealed against air. The feed temperature is maintained at 205 deg. or higher to drive out the entrained air. Further experiments are being carried on to determine whether a lower feed temperature with a higher vacuum in the barometric condenser will improve this condition.

Fig. 8 shows the relation between temperature and oxygen content as observed at Colfax. Table 3 gives the results of observations of dissolved oxygen in the boiler feedwater taken from the condensate-head tank and the boiler-feed tank.

TABLE 8 TYPICAL HEAT BALANCE DATA — COLFAX STATION

	October		November		December		January	
Coal as fired, B.t.u. per lb.	13,159		13,198		13,283		13,177	
Ash, as fired, per cent	9.28		9.37		9.11		9.05	
Moisture, as fired, per cent	4.15		4.12		3.91		4.49	
Inlet air temp. deg fahr.	70		70		70		70	
Exit gas temp. deg fahr.	465		467		478		471	
Carbon as fired, per cent	72.29		72.49		72.86		72.15	
Hydrogen as fired, per cent	4.92		4.93		4.96		4.93	
CO_2, per cent	9.5		10.3		11.2		11.1	
Combustible in refuse, per cent	26.36		29.10		26.99		26.76	
	B.t.u.	per cent	B.t.u.	per cent	B.t.u.	per cent	B.t.u.	per cent
Heat absorbed by boilers	10,261	78.00	10,189	77.20	10,202	76.8	10,225	77.60
Moisture loss	55	0.42	51	0.38	48	0.36	56	0.42
Hydrogen loss	545	4.14	547	4.14	522	4.16	548	4.15
Stack loss	1,713	13.02	1,585	12.01	1,522	11.46	1,502	11.40
Ashpit loss	482	3.66	558	4.23	490	3.69	479	3.64
Heat accounted for	13,059	99.24	12,930	97.96	12,811	96.47	12,810	97.21
Heat unaccounted for	100	0.76	268	2.01	469	3.53	367	2.79
Total	13,159	100.00	13,198	100.00	13,283	100.00	13,177	100.00

Tables 4 and 5 show the personnel of the boiler-room organization with one unit as at present, and as it will be when a second unit is installed.

Table 6 is a summary of boiler-room operations for the month of December, and Table 7 a recapitulation for the six months, August to January, inclusive.

The heat balance for the station is worked out daily. Table 8 shows the averages of the heat-balance figures for the months of October to January, inclusive.

Conclusions

In considering the results given in the paper the following points should be borne in mind:

a The operating results given are from the records of the operating department of the Duquesne Light Company

b The plant is not equipped with heat-reclamation equipment such as economizers or air preheaters

c The efficiencies given are not test results but have been made with the regular operating force and can be maintained year after year. The results are good but do not represent the best performance possible with the equipment. Some further improvement is expected as the operating force becomes more familiar with the equipment

d The amount of combustible in the ash is high, but as explained above, the necessity for early quenching of the ash to prevent clinker makes improvement in this respect doubtful. In the light of over-all efficiency the slight excess in combustible is a lesser loss than the formation of hard clinker masses would occasion.

POWER DEVELOPMENT IN SOUTHEAST

(*Continued from page 294*)

The lowest stream flow ever recorded was 6900 sec-ft., which corresponds to a load of 43,125 kw. under the proposed plans for the development.

The greatest fluctuation in any stream in the Southeast probably occurs in the Tennessee River. The United States Government in planning a development at Muscle Shoals recognized this fact and contemplated an installation of 400,000 kw., only a portion of which can be depended upon for continuous power. According to the hydrographs of the river at this point, the amount of strictly primary power at Muscle Shoals averages about 100,000 hp., and even this figure is based on the assistance of some steam capacity which must be maintained. It is a source of considerable regret to engineers who are familiar with the Tennessee River to read in the press of the enormous amount of power allotted to Muscle Shoals development, usually stated as 1,000,000 hp., and the consequent misleading of the general public on this much discussed project. The development has distinctly a stream-flow characteristic, the discharge of the river varying widely from month to month, and more markedly from year to year. The contemplated capacity of 400,000 kw. at Muscle Shoals could be operated under full load only at widely separated intervals, since the river flow does not equal this amount of power except on an average of less than thirty consecutive days per year.

In Fig. 3 are shown hydrographs of the Tennessee River at Florence, Ala., for the year 1906, which is the maximum water year recorded, and for 1904, which is the minimum water year recorded. It will be noted from the curve for 1904 that for a large part of the year the flow at Dam No. 2 would have produced only approximately 50,000 kw., while in the maximum water year, for a large part of the time, the flow falls below 200,000 kw. In studying the hydrographs of this stream covering a period of approximately thirty years, the years 1900 and 1907 have been found to represent about the average conditions of river flow. The hydrographs for these two years are shown in Fig. 4, and it will be noted that the continuous output that can be depended upon throughout these average years is in the neighborhood of 100,000 kw.

In Fig. 5 is shown a powergraph of the river for four consecutive years, 1912, 1913, 1914, and 1915, which are typical years, based on an installation of 400,000 kw. capacity, as proposed by the United States Government at Dam Site No. 2. It will be noted that in each of these years except one the stream flow at some times falls below 100,000 kw., and that only at widely separated intervals does the stream flow equal or approach the 400,000-kw. mark. It can be seen from these hydrographs that the statement of one million horsepower which has appeared in the press repeatedly, is a gross exaggeration of the output to be expected from the plant at this location. There are many undeveloped water-power sites in the Southeast which can be developed on a commercial basis to much greater advantage than the development at Muscle Shoals.

From the foregoing it can be seen that the Southeast is open for great industrial development, as it either has or can develop the necessary hydroelectric power, and enjoys the natural advantage of an even and salubrious climate, together with a very large store of raw materials in both its agricultural and mineral resources.

Results of an investigation made by the U. S. Geological Survey in 1921 show that the total water power developed in the United States is now 7,852,948 hp., the figure representing the capacity of the water wheels installed in plants of 100 hp. or more. There are 3116 such plants; 79 per cent of their total capacity is in public-utility plants and 21 per cent in manufacturing plants. Undeveloped water-power resources are shown to be a minimum of 27,943,000 hp., based on low-flow data.

Modern Shop Practice in the Building of Revolving Flat Cards

Details of Special Machines Developed for the Work—Production Cost Per Unit Lowered by Efficient Shop Arrangement, Careful Machine Designing and Standardization

By F. E. BANFIELD, JR.,[1] NEWTON UPPER FALLS, MASS.

BEFORE taking up the details of manufacture of the modern revolving flat card, it may be of interest to trace briefly the development of this machine in order that one may better appreciate the extent to which the art of its manufacture has been developed.

The primitive method of carding or cleaning cotton fibers was by means of hand cards which consisted of brushes made of short pieces of wire instead of bristles, the wires being fastened into a sheet of leather at a certain angle, and the leather fastened into a flat piece of wood about twelve inches long by five inches wide and provided with a handle. The cotton was spread upon the surface of one of these cards and then combed with another until all the fibers were straight, after which it was stripped off in the form of a roll.

The first attempt to card by the rotary motion of a cylinder was covered by the English patent taken out by Lewis Paul in 1748, but it was not until 1790, when Samuel Slater, an Englishman who had settled in Pawtucket, R. I., built the first cards to be operated in this country that carding or cleaning cotton fibers by machine was introduced here.

In 1857 Evan Leigh produced a card embodying all previous developments and having the additional advantage of being equipped with a mechanical device to automatically strip the tops or flats. This type, known as the revolving flat card, was destined to come into almost universal use and is today the standard of the world for carding cotton fibers. Although many modifications and improvements in the construction of this machine have since been made, its fundamental features remain the same.

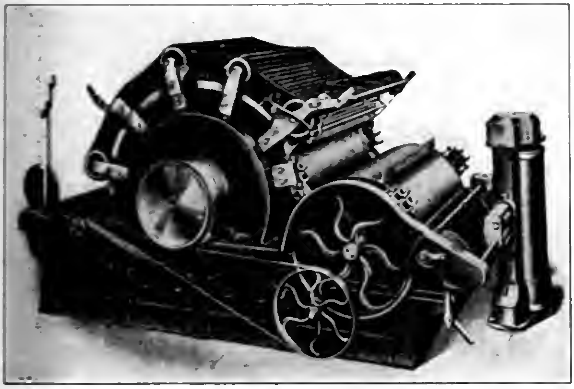


FIG. 1 MODERN REVOLVING FLAT CARD

In Fig. 1 is shown a revolving flat card as it is built today. While there are several different makes of these machines, varying somewhat in details of design, the essential features and characteristics are the same in all.

It was not until the year 1884–1885 that American manufacturers came to realize that the efficiency of this type of card was at least 100 per cent higher than the best of the wooden-top flat cards. As soon as this advantage was made apparent to mill owners the demand for these cards became large, and during the next decade English cards of this type were brought into this country by the shipload. It therefore became necessary for the American machine manufacturer to adopt this new design for his product in place of the old-style machine, in order to compete successfully with the English builders. He was not prepared to manufacture this radically different and highly developed machine. Many of its component parts were so designed that they were not readily adapted to machining on standard commercial types of tools. A start was made by purchasing from England such machines as were available, but it soon became apparent that it was up to the American manufacturer to devise and build special-purpose tools and equipment if he hoped to succeed against the English competitor.

It is the purpose of this paper to show some of the results of the efforts in this direction by describing some of the more important machines which have been developed for this work. In designing these machines the one object which has been constantly borne in mind has been that they must not only do the work cheaper, but it must be of better quality.

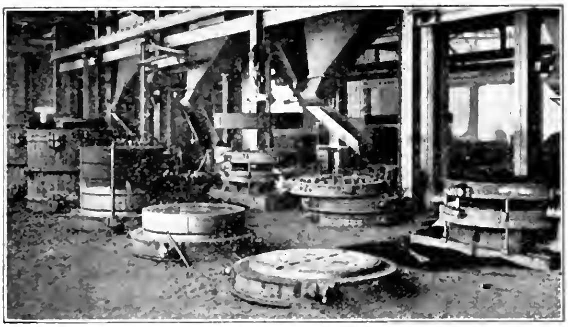


FIG. 2 CYLINDER MOLDING FLOOR

One of the first requisites for economic machine-shop production on a quantity basis is carefully molded uniform castings; otherwise satisfactory work cannot be obtained from the jigs and fixtures employed in holding the castings for the subsequent machining operations. For the average card casting with its more or less deep draws and flanges, the stripping-plate type of molding machine has been found best suited. An iron pattern once properly fitted to a stripping plate is good for almost a countless number of castings, and thus made their accuracy in no wise depends upon the skill of the molder. In fact, an ordinary laborer can in a few days be taught to make as good castings from a stripping-plate pattern as a skilled molder who has served his time in a foundry.

Developments in molding machines in recent years have made it even possible to adapt the cylinder and doffer patterns to stripping-plate machines and in Fig. 2 we have a view of the cylinder floor showing some of these machines and illustrating the method by which the molds are built up. This equipment consists of four jolt stripping-plate machines, the drag, the cope, the core and cheek, the first two being seen at the center and the right of the photograph. The molds are shown from the right to left in their successive stages of completion. To provide for the flanges on the inside surface of the cylinder, the core is built up in four sections, one of which is seen suspended from the overhead crane by which it is handled. Each section is built upon a cast-steel arbor which serves as a means for handling and also provides a support for the upper cores. After the cores are in place the cheek is lowered into posi-

---

[1] Superintendent, Saco-Lowell Shops. Mem. Am.Soc.M.E.

Abstract of paper for presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

tion and the mold is then closed with the cope and ready for pouring. This is done through a central sprue passing down through the cores and thence through radial gates in the drag to the cylinder wall.

Fig. 3 is a view of the card-side floor showing the pattern mounted on a stripping-plate machine at the right. The drags are made from this machine while the copes are rammed up on the plate at the left. In the foreground may be seen two drags ready for the cores to be set. Over 70,000 molds have been made from this pattern and it is still in serviceable condition.

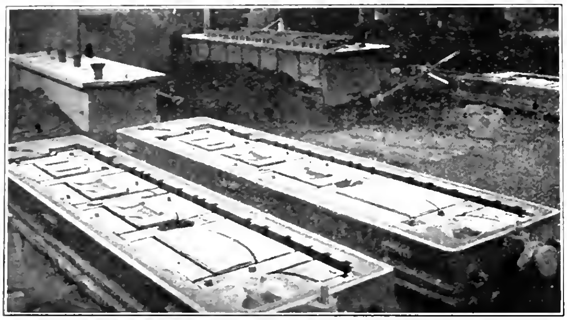


Fig. 3 Card-Side Molding Machines

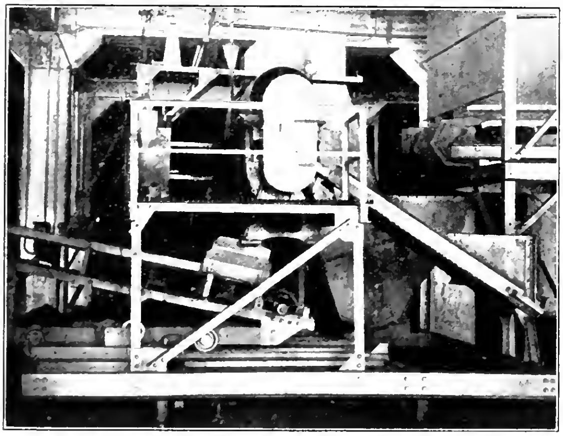


Fig. 4 Sand-Mixing Machine

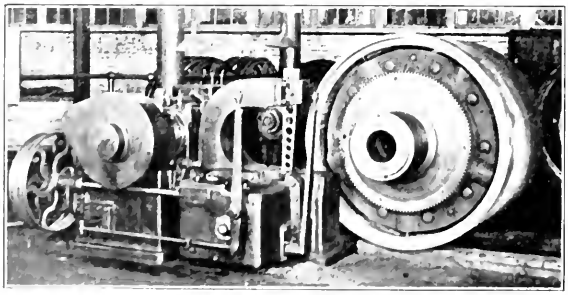


Fig. 5 Cylinder-End Milling Machine

After pouring, the molds are shaken out over gratings in the floor, through which the sand falls into hoppers located in the basement. Serving these hoppers is the sand-mixing machine or car, shown in Fig. 4. A hopper is located on the right from which a slow-moving feeder delivers the sand to the hopper of a bucket elevator mounted on the car. This elevates the sand to the mixing machine where it is riddled, tempered and mixed and then dropped on to a belt conveyor which delivers it to the bucket elevator at the left ready for the hopper over the molding floor above. This sand car is operated on a track, running the length of the foundry and so located that the car serves all of the hoppers in the bay in which it operates. This equipment does away with the laborious work of shoveling the sand and it also mixes and prepares it much more thoroughly than is possible by hand, thereby producing not only better but cheaper castings.

For transportation of materials, an electrically operated monorail system has been installed. Not only are the cars electrically driven but the switches are also operated in this manner, being controlled by a button in the operator's cab. Special cars are also arranged with ladles for carrying the molten iron from the cupola to the molding floors, and arranged so that the tilting of the ladle for pouring is done by the operator of the car. This system has aided materially in reducing the cost of transportation as well as increasing the capacity of the foundry by speeding up the work.

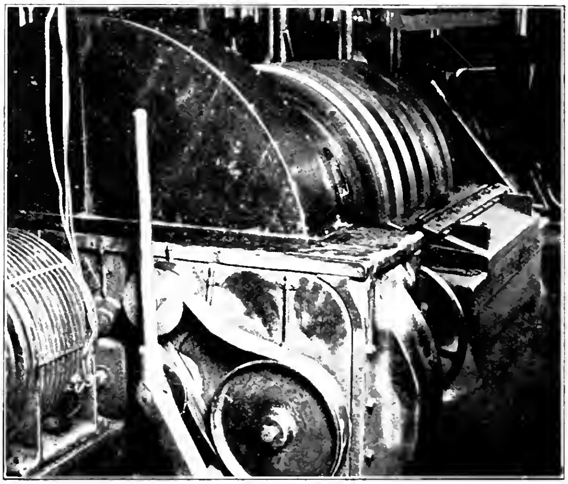


Fig. 6 Cylinder Roughing Lathe

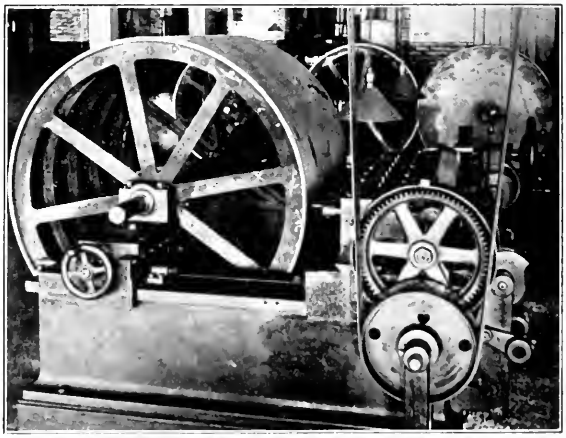


Fig. 7 Cylinder Drilling Machine

Machining of the Castings

Upon the solid construction, the true running and the perfect balance of the card cylinder, depends to a large degree the successful operation of the card. Its surface is covered with card clothing which in turn is set to run but a few thousandths of an inch away from the surfaces of the lickerin, the flats and the doffer, and it is

Fig. 8 Shaft Roughing Lathe

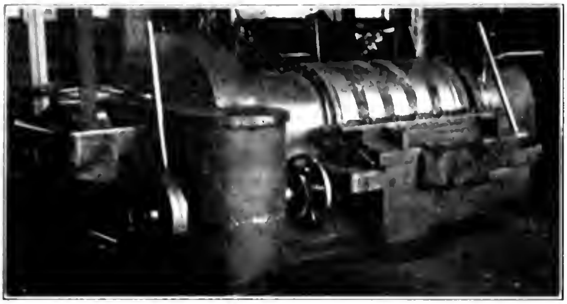


Fig. 9 Doffer Roughing Lathe

essential that this small clearance be accurately maintained as otherwise serious damage might result to the clothing. This cylinder has a diameter of 50 in., a length of 40 or 45 in. according to the width of the card, and runs at a normal speed of 165 turns per minute. It is the largest of the parts entering into the assembly of the card and its machining operations are such as require the use of several of the special single-purpose tools heretofore mentioned.

The first operation on the cylinder consists of squaring up and boring out the ends to receive the spiders. For a long time this was done on boring out lathes designed and built for this purpose in England, several of which were purchased and brought to this country.

Then in order to obtain an increased production and at the same time eliminate the possibility of inaccuracy, it was decided that a milling machine was the type best suited to produce these results. Accordingly the special machine shown in Fig. 5 was designed and built for this work. The cylinder is held on an expanding arbor or chuck, one end of which carries the feed gear corresponding to the rack of the ordinary milling-machine table. The cutters are mounted on the inner ends of two spindles, one on each side of the machine, these spindles, in turn, being driven by spur gears from a motor-driven cross-shaft at the rear. The spindles are mounted in quills so arranged that they may be fed into the ends of the cylinder to the desired depth after it has been rolled into place. A sliding-drive pinion is then moved into mesh with the feed gear on the chuck; this pinion being driven from the cross-shaft shown on the side of the machine. A tight and loose pulley on this shaft receives a belt from a pulley on the motor shaft, the feed being started and stopped by the shifting of this belt. The arbor on which the cylinder is mounted is held in position in the horizontal U-shaped bearings of the machine by means of the steel wedges shown. The photograph shows the cylinder ready to be rolled into position. The head carrying the cutter spindles is adjustable and when once set for a certain diameter of cutter, work of uniform dimensions is produced and is not dependent on the care of the operator, who merely loads and unloads the machine. This machine is capable of finishing one cylinder per hour, one-third the time required on the previous lathes.

When bored or milled out the cylinder is taken to the roughing lathe (Fig. 6) where it is held by the bored ends and a roughing cut is taken across its outer surface. To convey an idea of the size of this machine, it may be of interest to state that the head- and tail-stock spindles are both 30 in. in diameter, the former carrying a driving gear 6 ft. in diameter. The spindles are of cast iron and run in cast-iron bearings, which have shown no appreciable wear during ten years of continuous service. The tool block carries six tools spaced at equal intervals so that each tool travels but one-sixth of the length of the cylinder, the entire surface being finished by this movement.

A spider is then driven into each end of the cylinder where it is securely bolted and doweled in place. The holes are then line-reamed to receive the shaft, which is pressed into place in a heavy horizontal power press, 0.005 in. being allowed for the forced fit. As a further precaution, a $^5/_8$-in. dowel pin is driven through the hub of the spider and shaft at the driving end. This method of construction obviates any possibility of the shaft becoming loose from long-continued operation and insures a true-running cylinder.

It is then mounted on its own bearings in a special finishing lathe where a continuous chip is taken from one end to the other with a single tool, after which it is ready to be drilled for the wooden plugs which are driven into its surface and to which the clothing is tacked. This drilling operation is performed in the horizontal gang drilling machine shown in Fig. 7. The drills used here are of the flat type and so shaped as to drill and ream a tapered hole suitable for receiving the wooden plug.

After plugging, the cylinder is carefully ground on a special cylinder grinder. Operations on the spider, consisting of boring and reaming the hub, of turning the outside circumference to size and of facing one side of the rim, are done on a boring mill so equipped that all of these operations may be performed at one setting of the work.

Finishing the Shafts

The shafts used in the cylinders and doffers are of cast iron and each end is finished to three different diameters, one to fit the spider, one the bearing, and the third, or outer one, the pulley. For rough-turning these shafts the special machine shown in Fig. 8 was developed to turn both ends of the shaft at the same time. As

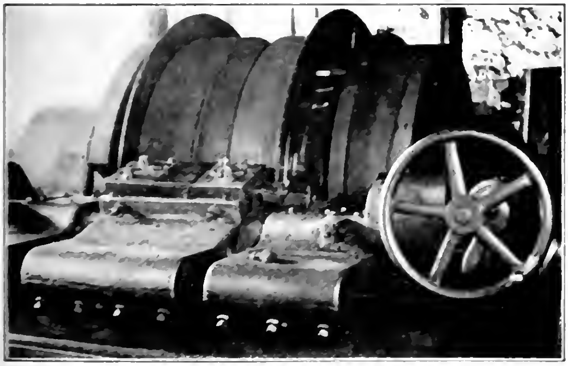


Fig. 10 Arch Milling

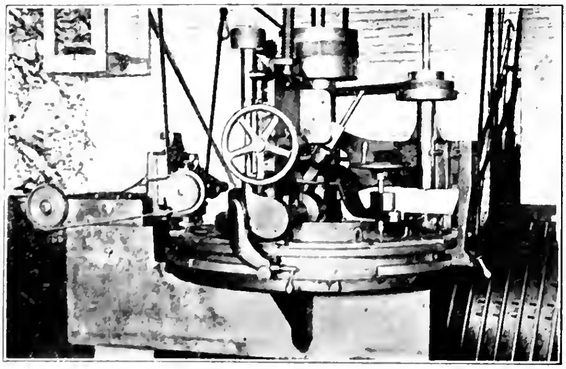


Fig. 11 Arch Milling, Drilling and Tapping

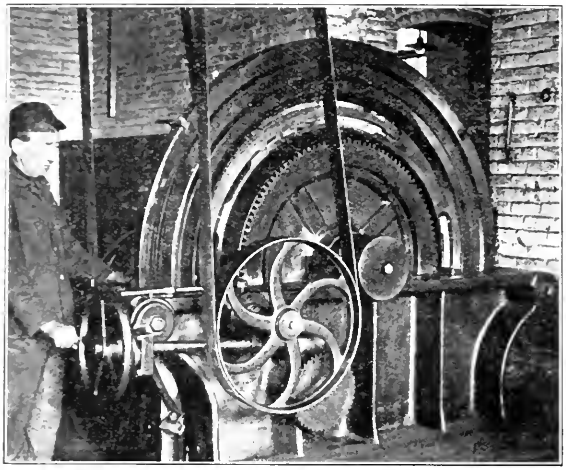


Fig. 12 Flexible-Bend Milling Machine

will be seen, the central head carries a hollow spindle driven by a gear on the main driving shaft at the rear of the machine. On each end of this hollow spindle is mounted a special concentric chuck for centering and gripping the casting to be turned. The tailstock spindles, one at each end of the machine, are arranged in horizontal turrets or drums which may be rotated in their respective heads and whose axes are located below that of the driving spindle. These turrets are also fitted with a rotating center drill, the driving gears of which are thrown into mesh as it is moved up into line with the axis of the shaft. The third position of the left-hand turret carries a stop which locates the work in the machine, while the corresponding position of the right-hand one is provided with an opening through which the work is passed into and out of the machine. Each carriage is provided with a front and back tool block, the former carrying two turning tools, while the latter carries a single inverted one. Thus, three tools are in operation at each end of the shaft, one for each of the three diameters.

The shaft then goes to a lathe equipped with two carriages, each of which is fitted with a tool block arranged with tools for squaring the shoulders to length. It is then ready for the grinder where both ends are carefully ground to size. After cutting the keyway for the driving pulley with a vertical end mill, the hole for the oil screw is drilled and tapped in the end and the shaft is completed, ready to be pressed into the cylinder.

The operations of finishing the doffer follow closely those of the cylinder, the rough-turning being done on the machine shown in Fig. 9, which greatly resembles the cylinder roughing lathe (Fig. 6). After the spider and shaft are in place, the doffer is drilled, ground, and balanced in a manner similar to the cylinder.

The sides and arches of the framework of the cards are finished by special machines since the successful manufacture of these parts requires close adherence to accuracy in order to insure interchangeability and to reduce to a minimum the fitting required in the erecting room. In order to secure a straight and even surface on which to erect the card and attain proper alignment of the bearings, the top surfaces of the sides are further finished on a special planer type of grinder carrying a vertically mounted motor-driven ring wheel.

The arch which is that portion of the frame carrying the stands which support the flats and their driving and adjusting mechanism as well as the sheet-iron casing below them, is by the nature of its design, the most awkward as well as one of the most important parts of the card to machine. The proper settings of the different parts require the accurate location of the various spottings on which the stands are mounted. The first operation after squaring off the bottom of the feet is the milling of the outer rim, this being done on the machine shown in Fig. 10. The rotating drum carries a pair of these arches, one right and one left hand. As this drum rotates slowly the circumference of the rim of the arch is carried past the cutter, plainly seen in the photograph, while below this cutter, but hidden from view, are two face mills so located as to mill the inner and outer sides of the rim. Means are also provided for automatically changing the space between these two cutters to allow for the thicker portion of the rim on one side of the arch.

The final operations on the arch are accomplished at one setting on the machine shown in Fig. 11. The casting is clamped to the table in a horizontal position on its back and the pair of cutters mounted on the horizontal slide at the left side of the machine serve to mill the spottings to which the arch stands are bolted, while the pair of cutters carried on the vertical head in the center of the picture finish the spottings on both sides of the flange. In addition to these milling operations, the holes for the capscrews securing the stands in place are drilled and tapped. The table of the machine is revolved by hand to its successive positions under the horizontal cutters, while the vertical milling, drilling and tapping heads are free to swing about the central axis to any desired position. The locations of the various spottings and holes are all determined by tapered slots in the rim of the table into which plungers, mounted on their respective heads, are thrust to locate the spotting or hole to be finished.

Against the outer rim of the arch, the flexible bend, over which the flats travel, is held by its adjusting blocks. It is essential that this bend be close to the milled surface of the arch and its sides must therefore be true and even. The finishing of these sides is accomplished as in the case of the rim of the arch, by feeding the bend between two properly spaced face mills and removing the scale from both sides of the casting at the same time. This operation is shown in Fig. 12. It will be noted that this machine is of a type similar to some of the continuous milling machines which have been recently developed, where the loading and unloading is carried on while the machine is in operation. A rough casting may be seen entering the cutters, while in the rear the finished one is just coming into sight. The cutters are hidden from view in the cut,

(Continued on page 310)

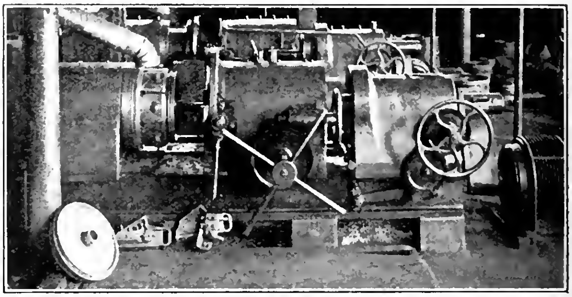


Fig. 13 Pulley Lathe

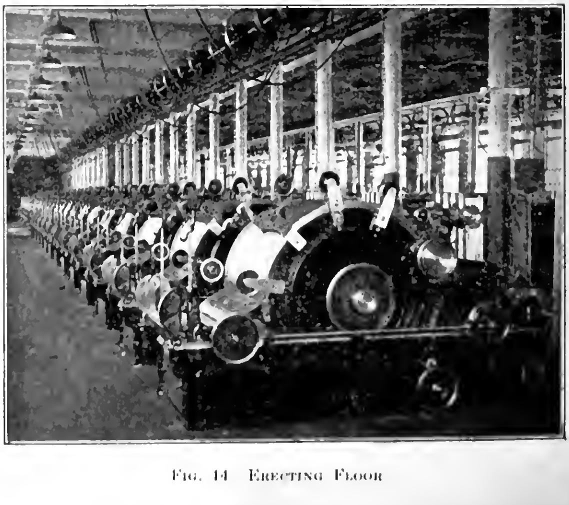


Fig. 14 Erecting Floor

The Value of Clean Blast-Furnace Gas

Savings Resulting from the Use of Clean Gas in Hot-Blast Stove and Boiler Operation—Superiority of Dry Cleaning Over Wet Cleaning—Possibilities Held Out by the Electrical Cleaning Process

By N. H. GELLERT,[1] PHILADELPHIA, PA.

THERE are so many factors entering into the general problem of making iron from iron ore that the blast-furnace superintendent is often at a loss to determine which of all of these is most important. The experienced operator has undoubtedly long ago arrived at the conclusion that many contingent, equally important factors make up his general problem, and looks for no panacea to remedy all his ills. Some operators, having tried several remedies, and having failed to find them as effective as originally supposed, have despaired of discovering in the future definite specifics for blast-furnace troubles. Such operators are few today and will be fewer in number tomorrow.

Steel and fuel have made our country strong and powerful among nations. We must look to our continued supremacy in these to maintain ourselves in that eminence of world power to which they have helped to raise us. This supremacy, however, can be maintained only by the most careful conservation of all our fuel resources, so that it may be possible for steel men to produce the sinews of world industry with the minimum expenditure of power.

Our geologists tell us that we are reaching the end of our known fuel resources, and that at the present rate of consumption, the end is measured by scores of years and not by centuries. In view of such a condition, it becomes not only the advisable business policy to effect a rigid conservation of our fuel resources, but the major part of duty also. Such conservation can be effected in a large measure by steel men. Each stage of steel making requires its huge quota of fuel. In each stage of steel making savings can be secured.

We are especially interested at this particular moment, however, with the consideration of the savings to be effected by the cleaning of blast-furnace gas. To this specific consideration, therefore, the remainder of the discussion will be confined.

THE VALUE OF CLEAN GAS IN STOVES AND BOILERS

The value of clean gas as against dirty or raw gas has been so well demonstrated that it might seem superfluous to most blast-furnace men to start any discussion on such a score. The policy of our largest and most progressive steel companies has been definitely established by the expenditure of millions of dollars to install cleaners, so that raw gas may not be fed to the boilers and hot stoves.

If the gas issuing from a blast furnace were a small item, overlooking its importance might be permissible, but the facts are these:[2]

1 Forty-eight to fifty per cent of the thermal value of the coke charged into the blast furnace issues from it in the form of latent and sensible heat of combustible gases.

2 Thirty per cent of the gas generated is used for increasing the temperature of the blast.

3 Sixty per cent of the gas is used in boilers or engines for power.

Consider for a moment what clean gas will do for hot stoves. At Duquesne[3] tests were made on hot-stove operation using gas in three different conditions. The results obtained as given in Table I, are at least interesting.

TABLE I AVAILABLE HEAT IN CLEAN AND DIRTY GAS

Kind of Gas	Dust content, grains per cu. ft.	Moisture content, grains per cu ft.	Temp. of gas, deg. fahr.	Available heat, per cent
Raw gas	3.0	35.0	400	77.03
Partly clean gas	...	saturated	125	71.33
Clean gas	0.2	7.98	70	79.51

Mr. Diehl's conclusions, drawn from a careful investigation of his data, were that at 1913 prices the following savings were made:

1 Increased stove efficiency	$0.0998
2 Saving in limestone	0.0072
3 Saving due to increased production	0.0521
Total saving per ton of iron	$0.1591

Now in none of these figures was any consideration taken of the increased life of the stoves, of the more continuous operation because of a decreased number of cleaning periods, or of the savings due to better combustion and other beneficial results when using clean gas in the boilers. Unfortunately, no really determining data have been made available to enable us to determine just what such savings might be. It is evident, nevertheless, that they must be considerable, as to them must be credited savings (1) in checker brick in stoves, (2) in stove linings, (3) in combustion-chamber brick, (4) in boiler-setting brick, (5) in boiler tubes, (6) in boiler fuel, and (7) in labor cleaning outside of boiler tubes.

Interesting data on boiler efficiencies were given by Mr. Diehl in the paper already mentioned, and results which he has tabulated indicate that when burning clean gas the average thermal efficiency was 66.1 per cent, while when burning raw gas it was 62.3, making a gain of 3.8 per cent when burning clean gas. Since, however, the clean-gas tests were run after the boiler tubes had been cleaned and the whole boiler put in good shape, it is obviously impossible to say just how much of this saving is due to the burning of clean gas. It may be said, however, that the results indicate clearly that a saving is to be procured when burning clean gas, since the removal of dirt from the tubes and the burning of clean gas made it possible to get the high efficiencies recorded. Such a conclusion is checked by other tests reported by Mr. Diehl in which one boiler burning raw gas had an average efficiency of 49.8 per cent, while another burning clean gas—both using common burners—had an efficiency of 51.2 per cent.

DRY VERSUS WET CLEANING

Now if it is conceded, by force of common practice and such data as can be used for argument, that clean gas is to be preferred above dirty gas in stoves and boilers, there remains but one other question to be answered: Shall gas be cleaned by a wet process or a dry process?

Heat Value of Dry-Cleaned Gas. Suppose we consider the operation of a 500-ton furnace here in the Birmingham District. If every ton of iron required 2500 lb. of coke, the total coke tonnage per day will be 625 tons. If we take 48 per cent of this to be in the form of gas, then 301 tons must be used for fuel purposes outside of the furnace. Here is presented a possibility for control that should result in savings.

Now there will be about 170,000 cu. ft. of gas generated per ton of iron made. At a 500-ton furnace this would give 85,000,000 cu. ft. of gas per day, 3,540,000 cu. ft. of gas per hour, or 59,000 cu. ft. per min. at 29.92 in. of mercury column pressure and 62 deg. fahr.

Assume the gas has a percentage analysis as follows: CO_2, 12.5; CO, 25.4; H_2, 3.5; N_2, 58.6. Assume also that the temperature of the gas in the mains is 400 deg. fahr. and the moisture at standard conditions is 35 grains per cu. ft.

The thermal value of the gas depends on (1) its latent heat of combustion and (2) its sensible heat; and if the products of combustion escape at, say, 600 deg. fahr., there will have to be subtracted from the total heat the sensible heat of the escaping products of combustion.

Latent Heat. First consider the thermal value of the gas.

Table 2, the author believes, is the first published attempt to assemble the data given from a number of sources so as to collect the most probable values of the constants involved. In addition,

---

[1] President, Gellert Engineering Company.

[2] A. N. Diehl, Burning Blast-Furnace Gas, Proc. Am. Iron & Steel Inst., 1915, p. 315.

[3] A. N. Diehl, A.I.M.E., Dec., 1913.

Abridgement of a paper read before the Birmingham Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Birmingham, Ala., October 28, 1921.

values have been calculated to correspond to a temperature of 62 deg. fahr., the temperature at which most technical gas calculations are made.

By the aid of this table it now becomes a fairly simple task to develop the latent-heat value of the gas which is being considered.

We have available 59,000 cu. ft. of gas per minute at 62 deg. and 29.92 in. mercury column. Of this amount 14,986 cu. ft. are carbon monoxide and 2065 cu. ft. hydrogen. The hydrogen has a total latent-heat value of 676,100 B.t.u. and the carbon monoxide a total latent-heat value of 4,771,100 B.t.u., or for all the combustible elements, a total latent-heat value of 5,447,200 B.t.u. per min. See Table 3.

TABLE 2 PROPERTIES OF GASES

Name of Gas (1)	Specific Gravity (2)	Lb. per Cubic Ft. at 29.92 in. Hg. at 32° F. (3)	Lb. per Cubic Ft. at 29.92 in. Hg. at 62° F. (4)	Heating Value B.t.u. per lb. (5)	Heating Value B.t.u. per cu. ft. at 32° F. (6)	Heating Value B.t.u. per cu. ft. at 62° F. (7)	Air Required Lb. per lb. gas (8)	Air Required Cu. ft. per cu. ft. gas (9)	Oxygen Required Lb. per lb. gas (10)	Oxygen Required Cu. ft. per Cu. ft. gas (11)	Cu. Ft. Gas per Lb. at 32° F. (12)	Cu. Ft. Gas per Lb. at 62° F. (13)
Carbon dioxide	1.5291	0.1234	0.1163	....	.....	.....	...	....	...	...	8.103	8.60
Carbon monoxide	0.9672	0.0781	0.0736	4,325	337.6	318.2	2.47	2.391	.571	0.5	12.810	13.59
Hydrogen	0.0695	0.00561	0.00528	62,032	348.0	348.0	34.56	2.391	8.000	0.5	178.273	189.14
Oxygen	[1]1.1054	0.0892	0.0841	....	.....	....	...	....	...	...	11.209	11.90
Nitrogen	[1]0.9674	[2]0.0782	0.0737	....	.....	.....	...	....	...	...	12.807	13.50
Air	1.0000	0.0807	0.0761	....	.....	.....	...	....	...	...	12.390	13.14
Aqueous vapor	0.6237	0.0503	0.0474	....	.....	.....	...	....	...	...	19.865	21.08
Methane	0.5545	0.0448	0.0422	23,513	1,053.4	992.2	17.28	9.564	4.000	2.0	22.324	23.70
Ethane	1.0496	0.0847	0.0799	22,230	1,882.9	1,776.1	16.13	16.737	3.733	3.5	11.807	12.51
Ethylene	0.9753	0.0787	0.0741	21,344	1,679.9	1,581.6	14.81	14.346	3.429	3.0	12.706	13.36
Acetylene	0.9056	0.0731	0.0688	18,196	1,330.1	1,251.9	13.29	11.955	3.077	2.5	13.680	14.63
Sulphur dioxide	2.2639	0.1826	0.1721	....	.....	.....	...	....	...	...	5.422	5.81
Sulphur	....	.....	.....	4,050	.....	....	4.32	....	1.000	...	.....	....
Carbon	....	.....	.....	14,600	.....	....	11.52	....	2.667	...	.....	....

[1] From Olsen's Manual. [2] Calculated. Columns 2 and 3, values from Liddell's Met. and Chem. Handbook; columns 4, 6, 7, 12, and 13, calculated; column 5, values from Poole's Calorific Power of Fuels; column 8, values from Babcock and Wilcox' Steam; columns 9, 10 and 11, from Pratt's Principles of Combustion.

Since, however, the water vapor formed in the combustion of the hydrogen is not condensed in the products of combustion, the lower heat value, 52,920 B.t.u. per lb., should hold. There must therefore be subtracted the difference between these two values for the total latent heat, or (62032 − 52920 =) 9112 × 10.9 = 99320.8 B.t.u. must be deducted, making the net value of the latent heat 5,347,900 B.t.u.

TABLE 3 LATENT HEAT OF COMBUSTION
(59,000 cu. ft. of blast-furnace gas per min.)

Constituent	Per cent by volume	Cu. ft. per min.	Weight per cu. ft. at 62° F., lb.	Total wt., lb.	Per cent by weight	Latent Heat in B.t.u. Per cu. ft. at 62° F.	Latent Heat in B.t.u. Per lb.	Latent Heat in B.t.u. Total
Carbon dioxide	12.5	7375	0.1163	838.3	18.6	...	...	....
Carbon monoxide	25.4	14986	0.0736	1103.2	24.6	318.2	4325	4,771,100
Hydrogen	3.5	2065	0.0053	10.9	0.2	328.0	62032	676,100
Oxygen	0.0	0000	0.0841	000	00	...	...	....
Nitrogen	58.6	34574	0.0737	2548.3	56.6	...	...	....
Total				4500.7				5,447,200

Sensible Heat. To this, however, must be added the value of the sensible heat of the gas. This may be determined from the formulas given in Table 4, which hold true for values of gases up to 2000 deg. cent. (3600 deg. fahr.) in temperature.

TABLE 4 THERMAL CAPACITIES OF GASES PER POUND FOR TEMPERATURES UP TO 2000 DEG. CENT. (3600 DEG. FAHR.)[1]

Gas	Pound-Calories	B.t.u.
Hydrogen	$3.370 + 0.0003t$	$3.370 + 0.00017t$
Nitrogen	$0.2405 + 0.0000214t$	$0.2405 + 0.0000119t$
Oxygen	$0.2104 + 0.0000187t$	$0.2104 + 0.0000104t$
Carbon dioxide	$0.19 + 0.00011t$	$0.19 + 0.00006t$
Carbon monoxide	$0.2405 + 0.0000214t$	$0.2405 + 0.0000119t$
Aqueous vapor	$0.42 + 0.000185t$	$0.42 + 0.000103t$

[1] Tabulated from data in Richards' Metallurgical Calculations.

We may approach our problem then in one of two ways:

1 We may find the mean specific heat of the gas between the limit $(0-t_1)$, and also the mean specific heat of the same gas between the limits $(0-t_2)$. From the total sensible heat found in the first instance we may subtract the total sensible heat in the second leaving us a net result. Or,

2 We may find the mean specific heat between the limits (t_1-t_2) and use this direct to obtain our net sensible heat. For ease in calculating specific heats the formulas in Table 5 may be used.

TABLE 5 FORMULAS FOR SPECIFIC HEAT

Gas	B.t.u. per lb. per degree
Hydrogen	$3.370 + 0.00017t$
Nitrogen and carbon monoxide	$0.2405 + 0.0000119t$
Oxygen	$0.2104 + 0.0000104t$
Aqueous vapor	$0.42 + 0.000103t$
Carbon dioxide	$0.19 + 0.00006t$

Take 500 lb. of carbon dioxide at 400 deg. fahr., to find its net sensible heat value if it enters a boiler when the air temperature is 70 deg. fahr. by the first method:

Specific heat of CO_2 (0°–400°) = 0.2140

Total sensible heat at 400 deg. fahr. = 0.2140 × 500 × 400 = 42,800 B.t.u.

Specific heat of CO_2 (0°–62°) = 0.1936

Total sensible heat at 62 deg. fahr. = 0.1936 × 500 × 62 = 6,002 B.t.u.

Net sensible heat (62°–400°) = 36,798 B.t.u.

In the above calculation the first method is used since it lends itself to greater clarity of thought and develops information as to the actual degree of heat energy of the gases in their various phases and at their various temperatures.

Now calculating the specific heat of the gas at 400 deg. fahr. the following results are obtained:

	Mean specific heat in B.t.u. per deg. fahr. per lb.
Carbon dioxide	0.2140
Carbon monoxide	0.24526
Hydrogen	3.438
Nitrogen	0.24526
Aqueous vapor	0.4612

Attention is here called to the fact that the specific heats here calculated do not agree with those obtained in later determinations of specific heats. In his Principles of Combustion, Arthur D. Pratt calls attention to the work of Holborn and Henning, Langen, Pier, and Austin, and considers the values as obtained by them the most authoritative for such investigations as we are here making. But since most of the past calculations have been based on Richards, the formulas given by him have been used in the present discussion.

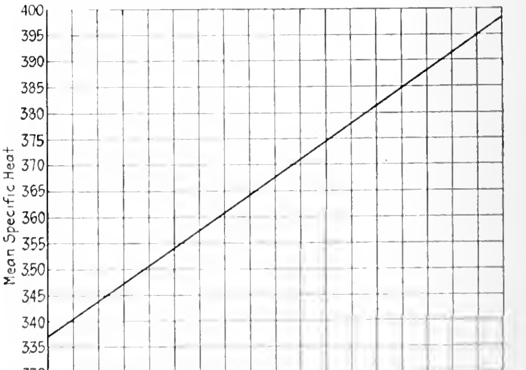


Fig. 1 Mean Specific Heat of Hydrogen between Limits 0 Deg. Fahr. and t Deg. Fahr.

Let us see now how the values of the specific heats may be used in our calculations.

In Table 6 we consider the weights of the components of the gas and the sensible heat they possess by reason of their specific heat at 400 deg. fahr., the temperature at which they are passed through the hot-stove and boiler burners for combustion.

This determination of sensible heat is based on values of specific

heats between the limits 0 deg. and 400 deg. fahr. To get an exact value they should be based on limits—temperature of air and 400 deg. fahr. Since this temperature varies from day to day and season to season, no data developed would hold exactly true. For purposes of comparison the method of determination used should give just as accurate, if not more accurate, results than a method in which daily temperatures must be estimated.

Assume, however, that this average temperature is 62 deg. fahr., the temperature used as a standard for gas-measurement comparison. We can then compute the total sensible heat at limits 0 deg.–62 deg. fahr. as in Table 7, and this subtracted from the sensible heat at the limits 0 deg.–400 deg. fahr. gives:

TABLE 6 DETERMINATION OF SENSIBLE HEAT OF BLAST FURNACE GAS AT 400 DEG. FAHR.

Given 1 Total cu. ft. per min. at 62 deg. fahr. and 29.92 in. Hg dry basis = 59,000
2 Moisture per cu. ft. dry basis 35 grains = 0.005 lb.
3 Temperature of gas = 400 deg. fahr.
4 Percentage analysis, dry basis CO_2, 12.50; CO, 25.40; H_2, 3.50; N, 58.60

Constituent	Per cent by volume	Cu. ft. at 62° F.	Wt. per cu. ft. at 62° F.[2]	Weight lbs.	Per cent by weight	Specific heat at 400° F.	B.t.u. per lb. at 400° F.	Total B.t.u.
CO_2	12.5	7,375	0.1163	838.3	18.6	0.2140	85.6	71,750
CO	25.4	14,986	0.0736	1103.2	24.6	0.24526	98.1	108,220
H	3.5	2,065	0.0053	10.9	0.2	3.438	1375.2	14,650
N	58.6	34,574	0.0737	2548.3	56.6	0.24526	98.1	249,990
[1]H_2O			[4]0.005	295.0		0.4612	184.5	54,430
Total	100.0	59,000		4795.7	100.0	[3]0.2414	996.57	499,040

[1] Aqueous vapor.
[2] Per cubic foot on basis of dry gas.
[3] Average calculated value mean specific heat dry blast furnace gas of above analysis.
[4] Per cubic foot dry gas.

Sensible Heat of Gas at 400 deg. fahr. = 499,040 − 74,390
= 424,650 B.t.u. per min.

TABLE 7 SENSIBLE HEAT OF BLAST-FURNACE GAS AT 62 DEG. FAHR.

Constituent	Weight lb.	Sp. ht. at 62° F.	B.t.u. per lb. at 62° F.	Total B.t.u.
Carbon dioxide	838.3	0.1937	12.0	10,100
Carbon monoxide	1103.2	0.2412	14.9	16,460
Hydrogen	10.9	3.3805	209.6	2,380
Nitrogen	2548.3	0.2412	14.9	37,970
Aqueous vapor	295.0	0.4264	25.4	7,480
Total	4795.7	0.2505		74,390

Total Heat of Gas. The total heat of the gas at 400 deg. fahr. will therefore be:

(1) Net latent heat of combustion	5,347,900
(2) Sensible heat of gas	424,650
Total thermal value	5,772,550 B.t.u. per min.

Combustion Products. Some of this heat will be lost in the escape of products of combustion at a temperature of 600 deg. fahr.

Now in a previous table the most probable values have been used as obtained from a number of sources, while the air and oxygen required were obtained from a source in which air was taken to consist of 23.15 per cent by weight of oxygen and 76.85 per cent of nitrogen. Since, however, our data show oxygen to weigh 0.0841 lb. per cu. ft. at 62 deg. fahr., while nitrogen weighs 0.0737 lb. per cu. ft. at the same temperature, the proportional parts in a cubic foot of air will be as given in Table 8.

TABLE 8 AIR-OXYGEN RATIO

Gas	Per cent by weight	Wt. per cu. ft.	Proportionate volume	Per cent by volume	Air-Oxygen by weight	Ratio by volume
Oxygen	23.15	0.0841	275	20.89	1.00	1.00
Nitrogen	76.85	0.0737	1043	79.11	3.32	3.79
Air	100.00	0.0761	1318	100.00	4.32	4.79

If, therefore, gas be burned by the combination with air, there will be present in the products of combustion, in addition to the new compounds formed, inert nitrogen amounting to 3.32 times the weight of the oxygen combined with the burning gases.

The combustion products when burning carbon monoxide and hydrogen will be as given in Table 9.

It is now possible to proceed with the calculation of the combustion products of the 59,000 cu. ft. of gas at 62 deg. fahr. with which we started our discussion.

TABLE 9 COMBUSTION DATA

		Air Required		Products of Combustion					
				Lb. per lb.			Cu. ft. per cu. ft.		
Constituent	Symbol	Lb. per lb.	Cu. ft. per cu. ft.	CO_2	H_2O	N_2	CO_2	H_2O	N_2
Carbon monoxide	CO	2.47	2.391	1.58		1.89	1	..	1.891
Hydrogen	H_2	34.56	2.391		9.00	26.56	..	1	1.891

By developing the calculations further (see Table 10) we find that when the gas is burned the total products of combustion are:

Carbon dioxide	2,581.3 lb. or	22,361 cu. ft.
Water	393.1 lb. or	8,289 cu. ft.
Nitrogen	4,922.7 lb. or	66,818 cu. ft.
Total products of combustion	7,897.1 lb. or	97,468 cu. ft.

Sensible Heat of Combustion Products. These escaping products of combustion take with them out of the stack and into the air a portion of the heat by virtue of their thermal capacities. To know what heat is available for useful work, the sensible heat of these products must be determined at a temperature of 600 deg. fahr. Using the formulas in Table 6, we are able to obtain the following values bearing on this determination:

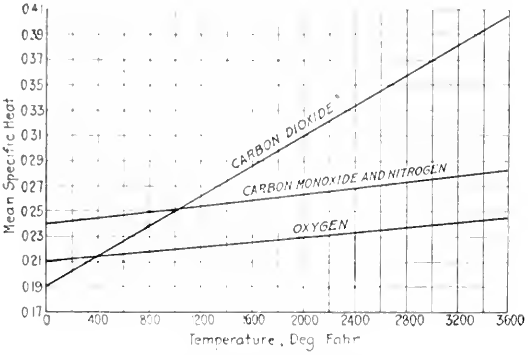


FIG. 2 MEAN SPECIFIC HEATS OF CARBON DIOXIDE, CARBON MONOXIDE, NITROGEN AND OXYGEN BETWEEN LIMITS 0 DEG. FAHR. AND *t* DEG. FAHR.

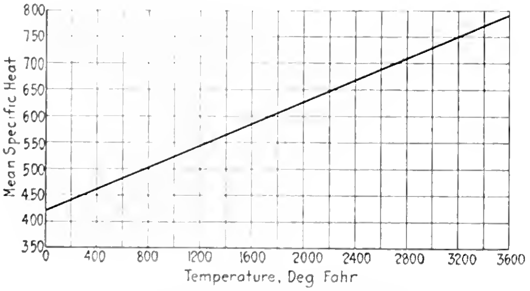


FIG. 3 MEAN SPECIFIC HEAT OF AQUEOUS VAPOR BETWEEN LIMITS 0 DEG. FAHR. AND *t* DEG. FAHR.

	Mean Specific Heat in B.t.u. per Deg. Fahr. per Lb.
Carbon dioxide	0.2260
Aqueous vapor	0.4818
Nitrogen	0.24764

At 600 deg. each pound of product will have 600 times the thermal capacity here shown. The full analysis of the total thermal capacity of all the products can then be developed and this total

TABLE 10 PRODUCTS OF COMBUSTION OF BLAST-FURNACE GAS
(59,000 cu. ft. per min. at 62 deg. fahr.)

		Per cent				Total Air needed		Products of Combustion					
								Total lb.			Total cu. ft. at 62° F.		
Constituent	Symbol	by vol.	by weight	Weight, lb.	Volume in cu. ft. at 62° F.	lb.	cu. ft.	CO_2	H_2O	N_2	CO_2	H_2O	N_2
Carbon dioxide	CO_2	12.5	18.6	838.3	7,375	....	....	838.3	...	....	7,375	..	..
Carbon monoxide	CO	25.4	24.6	1103.2	14,986	2724.8	35,832	1743.0	...	2084.9	14,986	..	28,339
Hydrogen	H_2	3.5	0.2	10.9	2,065	376.7	4,937	....	98.1	289.5	....	2065	3,905
Nitrogen	N_2	58.6	56.6	2548.3	34,574	....	....	....	..	2548.3	....	..	34,574
Aqueous vapor	H_2O	...	...	295.0	....	....	....	....	295.0	....	....	6224	..
Total		100.0	100.0	4795.7	59,000	3101.5	40,769	2581.3	393.1	4922.7	22,361	8289	66,818

sensible heat calculated to be 1,194,800 B.t.u., as shown in Table 11.

Here we must make the same corrections as made for the sensible heat of the gas. Our sensible-heat calculations for gases between the limits 0 deg. and 62 deg. fahr. are as given in Table 12 and the net sensible heat of the products of combustion will be 1,194,800 − 114,380 = 1,080,420 B.t.u. per min. We then have:

Total value of the original gas for both latent and sensible heat	5,772,550 B.t.u.
Net sensible heat of the products of combustion	1,080,420 B.t.u
Gross available B.t.u.	4,692,130 B.t.u.
Less 10 per cent lost because of original loss in gas	469,213 B t.u.
Net available B.t.u. per minute	4,222,917 B.t.u.

TABLE 11 DETERMINATION OF SENSIBLE HEAT OF PRODUCTS OF COMBUSTION OF HOT GAS AT 600 DEG. FAHR.

Constituent	Per cent by volume[1]	Per cent by weight[1]	Cu. ft. at 62° F.	Total weight lb.	Specific heat at 600° F.	B.t.u. per lb. at 600° F.	Total B.t.u. sensible heat
Carbon dioxide	25 1	34.5	22361	2581.3	0.2260	135.60	350,020
Aqueous vapor	.	...	8289	393.1	0 4818	289.08	113,640
Nitrogen	74 9	65.5	66818	4922.7	0.2476	148.56	731,320
Total	100.0	100.0	97468	7897.1	0 2522		1,194,980

[1] Figured on a dry basis.

TABLE 12 SENSIBLE HEAT OF PRODUCTS OF COMBUSTION

Constituent	Weight lb.	Specific heat at 62° F.	B.t.u. per lb. at 62° F.	Total B.t.u.
Carbon dioxide	2581 3	0.1937	12.0	31,000
Nitrogen	4922.7	0.2412	14.9	73,400
Aqueous vapor	393.1	0.4264	25.4	9,980
Total	7897.1	0.2341		114,380

AVAILABLE HEAT AND FLAME TEMPERATURES IN DRY CLEANING

All these figures are based on the assumption that blast-furnace gas is delivered at 400 deg. fahr. to the burners of the hot stoves and boilers. This is, of course, what a dry-cleaning device would enable the operator to do. If, however, he is forced to clean his gas by a wet process there must necessarily be a reduction in temperature of the ingoing gas. This reduction in temperature, it is true, will reduce the moisture content of gas. Whether this reduction in moisture content is of any considerable value, or whether it can compensate for the losses in heat incident to the cooling of the gas, is something that might well be determined. To arrive at a conclusion approaching a semblance of accuracy, two things must be taken into account:

1 The comparison of the flame temperature of the burning gases
2 The comparison of net available B.t.u. of the gas.

We have already started our study of the available B.t.u. of hot gas containing 35 grains of moisture per cubic foot at 62 deg. fahr. and 29.92 in. Hg.

Flame Temperature. Let us consider for a moment the theoretical flame temperature of this gas.

$$T = \frac{\text{B.t.u. produced}^1}{W \times S_m}$$

where T = the elevation in temperature
W = weight of products of combustion, and
S_m = mean specific heat of products between temperature of fuel and air and that of products.

The exact value of S_m cannot be found until the value of T is known. For that reason a trial method of computation must be adopted.

The average temperature of the fuel and air will depend on the temperature at which each was delivered to the point of combustion. The gas was delivered at 400 deg. fahr., the air at 62 deg. fahr., and the temperature of the mixture can be shown to be about 251 deg. This figure is interesting but not necessary to our calculations as we already have the total thermal value of the gas before burning.

TABLE 13 SENSIBLE HEAT OF PRODUCTS OF COMBUSTION PER DEGREE

Constituent	Total wt., lb.	Sp. ht. at 2180° F.	Sensible heat per deg.	Sp. ht. at 2400° F.	Sensible heat per deg.	Sp. ht. at 2380° F.	Sensible heat per deg.
Carbon dioxide	2581.3	0.3388	875	0.3340	864	0.3328	860
Nitrogen	4922 7	0.2700	1330	0 2691	1320	0.2688	1320
Aqueous vapor	393.1	0 6754	265	0 6672	262	0.6651	260
Total		0.2138	2470		2446		2440

Proceeding now to the determination of flame temperature, let us assume 2480 deg. fahr. as the correct value. Then, dividing the B.t.u. produced by the sensible heat per degree at 2480 deg. fahr., as given in Table 13,

$$T = \frac{5{,}772{,}500}{2470} = 2340$$

It is evident that this is the wrong temperature. Assuming 2400 deg. as the flame temperature,

$$T = \frac{5{,}772{,}500}{2446} = 2360$$

Again, taking 2380 deg.

$$T = \frac{5{,}772{,}500}{2440} = 2370$$

For our purposes we may take the halfway point between 2380 and 2370 or 2375 deg. fahr., as the correct flame temperature. Greater accuracy may of course be obtained by another trial.

AVAILABLE HEAT AND FLAME TEMPERATURE IN WET CLEANING

So far there have been determined for the gas which is considered as cleaned by a dry process:

1 A value for the available heat which has been found to be 4,222,917 B.t.u. per min. This is the net value after all losses are accounted for.

2 A value for the flame temperature which is 2375 deg. fahr.

We now approach the discussion of these same values when the gas is wet-cleaned. In this instance the gas will have the same analysis as before but its temperature will be 70 deg. fahr. and its moisture content 7.98 grains per cu. ft. of dry gas at 62 deg. and 29.92 in. Hg.

Latent Heat. Its latent heat will be exactly as before since the heat values of the combustible constituents of the gas have not changed. This gross latent-heat value was found to be 5,447,200 B.t.u. per min.

From this amount there was subtracted the difference between the gross and net value of the heat generated by the combustion of the hydrogen, since there was no condensation of the moisture in the products of combustion before escaping through the stack. In addition there was deducted a 10 per cent loss in gas itself.

With the deduction for the lower thermal value of hydrogen there was a net latent-heat value left of 5,347,900 B.t.u. This holds true with wet-cleaned gas also.

Sensible Heat. When we consider the matter of sensible heat, however, we have some differences to take into consideration.

The mean specific heats of the component parts of the gas at 70 deg. fahr. as calculated by the formulas in Table 5 are as follows:

Carbon dioxide	0.1942
Carbon monoxide and nitrogen	0.2413
Hydrogen	3.3819
Aqueous vapor	0.4272

With these values and such other data as we have already obtained, we may develop a table similar to Table 7 giving a total of 77,620 B.t.u. per min. for the sensible heat of all the gases. The total heat of the 59,000 cu. ft. of gas per min., therefore, is 5,347,900 + 77,620 = 5,425,520 B.t.u. per minute.

Combustion Products. Turning to the consideration of the products of combustion of this gas, we find that all the products will be the same excepting the moisture content which will be less by the difference between 295 lb. as found in gas containing 35 grains of moisture per cu. ft. and 67.3 lb. as found in gas containing only 7.98 grains per cu. ft. This difference is 227.7 lb. The products of combustion will therefore be:

Carbon dioxide	2,581.3 lb. or	22,361 cu. ft.
Aqueous vapor	165.4 lb. or	3,480 cu. ft.
Nitrogen	4,922.7 lb. or	66,818 cu. ft.
Total	7,669.4 lb. or	92,659 cu. ft.

These products must be assumed to escape at the same temperature as before in order to get a reasonably accurate comparison. If the stack temperature is 600 deg. fahr. as before, the specific heats of the products will be the same as before. The total sensible heat of each product will also be the same as before, excepting that of the aqueous vapor. In the previous calculation 393.1 lb. of aqueous vapor had a total sensible heat value of 113,640 B.t.u. or 289.08 B.t.u. per lb. Then 165.4 lb. of aqueous vapor will have a sensible-heat value of 47,814 B.t.u. and the total sensible heat of the combustion products will be: (CO_2, 350,020) + (N_2, 731,320) +

---

[1] From Pratt's Principles of Combustion.

(H_2O, 47,220) = 1,128,560 B.t.u. per min. From this total there must be subtracted the heat energy present at 62 deg. fahr.

This will be the same as before, excepting for the aqueous vapor. In the former case 393.1 lb. aqueous vapor had a heat energy of 9980 B.t.u. per min. Then 165.4 lb. of aqueous vapor which we have to deal with in this latter case will have a heat energy at 62 deg. fahr. of 4190 B.t.u. per min. and the total energy will be: (CO_2, 31,000) + (N_2, 73,400) + (H_2O, 4,190) = 108,590 B.t.u. per min.

The net sensible heat of the products will therefore be 1,128,560 − 108,590 = 1,019,970 B.t.u. per min.

It is now possible to determine our net available heat.

Latent and sensible heat of gas	5,425,520
Less net sensible heat of combustion products	1,019,970
Gross available B.t.u.	4,405,550
Ten per cent gas loss	440,555
Net available B.t.u. per min.	3,964,995

Savings. We have already found that the net available B.t.u. per min. when burning hot gas with 35 grains of moisture per cu. ft. = 4,222,917, and now we have the net available B.t.u. per min. when burning cold gas with 7.98 grains of moisture per cu. ft. = 3,964,995, giving a difference in favor of hot gas of 257,922 B.t.u. per min. or 371,407,680 B.t.u. per day saving in using hot gas over wet-cleaned gas.

On the basis of 500 tons per day the saving will amount to 371,407,680 ÷ 500 = 742,820 B.t.u. per ton. Now Birmingham coke contains about 14,290 B.t.u. per lb. on a dry basis.[1] This would mean that 742,820 ÷ 14,290 = 52.0 lb. of coke is saved per ton of iron made. It is not unfair to take $6 per ton as the price of coke charged into the furnace. Then the saving in the use of hot gas will be (52 ÷ 2000) × $6 = $0.156 per ton of iron made for coke alone.

Flame Temperature. We have now to consider the flame temperature of this wet-washed gas, and then we are through with our discussion as to heat values. Let us assume the flame temperature to have a value between 2000 and 2400 deg. fahr. See Table 14.

TABLE 14 FLAME-TEMPERATURE CALCULATIONS

Constituent	Total lb	Sp. ht. 2000° F.	B.t.u. per deg.	Sp. ht. 2200° F.	B.t.u. per deg.	Sp. ht. 2400° F.	B.t.u. per deg.	Sp. ht. 2380° F.	B.t.u. per deg.
Carbon dioxide	2581.3	0.3100	800	0.3112	805	0.3340	860	0.3328	860
Nitrogen	4922.7	0.2643	1300	0.2667	1315	0.2691	1320	0.2688	1320
Aqueous vapor	165.4	0.6260	100	0.6466	105	0.6672	110	0.6651	110
Total			2200		2225		2290		2290

Dividing 5,425,520 respectively by the values 2200, 2225, and 2290 from that table gives 2460, 2450 and 2370 deg. fahr., and we may therefore accept the flame temperature at 2375 deg. fahr., the mean between 2370 and 2380 deg. fahr.

Curiously enough the flame temperatures of the dry-cleaned and wet-cleaned gases as discussed thus far are the same. Practical experience bears this out also, as Diehl's observations indicate that during reasonable test periods the combustion chamber temperatures are 2040 deg. fahr. on wet-cleaned gas and 2030 deg. on hot raw gas.[2] If the latter had been cleaned, our calculations show it would have had as high a temperature as wet-cleaned gas.

Our discussion on heat values of gas may therefore be summed up as follows:

1 Dry-cleaned gas at 400 deg. fahr. even if it contains 35 grains of moisture per cu. ft. has a greater available heat value than wet-cleaned gas at 70 deg. fahr. and 7.98 grains moisture per cu. ft. This heat is 6.5 per cent greater for the former gas than for the latter. At $6 per ton for coke charged into the furnace it means a saving of $0.156 per ton of iron made, in favor of using hot-cleaned gas.

2 There is no difference in flame temperature between the two gases.

Savings Due to Dry Cleaning

We have taken up at great length the question of net heat values of the gases. There are, however, many more factors to be considered in the discussion of wet versus dry cleaning. These factors will be dealt with only briefly at this time.

The costs of wet versus dry cleaning are of interest. If we take the cost of water to be 3 cents per 100,000 cu. ft. of gas cleaned we will be figuring below the average. Let this, however, represent the cost of cleaning the gas, as labor items will be alike for both wet and dry cleaning.

Now, in the dry-cleaning plant about to be described there is but one expense outside of labor, namely, the power cost. Since about 0.3 kw. is used per 100,000 cu. ft. of gas, if power is charged at 2 cents per kw., the cost of cleaning will be 0.6 cent per 100,000 cu. ft. of gas. This means a saving of 2.4 cents per 100,000 cu. ft. or 4.1 cents per ton of pig iron made.

It is, of course, impossible to calculate in dollars and cents all the benefits to be derived from the dry cleaning of gas, as there are factors on which accurate data cannot be obtained.

If, however, we consider the factors already discussed for which a money approximation has been developed, we find

	Per ton pig iron made
Saving due to use of wet-cleaned gas in hot stoves over raw gas	$0.159
Saving in thermal value due to using hot clean gas over wet clean gas	0.156
Saving in operating dry over wet cleaner	0.041
Total calculable saving	$0.356
Estimated saving in using dry clean gas over wet gas in boilers	0.050
Estimated saving in hot-stove brick, boiler brick, etc.	0.060
Total calculable and estimated savings	$0.466

When making 500 tons of pig iron a day, these savings become—

	Calculable	Estimated	Total
Per ton pig iron	$0.356	$0.11	$0.466
Per day (500 tons)	$178	$55	$233
Per year (365 days)	$64,970	$20,075	$85,045

We have then definitely calculated savings of $64,970 per year, not including increases in boiler efficiencies and increased life of boiler tubes, boiler settings, stove checkers and stove linings.

If we are willing to accept the estimated savings which the writer believes are conservative, then an additional $20,075 may be credited to the dry cleaning of gas as against raw gas. The total savings then are $85,045 per year. The calculable savings are about 60 per cent return, and the total savings about 80 per cent return, on the cost of a dry cleaner.

One other benefit to be obtained by dry cleaning is that there is no effluent problem. Two methods of handling the discharge of a wet cleaner are open to the operator. He may empty it into a stream, or he may recover a large amount of the sludge and discharge a more or less muddy effluent into the stream. In either case he discharges a nuisance. If the stream is polluted he may be restrained by law from killing, by cyanide in solution, anaerobic bacteria which digest the contamination and prevent its becoming a nuisance. If the stream is not polluted he may be restrained by law because of his being a public nuisance.

There therefore seems to be no brief for the wet washer as against the dry cleaner. Far-looking blast-furnace men have realized this for years. Some have had enough daring to pioneer for the dry cleaner, and to them belongs a large measure of credit for what dry-cleaner men have accomplished in the last few years.

Electrical Cleaners

The writer has in a previous paper discussed dry cleaners in general, and has given detailed descriptions of the electrical cleaners now in use.[1] Those who are interested in the details are referred to that paper.

There are now operating—or were before the steel industry had to take a vacation—two electrical cleaning plants.[2] These are commercial units which have been operating under as severe conditions as any cleaner can be subjected to. They have regularly been cleaning gases up to 900 deg. fahr. in temperature, under conditions of slip and subject to all the other irregularities of blast-furnace operation. Such difficulties as were first encountered, common to all new undertakings, were overcome long ago and one of them is now in its third year of operation.

Under the best conditions they have cleaned gas to less than 0.1 grain of dust content per cubic foot, and under difficult conditions to 0.4 grain per cubic foot. They have handled gases directly from the dry-dust catchers with dust contents varying up and down as is common in blast-furnace gas.

These cleaners are built on the electrostatic principle, and in sim-

---

[1] Poole's Calorific Power of Fuels.

[2] Proc. Am. Iron & Steel Inst., 1915, p. 318.

[1] Electrical Cleaning of Gases as Applied to the Blast Furnace, Phila. Section A.I.S.E.E., Nov., 1919.

[2] One at plant of American Manganese Mfg. Co., Dunbar, Pa., and one at Sheridan Furnace, Lavino Furnace Company, Sheridan, Pa.

ple form may consist of a single vertical pipe with a chain suspended through its center. This chain hangs from an insulator, while the pipe is grounded. The chain is connected to a mechanical rectifier, acting as a high-tension commutator and converting alternating current to unidirectional current. This high-tension alternating current is supplied at from 30,000 to 35,000 volts by a transformer built especially for this work. The current from the transformer is furnished through a switchboard from the plant power lines at single phase and low tension. Three-phase current is supplied to the synchronous motor operating the rectifier.

A full-fledged electrical cleaning plant contains a small substation in which switchboards, rectifiers, motors, resistance and transformers are located. This house may be elevated or not, as desired, and occupies but a small amount of space.

All the electrical equipment is installed in units. The high-tension pieces are thoroughly caged and the operator is guarded by interlocking electrical devices. Only low-tension equipment is available to him for operation when the current is on.

The cleaners themselves are of steel, vertically built in small cylindrical units filled with tubes and chains—one chain for each tube. They are compactly built and have a high structural factor of safety to withstand excessive temperatures.

Operating a cleaning plant is simple. Gas may be discharged into the cleaner under its header plate from which the tubes are hung. It will pass down around the outside of the tubes and up through the tubes into the top of the cleaner, thence out to the hot stoves and boilers. As long as the current is off this gas will be uncleaned. Now if the rectifier is put into operation so that it may be in shape to convert alternating to unidirectional current at high voltage, the single-phase current may be impressed on the transformer. The corona discharge will then take place from the negative electrodes to the pipes and cleaning will begin, and as there is no complicated mechanism to operate, an unskilled workman handles a whole battery of cleaners as they are controllable from one substation in which he is located.

When cleaning has proceeded for one-half to one and one-half hours, depending on the dust content of the gas, the current is taken off and the pipes are rapped. This causes the dust to drop to the bottom of the cleaner into the hopper devised for that purpose. At the end of the day the hopper may be emptied into a car or conveyor system as desired.

Since the tubes have a total cross-sectional area greater than the mains leading to the cleaners, there is no greater back pressure than is found in the mains.

The cleaners are rapped one at a time so that most of the plant is operative during the cleaning periods. To make rapping as easy as possible, automatically controlled and operated mechanisms have been developed to close the dampers, cut off the current, rap the pipes and chains, open the damper and put on the current intermittently and successively on all the units.

One man can handle a whole battery of cleaners as they are controllable from one substation in which he is located.

All this goes to make possible a departure from past experience.

* * *

In the discussion following the presentation of the paper the author, in reply to various queries, stated that 6 to 7 units of 8 ft. 9 in. diameter would be proper for a 500-ton furnace and that each unit contains ninety 6-in. pipes. The units operated from an hour to an hour and a half before they had to be stopped and the dust knocked down, dependent upon the condition of the gas. If the gas dirt came about 2 to $2^{1}/_{2}$ grains it would be necessary to rap only about every hour or hour and a half. The rapping only takes about 20 seconds and about one minute if done by hand. Precipitators are now designed to handle gas at 15 ft. per sec. In cleaning ferromanganese the dry cleaner does not get rid of all the manganese fumes; if manganese fumes were a true gas it would not catch this gas. On pig iron it cleans to less than one-tenth of a grain, and he was sure that it would clean to two-tenths of a grain regularly if properly designed.

Mr. Swann stated that based on his experience with electric furnaces at Anniston manganese fume was a true gas. He further stated that he was operating electric precipitators on phosphoric acid and obtaining 85 per cent clean-up and had had practically no trouble with the electrical part of the installation.

MODERN SHOP PRACTICE IN BUILDING REVOLVING FLAT CARDS

(Continued from page 304)

but are mounted on the ends of the spindles, one on each side of the machine. Large-diameter pulleys for driving the cutters are mounted directly on the outer ends of these spindles. This method of driving a milling cutter directly by means of a belt has been found very efficient inasmuch as it eliminates vibration and tendency to chatter caused by a gear drive, the belt producing a certain cushioning effect, and cutters thus driven require less frequent grindings and may be operated at a higher speed than those driven through a train of gears.

Power for driving the card is applied to the main cylinder shaft where a pair of 20-in. tight- and loose-webbed pulleys receive the belt. On the other end of the shaft an 18-in. pulley serves to drive the lickerin and flats. These pulleys require a considerable amount of machine work inasmuch as each is made with one or more grooves on one side for driving a round belt in addition to the crowned face. The outer sides of the webs are also turned. A special lathe, Fig. 13, was developed for doing this work by forming tools which carry cutters the full width of the surfaces to be finished. Special attention is called to the massive design of this machine, the headstock spindle being 16 in. in diameter. The heavy heads absorb all vibration even under the heaviest cuts. A special tool block is arranged for each operation, two of which are shown at the base of the machine, the one at the left being used for forming the web and rim, while that on the right blocks out the grooves and half of the crown, the other half being finished in a second operation by turning the pulley around. A spring chuck clamps the pulley securely in place while turning. This machine also carries a boring bar by which the hole is bored and reamed while the turning operation is going on. The average time for finishing the pulley shown at the left of the machine is 11 minutes.

The boring out of the ends of the lickerin shell also proved to be an operation which could not be readily or economically performed on a commercial type of tool and many of the milling operations on the various smaller parts of the card are such as to require the use of gang or form mills.

Coming now to the erecting room, the cards are set up here in rows of twenty-five each as shown in Fig. 14. They are completely assembled with the exception of the clothing and the flats and are then run off and carefully inspected before boxing. Dowel pins are provided wherever necessary so that the work of assembling at the mill is reduced to a minimum.

From the foregoing descriptions and machines which have been illustrated, there are several points to which attention should be called. First, the all-important problem is to get the actual labor cost per piece as low as possible, consistent with the high standard of quality required. This problem is somewhat different from that of most production shops where the low cost of production is arrived at by getting as large a production per machine per day as possible. Many of these special machines are capable of turning out two, three and even four times the amount of work required and are therefore often stopped from one-half to three-quarters of the time. It has therefore been found advantageous to arrange the machines in groups so that one man by operating the group will produce the amount of work required from the machines in his group.

Second, in designing the special machines it will be noted that extremely liberal dimensions have been allowed, and that the lathe and milling-machine spindles have been made to approximate as nearly as practical the diameter of the work to be turned, or the cutter carried by the spindle. In many instances these spindles are made of cast iron, running in bearings of the same material, the surfaces of which when glazed over are almost impervious to wear. The large masses of metal in these spindles and other parts have been provided so as to absorb all vibration and prevent any tendency to chatter even under heavy cuts and feeds.

Third, each machine is designed to do one or more operations on one special part and is suitable for no other purpose. Equipment of this kind is possible only where the product has been thoroughly standardized and is not subject to major changes in design.

Maintenance of Textile Machinery

Purpose of Ball Bearings and Importance of Proper Lubrication Common Abuses and Suggested Corrections

By EDWIN H. MARBLE,[1] WORCESTER, MASS.

A MEMBER of a well-known firm of appraisal engineers recently stated that it was not practical to adjust values of textile machinery by any known annual depreciation percentages. Two machines placed in operation in different mills, receiving attention or lack of attention, will be represented on the valuation sheet by quite varying figures. It is the hope of the writer of this paper that some suggestion may be made that will bring the two valuations nearer together and assist in a better maintenance of the textile machinery that has been installed in so many of the mills.

While there is a difference in the character of the machinery used in the various processes incident to the manufacture of fabrics, the mechanical principles are the same, and adjustments or regulations are very similar for all types of machines.

We will take for specific illustrations that class of machines with which the writer is most familiar, namely, cloth-room machinery. The suggestions, however, will apply equally well to most of the machinery found in our textile mills. When machinery is being constructed by the builder, the frame is carefully leveled and the various bearings are adjusted and the machine when placed in its proper position on the mill floor should be carefully leveled and then securely fastened in its position. Several times we have had called to our attention a very careless carrying out of this suggestion. "The legs seem to be firm on the floor and the machine must be all right," was the report. This leveling is particularly important with machinery that has considerable length along the line of the main driving shaft, such as spinning frames, or with machines that have fine adjustments, such as shearing machines.

Having attended to this particular feature at the installation of the machines, it is well to repeatedly test out the stability of the leveling from time to time, particularly when the installation is in a new mill where the floors have not assumed permanency.

With the machine in position and various attachments and revolving parts in place, see that the bearings are not too snug and that each roll or shaft turns freely. We all expect a certain degree of stiffness in new machines and no matter how finely the builder may have made his fits, the transferring of the machine from one floor to another will have varied the adjustment to some extent, and a slight readjustment may be necessary.

With the machine starting off smoothly, what suggestions can we make to assist in maintaining its operating condition? Lubrication is possibly one of the prime considerations. Often it is no oil, an unstable oil, or a surplus of oil. The same oil cannot well be used on the high-speed spindle and the slow-revolving main shaft. The type of bearing may not be suitable for some of the heavy non-fluid oils. A regular system of oiling up should be practiced. Every morning the operator should see that any exposed oil holes are carefully cleared out and enough suitable oil applied to lubricate each bearing.

Oftentimes you will see on an automobile oiling chart, *A*, *B*, and *C* are to be oiled every five hundred miles; *H*, *K*, and *M* once in a thousand miles and by this means the maker of the auto endeavors to educate the owner in maintenance of his purchase. And more than that he specifies the quality of oil he thinks it best to use.

The textile-machine builder would like to furnish a similar chart and specify the grade or quality of oil, but the conditions under which his machines are used are so entirely different that it is not considered feasible.

However, requests for such charts have been received and it may be possible to construct such a chart at some later date.

On many textile machines, you will find ball bearings of various makes and they require considerable attention. First, we would ask why were these particular devices installed? Reducing all the answers to their lowest terms we find three reasons; they reduce bearing friction and save horsepower; they render good service by the saving of oiling troubles; or they were installed because some salesman convinced some one that he had a panacea for most of the ills mechanical devices are troubled with. The first answer is a rather limited one, for while the actual saving of horsepower is in many cases quite an item, the application of ball bearings to a particular revolving body should be considered carefully and the condition of working load examined and charted before any new installations are made.

In almost all cases the machine builder has looked the designing of his machine over pretty carefully before he has sent it out and is a fairly good judge of when and what kind of a friction-reducing bearing can be used to advantage.

Now regarding the second reason, which concerns the lubrication side of the ball-bearing question, any ordinary bearing must be oiled frequently. The installation of a proper ball bearing will in many cases reduce to a considerable extent both the time required to oil and the amount of oil used. The frequent oiling of ordinary bearings oftentimes breeds carelessness, and the surplus oil, conveyed to stock or fabric, produces damaged goods. This can be prevented in a great measure by a careful consideration of the application of a suitable friction or lubricant retaining bearing.

But don't for one moment think your troubles are ended when your ball bearing is installed. A ball bearing allowed to run dry can do as much damage as can any other type of dry-running bearing and perhaps from a financial point of view much more damage. We cannot attempt to tell how often a ball bearing should be repacked with suitable heavy oil or grease. The load under which it runs, the speed of the shaft and type of lubricant retaining washers or felt that is used, all have an influence on this. Three or four times a year may be necessary for one bearing, while another bearing can be allowed to run for six months without injury. But plainly speaking, every bearing must receive attention or your maintenance costs mount upward rapidly.

In the textile industry more than in any other, the ball-bearing salesman seems to have found a large number of gullible customers. Draft rolls on a cotton-brushing machine, approximately $1^{1}/_{2}$ in. in diameter, revolving 60 to 100 turns per minute, have been equipped with expensive self-alignment, self-adjusting, felt-washered, oil-retaining bearings, guaranteed to reduce the horsepower required to run the machine from 30 to 50 per cent. The large percentage of the horsepower required is consumed in drawing the cloth through the machine. The friction load on the bearing is very small and rarely have we seen any noticeable saving in power by such an application. On the other hand we have noticed on some machines ball bearings subjected to a heavy working load that have failed to stand up; due to not understanding the conditions or afraid to ask too high a price for the installation, the salesman had equipped the machines with bearings much too light for the duty required. Hence when in doubt about ball-bearing equipment on an old type of textile machine, ask the maker.

Many machines receive power in some of their parts, through friction clutches, and few mechanical movements have been subjected to so much abuse as have these devices. From a standing position you throw into action from $^{1}/_{2}$ to 10 hp., and expect an immediate response at approximately full speed. Promptness of action is demanded, yet little attention is given to the mechanism that must respond to the demand. The cone, or actuating part, is probably scored by the lever being too tightly pressed against it; as the clutch is handled the starting load is in excess of the best efforts of the friction band. Most clutches are designed to produce a pressure rapidly increasing toward the end of movement, yet the movement is often so rapid that the start is not made until the

---

[1] President, Curtis & Marble Machine Co., Mem. Am.Soc.M.E.

For presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th St., New York, N. Y. All papers are subject to revision.

extreme throw is completed. Through severe use the friction-creating surfaces are roughened so that instead of a gradually increasing friction application, the action is a grip or bite, demanding an immediate response on the part of the standing portion. Every application of the lever increases the roughness and necessitates more serious consideration of the remedy which eventually must be applied.

Give a little attention to the friction creating surfaces, cleaning them from gum or grease, smoothing any irregularities that may have been formed and particularly adjusting the toggle or connecting unit between the cone or actuating part. In fact, see that the clutch, as a whole, is in condition to respond to the call for its services. You are not dealing with a yielding movement like a leather belt, but rather a somewhat rigid device that depends on the frictional contact between two metallic surfaces for the transmission of energy—a splendid device when properly cared for, but usually one of the most abused attachments on any textile machine.

The moment any one says, "Use belting in a textile plant," some one else has his dissenting viewpoint. Every belt has to adjust itself in passing over a pulley, according to its thickness and flexibility. A stiff, thick belt on a small pulley is giving the operator about 60 per cent of the value of the proper belt. An overcrowned pulley of small diameter is another loss of power. Any piece of leather or perhaps canvas is good enough to transmit power, seems to be the idea of some of those in charge of textile plants, and one will find stiff and non-flexible belting being used to transmit power to a series of rollers running at a high speed and equipped with comparatively small pulleys. The result is that the belt will not conform to the arc of the pulley and hardly has time to straighten itself after leaving one curved surface before it must reverse its curvature in going around a second pulley. A pliable single belt of good quality will transmit more power and maintain more uniform speed. Then belts are often put on with little attention to conditions. The leather is stiff, dry and without flexibility and the belts are united by heavy hooks or plates, driven into the leather, with the ends probably not cut off square, so that the joint is irregular. Anything to get the machine started seems to be the policy, and yet every dollar saved by this poor method means several dollars lost in effectiveness of the machine.

Perhaps a final word will suffice about belt hooks, lacing, plates or other means of connecting the ends of belts. The nearer the joint is to the thickness of the belt and the more flexible its character the better.

How many machines are deprived of much of their usefulness by a disregard of the small things which enter into their construction. A thumbscrew may hold some attachment in position; it is lost and a piece of string or frequently a strip of cloth is used in its place. This makeshift is so inadequate that more or less loose motion continually takes place, and due to the resulting constant wear the attachment is soon either discarded or becomes inoperative. A cover is flopping about because some one broke the hinge or tore it from the wood or ironwork. Even a belt shipper is rendered unsafe by the wearing of the retaining section. We find shipper levers retained in place by a stick or block of wood and the discovery of this condition by a safety inspector prevented serious accidents in two cases known to the writer. "A stitch in time saves nine" can be applied to mechanical devices as well as to a pair of trousers.

Have any of you noticed the treatment which bearings receive in different textile plants? A driving shaft of suitable size has been installed on a machine by the maker. It is subjected to some hard usage, runs at a somewhat high speed and is carried in well fitted bearings lined with some anti-friction or babbitt metal. It may have been $1^{15}/_{16}$-in. diam. originally but neglected by the oiler eventually both the shaft and babbitt wear down and you have perhaps a $1^{13}/_{16}$-in. shaft running in an oblong hole 2 in. by $2^{1}/_{8}$ in. The result is a worn shaft wobbling around in a somewhat restricted space. At last the operator or foreman succeeds in calling a mechanic's attention to the condition and when the latter has time he takes out the shaft, removes it to the machine shop, finds it is out of round, turns it over to any odd size, takes off the bearings, knocks out the old babbitt and proceeds to rig up some blocking to rebabbitt. Without taking pains to center the shaft or to line up the bearings, he pours in his metal, chips off the surplus and repeats the operation on the cap to the bearing. He then endeavors to replace the bearing in its old position but not being true in alignment, he either packs up his bearing or the cap with cardboard or paper and finding he can turn the shaft in its revamped housing, goes off contented, "with other worlds to conquer" before him. Now this is not a notion or fiction, but has been found by the writer in more than one case. Let us suggest a plan of procedure. Turn your shaft to some special size, and carefully center the shaft in the bearings while they are in position. Then pack up under the shaft so as not to occupy quite one half of the bearing, pour your bearing, and repeat the operation with the cap, packing up the ears to the cap so as not to have a full half of the shaft in the cap. But remember one thing, the shaft that you use to babbitt the boxes in has been subjected to considerable heat. Take it back to the machine shop, true it up and then scrape your babbitted bearings to this straightened shaft until you have a good running fit. See that you have cut new oil grooves in both box and cap and on leaving your completed job, quietly suggest to the operator that a little more attention to lubrication would assist you indirectly.

Many of the incidents herein cited occurred during several recent visits of the writer to textile mills in the South and perhaps their presentation here will result in lessening the evils and abuses to which textile machinery is frequently subjected.

Hydroelectric Power Development on the Kings River, Cal.

One of the largest hydroelectric power development projects for which the Federal Power Commission has recently granted a license is that to be undertaken by the San Joaquin Light & Power Corporation on the North and West Forks of Kings River, Cal. An ultimate installed capacity of 266,000 hp. is planned, and if the present rate of growth in power consumption in the vicinity of the project continues, it is expected that it will be necessary to make the total capacity available by 1930.

The project, which will involve an estimated expenditure of \$51,000,000, will occupy about 14,000 acres of land in the Sierra and Sequoia National Forests. It will consist of three storage reservoirs designed to provide a combined storage capacity of 204,000 acre-feet; eight diversion dams ranging from 15 to 80 feet in height; and nine conduits of which 34 miles will be tunnel and one mile open ditch. Of the seven power houses planned, two will be built into storage dams and will operate under variable heads, the maxima being 175 and 245 ft., respectively; three will operate under heads of 365, 1420 and 1430 ft., respectively; and two, which will be among the very few plants in the United States operating under heads exceeding 2,000 ft., will operate under heads of 2,350 and 2,380 ft., respectively.

The main construction program is divided into five parts, for each of which the time of commencement and completion has been fixed subject to later modification with the approval of the Federal Power Commission, as follows:

Balch Development No. 1, May, 1922—June, 1924
Haas Plant, April, 1924—June, 1926
Kings River Plant, January, 1926—June, 1927
Balch Development No. 2, April, 1926—June, 1928
Farnham and Meyer Plants, April, 1927—June, 1929

Construction of the remainder of the project will be undertaken when market demands have grown to the extent which will warrant installation of additional capacity.

The developed power will be fed into the company's present transmission system through its substation at Sanger by means of a 110,000-volt transmission line to be built in two parallels, one of which will carry a single 3-phase circuit on wood poles, and the other, two 3-phase circuits on steel towers.

The entire development is covered by the license, but its provisions as to storage do not become effective until the corporation secures from the California department of public works the right to store water for power purposes. It now has the right to use the natural flow of the streams on which its diversion dams are to be built, except of Rancheria and Bear Creeks, tributaries, respectively, of the North and West Forks of the Kings River.

Extraction of Oil From Vegetable Matter

Together With a Description of the Operation of the High-Pressure, Yielding-Plunger Pump

By JOSEPH DAVIDSON,[1] ATLANTA, GA

THE vegetable-oil industry in the United States has grown from practically nothing forty years ago, until today there are about 800 mills in the Southern States, producing oil from cottonseed, and about 100 mills in other parts of the country producing oil from various other oil-bearing materials, such as linseed, corn germs, peanuts, soya beans and copra.

The growth and importance of the vegetable-oil industry in this country may be judged from the facts that the present investment represented by the industry is approximately $200,000,000, and the normal amount of oil now produced annually is approximately 2,500,000,000 lb., requiring the crushing of approximately 5,800,000 tons of seeds and other vegetable oil-bearing material.

The methods and machinery used, while considerably improved, are much the same in principle as they were forty years ago. To some extent the oil has been extracted by the solvent process, in which the mass of ground oil-bearing material is treated with a solvent which dissolves the oil and carries it out of the material; the solvent is then evaporated from the oil and used over again.

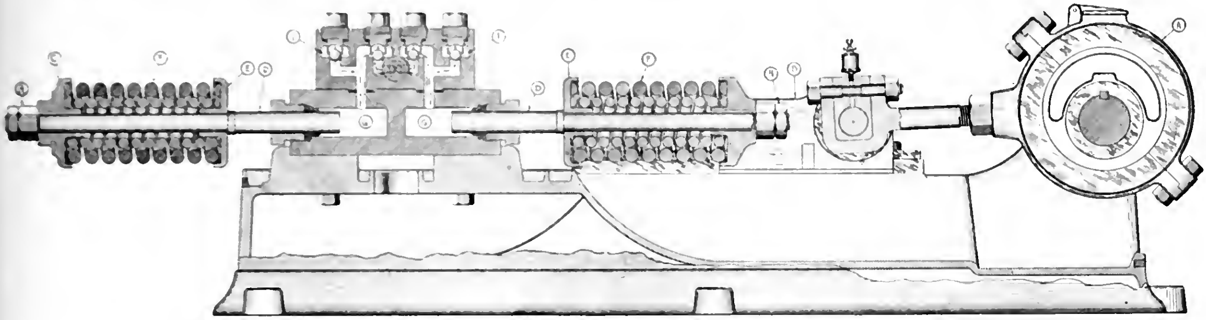


Fig. 1 Longitudinal Section Through High-Pressure Pump with Yielding Plungers

There is also in use to some extent a machine for extracting the oil by forcing the material under great pressure through a slotted barrel by means of a rotating screw.

However, the great majority and the most successful mills are still extracting the oil by hydraulic pressure. In this method the cooked or tempered material is formed into oblong cakes with an outer covering of cloth by a cake-forming machine operated by hydraulic pressure. The oil is forced from the material through the cloth, thence through the perforations and slots of the press boxes, and is collected in a suitable receiving tank. The pressure used against the ram in the press cylinder is 4500 lb. per sq. in., which exerts a pressure of approximately 2000 lb. per sq. in. on the cakes of material being pressed.

It has been found that the manner of applying the pressure has a very important bearing on the efficiency of oil extraction, and also in the economy of the cloth used for covering the cake.

A high-pressure yielding-plunger pump has been designed and put into general use, and has proved to be one of the most decided improvements recently made. This pump applies the pressure in a manner which gives a greater efficiency in oil extraction and saving in press cloth than any yet obtained in the hydraulic method.

A simple low-pressure pump is also used with plungers having a constant stroke, working in connection with a weighted accumulator and by-pass valve, which maintains a pressure of approximately 600 lb. per sq. in. This supplies the pressure in large volume up to 600 lb. per sq. in. on all presses, and also supplies the pressure for operating the machine that forms the material into cakes, preparatory to being put into presses.

Referring to Fig. 1, the eccentric *A* imparts a reciprocating motion to the crosshead *B*. Yoke *C* is connected to crosshead *B* by means of two rods (one on either side, not shown in this figure) and moves fixedly with crosshead *B*. The two plungers *D* are fitted loosely, one in *B* and the other in *C*. Each plunger *D* has a collar *E* fitted against a shoulder. Between these collars *E* and the crosshead *B*, in one case, and the yoke *C* in the other, is placed a double-coil spring *F*, which receives the thrust of the plungers. The initial tension in the springs will stand a pressure of approximately 1800 lb. per sq. in. against the plunger without yielding, but when the pressure in the pump barrels *G* reaches 1800 lb. per sq. in., the springs will begin to yield, and continue to do so, more and more, as the pressure increases. Thus the stroke of the plungers is gradually reduced until the maximum pressure is reached, when they will cease to move; then the maximum pressure is held constant until the extraction of the oil is completed. The pressure is then released, and the cakes discharged from the press, which is then refilled for another pressing operation.

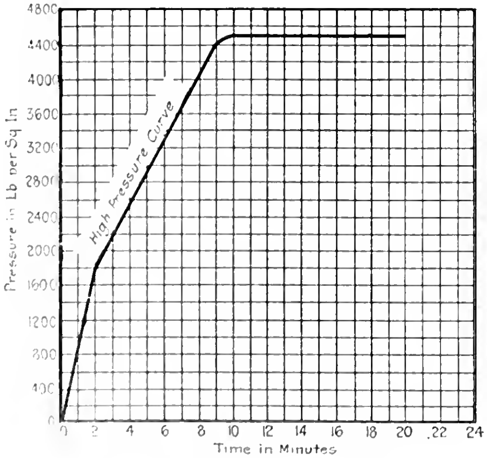


Fig. 2 Diagram Showing Pressure Curve

The pump can be set to maintain any maximum pressure desired, between the limits of 3000 and 5000 lb. per sq. in., by adjusting the nuts *H* on the ends of the plungers *D*. When this adjustment is once made, the plungers will continue to maintain

---

[1] Davidson & Kennedy, Oil Mill Engineers and Manufacturers. Mem. Am.Soc.M.E.

For presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. Copies may be obtained gratis upon request. All papers are subject to revision.

the same maximum pressure for a long period of time, without any further adjustment of these nuts.

Each chamber *I* around the discharge check has a $\frac{1}{2}$-in. discharge connection, and the common practice in applying pressure to vegetable-oil presses is to run a separate and independent $\frac{1}{2}$-in. pipe from each discharge connection to a press. Thus the high pressure on each press is supplied independently by one plunger, the pumps being constructed so as to provide one high-pressure yielding plunger for each press to be served. These $\frac{1}{2}$-in. high-pressure pipes are connected directly to each press cylinder, no valve being required to cut off the pressure. Each press is equipped with an inlet valve for low pressure and a discharge valve; also a check to prevent the high pressure from leaving the press cylinder through the low-pressure inlet valve. When the discharge valve on the press is closed, the high pressure is confined and builds up the pressure to the maximum required. The springs supporting the plungers are then in action, taking up the movement of the crosshead. When the discharge valve is open while the cakes are being discharged and the press boxes refilled, the plungers are moving full stroke and the springs are not being compressed; the volume of liquid being moved by these plungers merely circulates under no pressure through the press cylinder, and out of the open discharge valve, back into the tank supplying the liquid to the suction of pump.

The use of this pump in supplying pressure to the presses used in the vegetable-oil industry obviates the necessity for any outside controlling devices such as safety valves, retarding, or choker valves, etc.

The power required is the minimum for the amount of work being done. The peak load comes when the pressure reaches 1800 to 2000 lb. per sq. in., and while the plungers are still moving full stroke. But from the moment the plungers begin to yield, and the pressure continues to rise until it reaches the maximum, and the plungers cease to move, the power required decreases; so that the maximum pressure is maintained with little more power than is actually necessary to overcome the friction of the moving parts of the machine.

Fig. 2 shows the pressure curve obtained by this pump when the plungers are making 60 strokes per minute.

This constantly and gradually increasing pressure, especially above 1800 lb. per sq. in., secures the maximum oil extraction due to the fact that the density of the material being pressed is increased very slowly. This gives time for the oil to be forced out of the material, with the least possible resistance which would be set up in case the density was increased too suddenly by a rapid rise of pressure.

The minimum wear and tear on the cloth in which the material is folded is also secured, due to the cake's being much less distorted and exerting much less force against the unsupported parts of the cloth than is the case when the pressure is applied too rapidly.

The Southern Worker—His History and Character

How Industrial Life is Affected by the Development of the Cotton-Raising Industry; the Need for Vocational-Training Schools, Industrial Leaders and General Education

By FRANK H. NEELY,[1] ATLANTA, GA.

THE Odyssey of the southern worker is the story of his wanderings brought about by various economic and industrial changes that the South has undergone in the last one hundred or more years. The tale is picturesque in setting, emotional in action, and certainly inspiring in its present denouement.

Scattered loosely over a large territory, we find in the year 1800 many districts whose inhabitants are artisans, come over from England, Scotland, Ireland, Germany and Holland. These people were essentially of a manufacturing turn, and made of the South an industrial country, so much so, that up to 1810 the manufactured products of Virginia, the Carolinas, and Georgia were greater in value and variety than those of all the New England States.

This aspect continued until the invention of the cotton gin in 1793 by Eli Whitney which changed the whole face of the picture. Almost immediately cotton raising proved of such profit that all manufacturing was stopped and the artisan had in reality "lost his job." He was not an agriculturist, but wanted a high wage for a new pursuit which he was not able to control because of different training and lack of sufficient numbers. Cotton raising was so profitable that it behooved the southern planter to acquire all the land and slaves he could, as cotton brought over twenty-five cents per pound during the next forty years. The artisan was forced by this development to move farther back away from the plains, which were highly suitable for cotton raising, toward the mountains, where he formed a social group, with manners and customs of his own. He made now only the articles that he needed for the use of his family, for the slaves were taught all the homely arts that were needed for life on the plantations.

By 1860 these people were thoroughly settled near the foothills of the Blue Ridge where they became small farmers raising some cotton and grain, and carrying on small trades.

The call to arms in 1861 was answered not only by the men, but also by all boys who had reached the age of sixteen. After the four years of struggle, the man power of the South was depleted, plantations devastated and neglected, railroads torn up, bridges wrecked, the whole country, battle-scarred and desolate. Men straggled back to towns that were no more, living was precarious; men were broken in body and spirit, and their land and tools in no condition for the resumption of work.

Among those who formerly were in condition to help the less fortunate there was scarcely any difference, for the whole economic and social structure had been upset by the abolition of slavery.

The emergence from this condition was necessarily slow. The transition from an agricultural country employing slave labor to one semi-agricultural and manufacturing was difficult, and the years 1865 to 1872 were unfruitful in the development of manufacturing establishments.

However, one by one, cotton mills were built, and once more these artisans of the years before slavery came into their own and began to be what they now are, the foundation of the cotton-mill industry.

These first mills, then, and their builders were heralded at that time as the saviours of widows and children, who were largely without means of support, and the editorials of the day lauded the enterprise of these men and looked upon their activities as a godsend to the South and its population.

The Southern Worker

The characteristics of the industrial workers of the South make them at the same time good and bad factory artisans. Living largely in the mountains and by means of their own devices, they have had only such necessities of life as a poorly managed and fertilized farm would yield. Having no educational advantages, they are ignorant, in many cases illiterate; having for generations lived to themselves, they are sometimes unmoral, seldom immoral; but preëminently, because of their ancestry, they are proud. To some extent their word can be depended upon. They have common sense and are generous to a fault, yet their prejudices will sway them at times to unreasonable ends. They are improvident and wasteful, yet understand basic principles of business because of actual experience on their farms, which has taught them that they who do not produce cannot eat. It is easy for them to understand that a business may fail, because many times their crops have failed.

---

[1] Industrial Engr., Fulton Bag and Cotton Mills. Mem. Am.Soc.M.E.

For presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. Copies may be obtained gratis upon request. All papers subject to revision.

They are of a mechanical turn of mind because of the necessity through generations of shoeing their own horses, sharpening their plows, and doing carpentry work around their own homes and those of their neighbors.

When properly approached and when they are not distrustful of their leaders, they are easy to stimulate. From the time when their mode of life dated back to the period when they felt a certain aristocracy due to slavery surroundings, following through to the present day, they developed a sort of cult, and one must understand not only their present conditions, but also the conditions generations back to comprehend fully their frame of mind and overcome their strong prejudices. Their lack of training of hand and mind makes them difficult at first as factory workers, but their knowledge of the English language makes them, *when trained*, a group of the most satisfactory and able artisans.

Every point of leadership must be exerted to encourage the untrained and unlettered worker to exercise the proper effort for accomplishment. Response is not quick, but when once trained, he develops skill and ability, which added to his native *stability*, enables him to outclass in many cases the workers of other sections of the country. Manufacturers of the South have never understood that pride in artisanship is one of the prime moving forces of the southern worker. Moreover his home training has developed his respect for authority; he has lived in a patriarchy, in which the whole family follow the laws laid down by the father.

Eastern Immigrant Labor

When, then, the Southerner comes to work in a factory, he already has that respect for authority which is lacking in the immigrant worker who has come to America only recently; searching, expecting, and demanding freedom from every American institution, national and local, civic and commercial. The newcomer ignores the voices of his parents who have not yet learned our language and our customs, and he totally misunderstands the symbolism of the Statue of Liberty.

Foreign workers in New York, Boston, or Philadelphia, make of the factory a veritable tower of Babel, speaking various languages, unimpressed with the fundamental principle that they who would eat must work, failing to realize that the "tools belong to the hands that can wield them." They cannot be made to see that production is the source of all wealth and that buildings and equipment are of no avail unless properly organized to produce. They cannot be made to understand the parallel between the idle farm and an unproductive factory. Deceived at times by unscrupulous management, they are skeptical and distrusting, so that a satisfactory understanding with them is difficult. They are suspicious of authority, and are continually looking for injustices. Such a frame of mind constantly aggravates actual conditions. The result is an unstable working force, difficult to control. There are continual demands of unreasonable individuals; there are high training costs brought about largely by lack of understanding of the instructions given by English-speaking foremen to the many-languaged workers.

Middle-Western Workers

In St. Louis and New Orleans we find conditions which make for better factory control as there is a stability which is due to the predominance of German and French elements. These people have been in these sections of the country for more than a generation. They have learned confidence in the constituted authority of the Government and therefore in the constituted authority of organization. They can speak the language, and are more energetic and better educated and more intelligent than the southern worker. They take training quickly in particular trades, yet their stickability is somewhat less than that of the Southerner.

The control and operation of plants in widely separated sections of the country present, then, problems of management that involve not only the differences of the men in control, but also present the differences of the individuals and the characteristics that make up the *working force*.

When we were training an army we had discipline born of military necessity. The rapidity of the training depended on the ability to discipline the soldier regardless of his type, or the locality of the training camp, and on enforced uniform methods.

If uniform results are to be secured in factory organizations, certain well-defined methods of control must be practiced. Not having the absolute power of the army, our discipline must be built on leadership, fair play, and the necessities of the plant as a whole. All workers must be judged by their performance, as shown by fair, equitable, and scientifically set standards.

When the Gantt methods began years ago to point the questioning finger at our many organizations throughout the United States, they inspired the campaign for facts, which facts every honest factory manager had to answer sooner or later. The eternal question of why the fall-down, if honestly answered, placed the responsibility upon the managerial control of the plant, and in most all cases showed that the worker was the scapegoat.

Good Management Essential

The answer always lay in planning, scheduling, disciplining, and training. The most important of these elements of good management as we view the many kinds of people in the various parts of the country, is training. It is comparatively easy to plan the work in New York or to schedule a factory's operations in San Francisco, but the accomplishment of such plans and the carrying-out of such schedules is absolutely dependent upon the training, discipline, and control of the organization wherever located.

During the most trying period that the productive forces of industry have ever passed through, our experience has proved that equal results *can* be secured regardless of the locality of the factory or the type of the worker. We further know that such results only come with the proper training and that such training is only possible when all favoritism is eliminated from an organization and well defined principles of discipline are insisted upon among our superintendents.

The South needs training schools to teach all arts. Having been raised through the generations to do things in a crude manner, no artisanship has been taught to the mass. The South needs leaders in the management of every industry. Specific and scientific methods of training and scientific methods of carrying on operations must be developed. The worker cannot train himself—he needs help—he needs instruction, and must have it.

Industrial leaders must be furnished by our technical schools. General education must be made available for the majority, so that the South may take its just place in the industrial world.

American Labor as Viewed by a British Business Man

B. Seebohm Rowntree, a well-known business man and a director of the Industrial Relations Department of the British Munitions Bureau during the war, is of the impression that on the whole an unskilled man emigrating to American today improves his condition. If he is a Britisher his real wages in the new country may not be better than in the old country, but he has a better chance of promotion. An immigrant from Eastern Europe receives more money immediately, and in addition to that has a chance of progress. The skilled worker in America is decidedly better off than a man in similar position in England.

There is more "push," youthful enthusiasm, willingness to take chances in American business than the author found in England. Hand in hand with this goes, however, as he points out, the fact that the American employer is on the whole a better administrator than the English one. He is more alert, more critical of his methods, and quicker to adopt improvements.

The author was particularly impressed by the excellent research work which was being carried on in America, and, as an example, he cites the case of the laboratories of the National Electric Light Association in Cleveland, about which he says that as he came away he felt that no country that is not determined to make the widest possible use of science can long hope to remain in competition with America.

As regards the situation in the labor organizations, the author is a good deal less enthusiastic. He is inclined, however, to blame the employers, who he claims are adopting the same attitude toward the unions as the British employers did 30 or 40 years ago, and, in his opinion, will have to pay for their mistake by years of labor unrest.—*The Century Magazine*, April, 1922, pp. 944–949.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

The Still Engine

THE Still engine which was first described in a paper by Frank B. Ackland before the Royal Society of Arts in May, 1919, is a combination of internal-combustion engine of the high-compression type and a steam engine. It is being developed by the Still Engine Co., London, and its licensee, Scott's Shipbuilding and Engineering Co., Greenock.

Extensive tests have been carried out on this engine—in particular, those lately conducted by Capt. H. Riall Sankey, former president of the Institution of Mechanical Engineers. Besides its main feature of combining an internal-combustion engine and steam engine in which steam generation is a by-product of the main engine operation, in the Still engine steam is utilized for cooling the piston, and as a certain amount of superheat is added to the steam during that process, the efficiency of the steam cycle is thereby improved. Also, by burning oil in the regenerator, steam may be used for starting and maneuvering.

The experimental engine described in the present article, known as the Scott-Still engine, was built to cover a range of power varying from about 700 to 7000 b.hp., and has cylinders 22 in. in diameter and 36 in. stroke. Such an engine running at a speed of 120 r.p.m. was estimated to give a normal brake horsepower of 350 in one cylinder and an overload of about 400 b.hp.

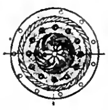


Fig. 1 Combustion-Cylinder Ribbing, Still Engine

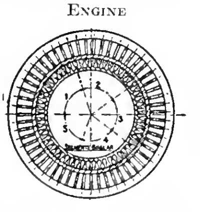


Fig. 2 Piston-Head Ribbing, Still Engine

The crankshaft and the bed plate were designed so as to be suitable for six cylinders of this size in line. As however, it was considered desirable to work the experimental engine on the compound principle on its steam side, so that its working condition might approximate as closely as possible those which will obtain in a multi-cylinder engine on board ship, a small independent single-acting high-pressure steam engine with a cylinder of 14 in. diameter and 22 in. stroke was also constructed and coupled direct to the main-engine crankshaft. The cranks of the two cylinders are arranged at the same angle relative to the dead centers so that the pistons move up and down together. By this arrangement the steam side of the main or combustion cylinder which forms the low-pressure stage is ready to take steam just as the high-pressure cylinder begins to exhaust. The steam side of the main cylinder is 180 deg. of crank angle behind the oil side, so that the engine is double-acting in its operation with this limitation, however, that the power developed on the steam side is considerably less than that developed on the oil side.

Cylinders are provided with liners, which, in this case, are only $^5/_8$ in. thick in the body (see Fig. 1).

The main idea underlying the design of the Still engine liner is the reduction of the temperature differences and consequent heat stresses between its inner and outer walls to the lowest possible minimum, and the provision of ample surface for the rapid transfer of heat to the jacket water. The whole combustion load is taken by the breech end of the liner, and transmitted through the conical joint to the large steel bolts. There is no cylinder cover on the engine in the sense in which a cover is understood in oil-engine practice.

The steam and the exhaust valves, of which there are two and four, respectively, of simple piston type, are carried well on to the cover head to reduce the steam clearance volume to a minimum, and are directly connected to their operators bolted on to the cover flange.

In this connection it should be understood that the combustion and steam cylinders are rarely component parts of the whole with a common piston.

The piston is made in two parts. The skirt calls for no remark, but the head is spirally ribbed internally as shown in Fig. 2, to guide the flow of steam over the crown in as long a path as is reasonably possible. At the same time this formation provides the piston with some degree of flexibility and allows it to adjust itself to temperature conditions without danger of fracturing the ribs. The piston rod is deeply embedded in the piston head with spigot and flange, and the attachment of the two is made by studs and nuts. The piston head is pierced by six holes for the guidance of the steam to the piston head, and is enlarged in diameter at this part to maintain its strength. These holes, acting in conjunction with the steam valves and ports, convey the steam during the admission period into the cylinder by way of the ribbed space on the under side of the piston head, heating the steam and cooling the head, to the manifest advantage of both.

The piston-rod crosshead is of special design. It is well known that the crosshead bearings of most types of Diesel engines are very heavily loaded and frequently give trouble from that cause. In the Still engine, although the load is naturally reduced because of the cycle, the crosshead has been designed to still further reduce the load, and to insure cool and easy working under all conditions. The design adopted admits of the length and diameter of the pin on its underside being available for the downward combustion load. On its upper side the pin is secured to a saddle, which takes the half-bearings for the upward steam load. This saddle is bossed, and provides for the attachment of the complete crosshead to the piston-rod by cotter. In this construction the top and bottom bushes work on different bearing diameters, but these being concentric, no real objection can be taken to the design on this account, and in practice the whole bearing works satisfactorily.

As regards the valve gear when the engine is running, the only valves in operation are the fuel-injection valve on the combustion side and the steam-exhaust valve on the steam side. The former is worked automatically by the fuel,-injection pressure and the latter by oil under pressure. The fuel-injection pump has a solid plunger $1^1/_4$ in. in diameter with a stroke $^1/_3$ in. fitted to the pump barrel without backing. The timing of the fuel injection is fixed by the fuel cam and the period of injection by a spill valve. (The interesting operation of this spill valve is described in the original article.)

The oil-pressure system for operating the steam inlet and exhaust valves is such as to eliminate all layshafts, eccentrics and similar mechanism. Its operation is shown by Figs. 3 and 4 and is, as follows: A simple plunger type of pump worked from the main shaft supplies oil at a pressure of from 350 lb. to 450 lb. per sq. in. to the valves to be operated. The oil passes from the pump through a distributor worked by spiral gearing from the main shaft. Separate distributors are provided for the steam inlet and exhaust valves. These are shown in Fig. 3 at *A* and *B*, and sectionally in *C* and *D*, Fig. 4. The ports are so arranged in the cylinder and piston that once per revolution they register and give an impulse to the column of oil between them and the valves, thus opening the latter. An operator directly connected to each valve is interposed between this volume of oil and the valve, to receive and transmit the impulse. It is under a constant pressure of oil direct from the pump on its upper side, and is subject to an intermittent impulse pressure load on its under side. As soon as the impulse load is released the constant pressure closes the valve. The operator on its under side is of greater area than on its upper side, and this difference gives the upward load required to open the

valve when the ports which are used for operating the steam inlet valves to give a late cut-off when starting up the engine. This exhaust and starting distributor is fitted with a shuttle valve which is set by oil pressure for ahead and astern running. The steam inlet, on the other hand, is provided with a slipping arrangement on the plug coupling for this purpose.

The oil-pressure system is used also for starting up the engine and for maneuvering. During these processes the oil-pressure supply is obtained from an independently driven stand-by pump. The regenerator is a small boiler of 150 lb. working pressure, 5 ft. 6 in. in diameter and with 300 sq. ft. of surface.

In starting from cold the burner under the regenerator is lighted and steam is raised as in an ordinary boiler. The engine may be kept running on steam alone for any desired length of time, or fuel may be cut in as soon as it becomes warmed up, and the engine brought up to the required speed. The cutting of the fuel is accomplished simply and easily by means of the governor or hand-lever control acting on the spill valve above referred to.

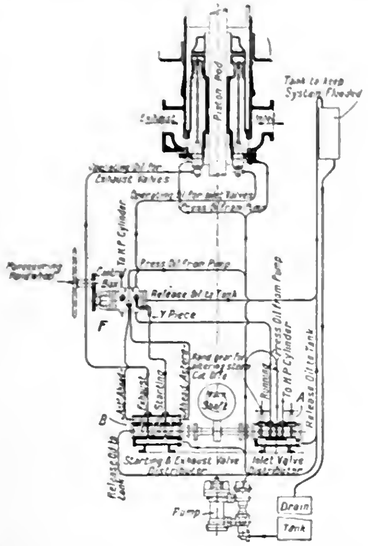


Fig. 3 Diagram of Oil Valve-Control System

Tests were made to determine the weight of steam generated in the experimental unit. The quantity of steam generated from waste heat by the single cylinder is 800 lb. per hr. at 120 lb. pressure per sq. in. when the combustion cylinder is working with about 80 lb. mean pressure equal to a normal load of about 340 b.hp. It increases as the load is increased and falls away as the load is reduced, until at about 35 lb. mean pressure in the combustion cylinder just sufficient heat is being recovered to equalize the radiation losses.

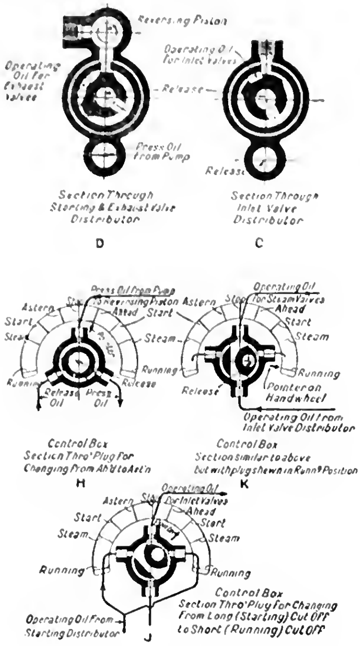


Fig. 4 Diagram of Oil Distributors

The preparation of power obtained from the steam side amounts to about 12 per cent of the total horsepower at full normal load. This applies, however, only to the single-cylinder engine and from 15 to 20 per cent are expected from the multi-cylinder engine. Extremely interesting data of tests are reported in the original article which cannot be abstracted owing to lack of space. (*The Engineer*, vol. 133, nos. 3451 and 3452, Feb. 17 and 24, 1922, pp. 180–182 and 204–207, 20 figs., *deA*)

The Manufacture of Iron and Steel Tubing and Pipe

By EWALD ROEBER

All iron and steel tubing and pipe may be divided into two main classes; viz., A, those with a longitudinal seam, and B, those without a longitudinal seam (seamless tubing).

There are quite a number of processes for making tubing and pipe in each of the two classes. The author considers the various processes, with the exception of cast pipe. Welded pipe is made now practically exclusively out of mild steel and no longer of wrought iron. The most important processes (*Verfahren*) for the manufacture of welded pipe are as follows:

I Butt welding by drawing
II Lap welding by rolling
III Water-gas welding
IV Autogenous gas welding
V Electric welding.

Seamless tubing is made practically exclusively from ingot steel by the following main processes:

VI Cross-rolling and rolling in pilgrim rolls (Mannesmann process)
VIIa Piercing-press and draw-press process (Ehrhardt process)
VIIb Piercing press and draw press for larger sizes
VIII Cross-roll piercing and continuous rolling
IXa Cross-roll (disk) piercing (Stiefel process) and duo-rolls (Swedish rolls)
IXb Press pointing, press piercing and duo rolling
IXc Press piercing (Ehrhardt) and duo rolling
IXd Cross-roll piercing and duo rolling.

In addition to these the following process is used for the manufacture of tubes of large diameter and comparatively short length:

X Press piercing, press drawing and rolling on special rolls.

The processes of manufacture of butt-welded pipe by drawing and lap-welded pipe by rolling (I and II) are the oldest by which pipe has been manufactured.

The material used in making welded pipe comes in the form of skelp, of which the length, width, and thickness correspond to the length, diameter, and wall thickness of the finished pipe. For the manufacture of seamless tubing, the material comes in the form of solid billets of round or rectangular section, those for the smaller sizes being rolled previous to piercing.

In process I of welded-pipe manufacture the skelp goes first to the cold shears where it is beveled on the edges and, to a certain extent, shaped. From the shears it goes to a furnace heated by coal or producer gas and is there brought to a welding heat. The white-hot skelp is gripped by tongs and drawn through a bell-shaped die in which it is simultaneously bent to proper pipe shape and butt-welded. First, before the skelp enters into the bell die the edges are subjected to a blast of compressed air, the purpose of which is to clean them of slag and raise the temperature so as to facilitate the welding. With this arrangement it becomes possible to complete the welding of pipe in one draw, i.e., in one heat. The welded pipes then go to sizing rolls where they are brought to proper dimensions; from these they go to straightening rolls, the purpose of which is indicated by the name, and thus, final shaping of ends and inspection.

In process II, lap-welded pipe, the preheated skelp goes to special rolls where its edges are beveled, and then it is passed on the same heat through the bell die and shaped into a tube. This tube with the edges apart is sent again, while still warm, to the heating furnace where its temperature is raised to welding heat. From the furnace the tube goes to the welding rolls where the actual welding is done. The larger sizes of pipe are bent to tubular shape not in bell dies but in plate-bending machines, from which they likewise go to the reheating furnaces.

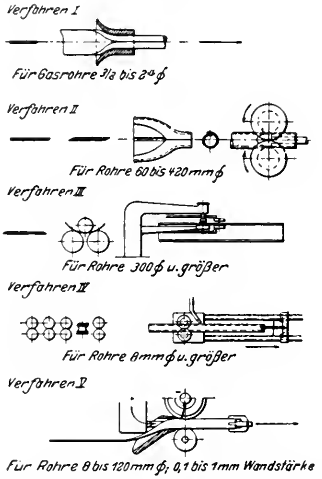


Fig. 1 Various Processes for the Manufacture of Welded Pipe
(For particulars see text.)

To some extent pipe may be made complete in one pass in the weld-heating furnace. As a rule, however, from two to three reheats are necessary. The welding rolls consist of a pair of grooved rolls in which the tubes are rolled over a mandrel which is supported by a long, strong bar. Lap-welded tubes after welding have also to be passed through sizing rolls, straightening rolls, etc., like butt-welded pipe.

In the water-gas welding process of pipe manufacture (process III) only the edges of the skelp are brought to welding heat. The skelp is beveled in beveling machines and then bent to pipe shape on plate-bending machines, this bending being carried out either in the cold or in the hot state, depending on the diameter of the pipe and its wall thickness. The pipe is then brought, spot after spot, to welding heat by a water-gas torch inside and out and welded over an anvil by steam, compressed air, or hand hammer. In some instances hydraulic pressure is employed instead of hammering. This kind of pipe comes out from the welding smooth and even. In processes IV and V (autogenous welding and electric welding), as in the previous process, only the welding edges are heated; in process IV, acetylene or hydrogen are used practically exclusively.

For producing seamless tubing on the Mannesmann cross-rolls and pilgrim rolls (process VI), it is necessary to start with solid round billets. These are preheated in a coal- or producer-gas-fired furnace, pierced on the cross-rolls and drawn out into long tubes on the pilgrim roll stand. In the case of pipes of more than 300 mm. (11.8 in.) diameter it has been so far necessary to put the billet through the cross-rolls twice, although there are new installations in which these tubes can be pierced in one pass. The tubes from the pilgrim roll stand are usually brought to the right size on draw benches or sizing rolls.

In process VIIa, press piercing and press drawing (cupping), square-section billets are used. These billets are preheated in a furnace and then pierced in a press in such a manner, however, that the hollow billet retains a solid bottom. The hollow block is then (on its original heat) put into a long horizontal press and mandrel attached to the press plunger is fixed into the billet which is then forced under pressure through a series of consecutively placed dies, and thus drawn out into a tube. Process VIIb is substantially the same as VIIa, only instead of having the dies in the draw press located consecutively one after another, the billet with the mandrel inside is passed through a single die, then drawn back and the die replaced by a smaller size, after which the process is repeated.

The cross-roll piercing and continuous rolling process (VIII) at the outset is like process VI with solid round billets, which are pierced in the cross-roll stand and on the same heat put over a long mandrel and sent through a set of consecutively located pairs of rolls, of which there may be seven. In processes IXa to IXd, inclusive, various special devices are used for piercing a solid block, but the duo rolls are used in all of them for rolling. For the Stiefel process (IXa) and for process IXd round billets are used, while for processes IXb and IXc square-section billets are preferred. The Stiefel stand is essentially similar to the Mannesmann stand, but is used for producing thinner-walled tubing than the Mannesmann.

In the piercing press of process IXb a mandrel is pushed through to the middle of the billet from both sides after which the billet thus pointed is put on a piercing press and there pierced entirely by a bigger-size mandrel. In the piercing-press operation in process IXc the square-section billets are pierced through by a single mandrel exactly as in processes VIIa and VIIb, but the hole goes clear through and no solid bottom in the billet is left. The hollow billet from the presses in all of these four processes goes to the duo rolls on its own heat. The duo rolls consist of several sets on which the hollow billet is rolled into a tube over a plug. The plug lays here in a groove between the two rolls and is supported by a bar located behind the rolls.

The stand in this roll is from 1.2 to 1.8 m. (47 to 70 in.) wide and contains a number of flat rolls placed side by side.

For some time now the practice has been to send the pipe coming from the duo rolls through finishing rolls to give it a smooth surface and possibly to size up closer the wall thickness. From the finishing rolls the pipe goes through sizing rolls, then straightening rolls, and after passing through anneal, on to inspection. Process X is the well-known Ehrhardt process for making large seamless hollow bodies. Billets are hollowed out in big presses similar in character to those employed in processes VIIa and VIIb, i.e., with solid bottoms (cupping process), and then further drawn in big cupping presses, after which the bottom of the cup is cut off and the hollow billet rolled in a special mill in which there are rolls inside and outside of the billet.

Figs. 1 and 2 show diagrammatically the essential features of the various processes (*Verfahren*) of manufacturing welded and seamless iron and steel tubing and pipe.

In Germany butt-welded pipe is made in sizes of up to 60 mm. (2.36 in.) in diameter and abroad in sizes up to 3 in. The wall thickness varies from 2.5 (0.1 in.) to 4.25 (0.16 in.) mm. for gas pipe, and 2.75 (0.108 in.) to 5 (0.19 in.) mm. for steam pipe. Pipe by this process is made in lengths of 5 to 6 m. (16 to 20 ft.). Lap-welded pipe by process II is not made by welding rolls in sizes less than 60 mm. (2.36 in.) outside diameter. The usual range for such pipe is 60 to 420 mm. (2.3 to 16.5 in.) although abroad such pipe is made in sizes up to 520 mm. (20.4 in.). With this process there is no trouble in making pipe of standard thicknesses for boiler use, and pipes with thinner walls can be also made without trouble. Such pipe is made in lengths up to 7$^1/_2$ m. (25 ft.).

Pipe welded by water gas (process III) is made with diameters

starting from 300 mm. (11.8 in.) and can be made in thicknesses up to 90 mm. (3.5 in.) and lengths up to 8 m. (26 ft.). Gas- (acetylene or hydrogen) welded pipe (process IV) can be made with diameters from 8 mm. (0.3 in.) up to the largest desirable, and in wall thicknesses from 0.5 mm. up to 10 mm. (0.019 up to 0.39 in.). Pipe in sizes from 8 to about 120 mm. in diameter (0.314 to 4.72 in.) and in length up to 9 m. (26 ft.) is made on special automatic machines. Larger sizes of pipe are welded by hand, and in such cases the length of the pipe is practically unlimited. The range of electrically welded pipe is the same as that of gas pipe. It must be noted, however, that its development has not progressed as far as that of the other methods in Germany, and it is only quite recently that methods have become known there for welding such pipe in wall thicknesses under 1 mm. (0.039 in.).

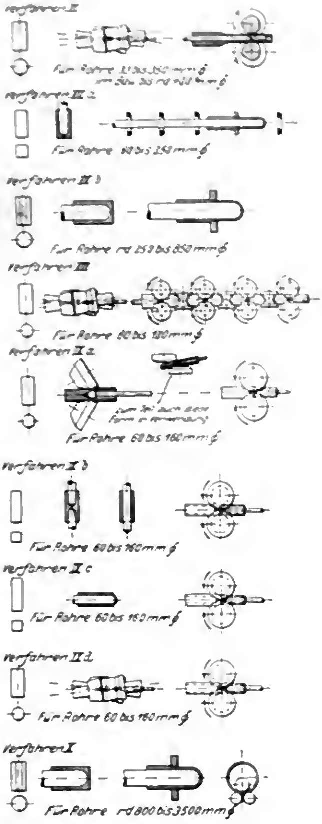


Fig. 2 Various Processes for the Manufacture of Seamless Tubing
(For particulars see text.)

As regards seamless tubing, the Mannesmann cross-roll and pilgrim-roll process (VI) gives pipe from 35 to about 350 mm. (1.3 to 15.7 in.) outside diameter with wall thicknesses of boiler-tube standard as a minimum, i.e., 2¼ to 9 mm. (0.08 to 0.35 in.). This kind of tubing is made chiefly in double lengths of 12 to 15 m. (0.47 to 0.59 in.). Longer tubing, however, can be made by this process.

By the Ehrhardt cupping process (VIIa) the smallest tubes made are 60 mm. outside diameter (2.36 in.) and the largest up to about 250 mm. (10 in.), but pipe with wall thicknesses less than 3 mm. (0.12 in.) have not been made here. Process VIIb is a very modern development. By it pipe is already made with outside diameters up to 850 mm. (33.5 in.) and lengths up to 5½ m. (18 ft.) with wall thicknesses of about 150 mm. (6 in.). Process VIII permits making pipe from 60 mm. to 120 mm. (2.36 to 4.72 in.) diameter and processes IXa to IXd, inclusive, pipe from 60 to 160 mm. (2.36 to 6.3 in.). In all of these processes the wall thicknesses range from about 3 mm. up to 15 mm. (0.11 to 0.59 in.), while the lengths vary from 7 m. to, say, 10 m. (23 to 33 ft.). Process X permits the making of tubular bodies from 800 mm. to 3500 mm. (31.4 to 138 in.) in diameter with wall thicknesses ranging from 10 to about 150 mm. (0.39 to 6 in.). The original article gives a diagram showing these various dimensions.

A comparison of the various processes for the manufacture of seamless tubing shows that for tubing in excess of 160 mm. (6.3 in.) in diameter and in lengths up to 6 m. (20 ft.) the Mannesmann process (VI) and processes VIIa and VIIb may be used, while for lengths in excess of 6 m. (20 ft.) the Mannesmann process alone is available. Tubing with diameters smaller than 60 mm. (2.36 in.) likewise tubing with wall thickness of less than 3 mm. (0.118 in.) have to be finished on hot or cold draw benches. (*Stahl und Eisen*, vol. 42, no. 7, Feb. 16, 1922, pp. 253 to 258, 5 figs., *d*A)

Short Abstracts of the Month

AIR ENGINEERING (See also Internal-Combustion Engines)

BUREAU OF STANDARDS (See Varia)

FUELS AND FIRING

Anthracite Briquetting in Canada

Briquetting Anthracite Fines with Crude-Oil Residuum. Description of the briquetting plant of the Nukol Fuel Company, located at Port Stanley, a few miles from London, Ont., Canada.

The first step in briquetting is to free the raw coal of excessive moisture, which must not exceed about 2 per cent in the final product. In this case this is done by a drier of the single-shell rotating type, 6 ft. in diameter and 40 ft. long. The receiving end projects into a Dutch-oven type of furnace, located directly beneath the wet-coal bin. The coal is delivered to the drier from the bin in a measured flow by means of an apron conveyor and a cast-iron chute passing through the roof of the furnace. The flow of coal is accurately controlled by means of an adjustable gate which permits the regulation of the moisture content. The coal passes through the drier in contact with the hot gases, and when dry is carried away by means of a spiral conveyor and bucket elevator into a bin at the top of the building. Beneath this bin is a pug mill or paddle mixer. The binder is carefully measured in correct proportion to the coal by means of a needle valve, is also introduced by this point. The matter of proportioning is very important. Too little binder results in a weak briquet that will disintegrate on subsequent handling, and too much binder in a soggy briquet produced at an excessive cost. The stirring action of the paddle mixer gives a preliminary mixing to the materials preparatory to fluxing, which is the next step in the operation.

The fluxer is a vertical cylindrical steel tank 40 in. diameter and 6 ft. deep, mounted on a cast-iron base. A shaft within this container carries a series of radial arms and rotates at a uniform speed. Stationary arms attached to the inner surface of the tank project toward the center. The partly mixed material is dropped into the fluxer from the paddle mixer. Here the ingredients are further mixed, or, as it is termed, fluxed, in the presence of steam admitted through openings in the bottom of the tank. This serves to moisten the mixture, or flux, as it is now called, and gives it a peculiar plasticity that facilitates the final mixing, or mastication. The flux is delivered directly into the masticator in a continuous stream, an adjustable gate regulating the flow at a rate synchronized with the delivery of the material into the fluxer.

The next and most important step in the operation of briquet manufacture is the mastication of the flux. The masticator is a ponderous Chilean mill, or *arrastre*. It consists of a heavy cast-iron bed securely bolted to a massive concrete foundation, two A-shaped standards mounted on the bed carrying the steel framework that supports the drive gearing and two huge cast-iron rolls, each weighing several tons, arranged to chase around the bed at eighteen turns per minute. The flux is fed in at the outer edge of

the bed and is gradually moved over by a series of adjustable plows to the center, where it is discharged.

Meanwhile the heavy rolls repeatedly passing over the fluxed material grind and masticate it to such an extent that the coal and binder are intimately mixed. In fact, the binder is literally ground into the coal, and the material has been changed into a practically homogeneous mass.

Under the masticator is a conveying device similar in design to the paddle mixer. This receives the masticated flux, reduces any caking, and delivers the material to a bucket elevator that carries it to the press, where the briquets are formed under a pressure of 3000 to 4000 lb. per sq. in.

Dropping from the press, the briquet fall directly into a bucket elevator which carries them to a rotating cylindrical screen. The peculiar shape and arrangement of the molds cause a small quantity of material to adhere to each briquet in the shape of a rough edge or fin. The tumbling action of the screen removes this material, and also eliminates occasional weak or imperfect briquets. This waste is returned directly to the masticator to be reworked.

Material to be briquetted passes through the press in a heated state, usually at 125 to 140 deg. fahr., and though the briquets at this temperature are strong enough to withstand the action of the elevator and screen, they are still so plastic that they would crush under the imposed weight of piling in a car or bin. It is necessary therefore that they be thoroughly cooled.

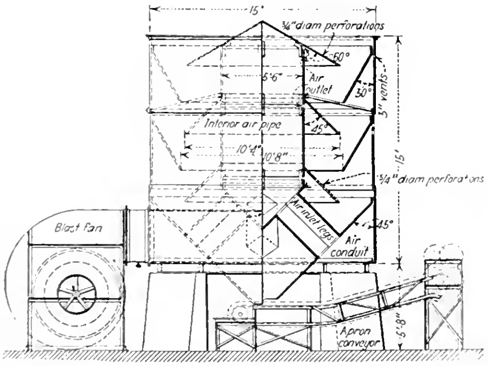


Fig. 1 Device for Cooling and Hardening Briquets

Instead of the usual water cooling of the briquets, air cooling is used. The air cooler, Fig. 1, is a vertical steel tank 15 ft. in diameter and 15 ft. deep, mounted on a concrete base. Extending through the center of the tank is an interior tower, or pipe of large diameter, which serves to conduct and distribute the cooling air.

Forming the top of the inner pipe and extending beyond its periphery, is a cone of projected area about half the area of the main tank. In order to give the briquets an inclined descent, and at the same time break up the mass into sections of small area, keeping the individual briquets in motion relatively to each other, a series of plates, or cones, are provided, so arranged that the briquets pass over first one and then the other as they move downward through the apparatus. These deflecting plates are placed alternately on the interior pipe and the exterior casing.

A funnel-shaped plate, attached to the exterior casing about 3 ft. from its lower edge and converging in the center with an opening for discharging the briquets, forms the bottom of the tank. The interior pipe is supported from this plate by four hollow legs. The annular space beneath the bottom plate is sealed and serves as a conduit for the air.

The required volume of air for cooling is supplied by a large fan connected to this annular conduit. From this chamber the air goes through the hollow legs into the interior pipe. A series of gaps, or openings, allow it to escape at points beneath the interior deflecting plates. These are perforated with many small holes, so that the air passes directly through the mass of briquets, absorbing their heat and finally escaping through vents in the outer casing to the atmosphere. The fan develops a pressure of about 1 oz. per sq. in. and maintains a constant circulation of air throughout the entire tank.

The briquets are received at the center of the cone top. In operation the tank is kept full, the discharge being controlled in accord with the input. The tank will hold fifteen tons, or an hour's output of the plant, and the briquets will thus be subjected to the cooling action of the air for this same period.

It is said that conditions in the coal trade in middle-eastern Canada are such as to favor the development of the anthracite briquet industry. (*Coal Age*, vol. 21, no. 10, Mar. 9, 1922, pp. 403–406, 2 figs., *d*)

HEATING AND VENTILATION

Mechanical Utilization of Energy Content in Steam at very Low Pressures as a Means of Improvement of Efficiency of Central-Heating Stations, Andre Nessi. The author discusses various types of heating such as hot-water and hot-air, and the methods of utilizing the mechanical energy content in the steam at very low pressures, which is a by-product of these installations. The article is essentially descriptive, and therefore not suitable for abstracting, notwithstanding its interest. The conclusion of the author is that in large heating units it is advisable to install machinery for utilizing the residue energy in the steam, providing, however, the operation of such machinery is continuous and automatic. The machinery can be so designed, as he shows, as not to entail any extra demand on the personnel operating the heating plant. (*Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, vol. 133, no. 10, Dec., 1921, pp. 1322–1363, 31 figs., *dd*)

Reversed Heat Engine for Heating Purposes

The Reversed Heat Engine as a Means of Heating Buildings, P. B. Morley. In 1852 Lord Kelvin pointed out that in heating a building by the burning of oil one may employ an indirect process comprising a heat engine and "warming machine" driven by the engine, by means of which the heat delivered to the building might be much greater than heat of combustion of the coal consumed. In other words, the system, considered merely from the point of view of coal consumption, would work at an efficiency better than 100 per cent. The author states that he is not aware that this proposal has ever been put into practice and discusses the theoretical possibilities and the nature of the difficulties to be overcome in its application.

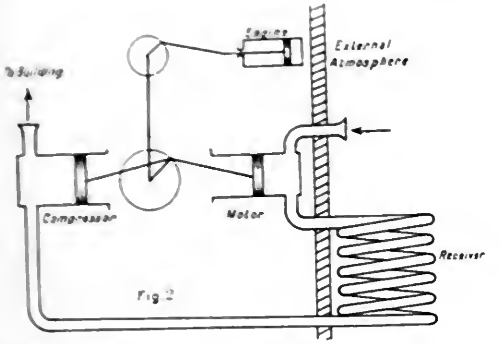
It being desired to pass into a building a supply of heated air, it is convenient that the air to be heated be itself the working substance in a reversed heat engine or warming machine. The machine would have two cylinders, which Lord Kelvin called "ingress" and "egress" cylinders. We shall refer to them as "motor" and "compressor," since the air does work in the former while work is spent on compressing in the latter. The cycle of operations would be as follows: Air from the external atmosphere would be admitted into the motor cylinder for part of the stroke, the inlet valve would then close and for the remainder of the stroke the air would expand, falling in pressure. The drop in temperature during the expansion would be reduced as much as possible by making the motor cylinder of highly conducting material with a large surface for heat transmission. On the return stroke the air would be discharged into a receiver, also designed to encourage heat transmission and having its external surface exposed to the external atmosphere or, better still, to a stream of water. The intention, in fact, is to obtain as nearly as possible isothermal expansion and to obtain in the receiver air at a pressure below that of the atmosphere and as little below the outside air temperature as possible. The receiver might well take the form of a coil of pipes as shown diagrammatically in Fig. 2. As the object is to obtain warm air finally, the warmer the air is in the receiver the better, provided the receiver temperature is not obtained by the expenditure of fuel or energy.

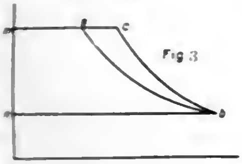
The low-pressure air would then be passed into the compressor cylinder and would be compressed therein till atmospheric pressure was again reached, the operation this time being adiabatic. The temperature at the end of compression would then be a maximum, and this heated air would finally be delivered into the building.

Fig. 2 shows diagrammatically the arrangement of the apparatus. The work spent on the air in the compressor would exceed the work done by it in the motor cylinder, the difference being supplied by an independent engine, water motor or electric motor.

The indicator diagrams for the process would be as shown in Fig. 3 or Fig. 4. In Fig. 3 it is assumed that the expansion is isothermal; the motor diagram is *mabn* and that of the compressor *abcm*. Fig. 3 is for the more likely case in which the expansion *ad* is not isothermal, but in which the original temperature is regained in the receiver, the air therefore increasing in volume in the receiver from *nd* to *nb*. The point *b* corresponds to *b* in Fig. 3, and the compressor diagram *abcm* is the same as before.

Lord Kelvin took as an example the heating of air from an external atmospheric temperature of 50 deg. fahr. to a final temperature of 80 deg. fahr. and calculated that by means of an ideal machine 1 lb. of air would be delivered per second with an expenditure of 0.283 hp. for driving purposes. The heat equivalent of this power is 0.2 B.t.u. per sec. The heat required to warm 1 lb. of air from 50 deg. to 80 deg. fahr. is about 7 B.t.u., so that the heat given to the air would be thirty-five times the heat equivalent of the work spent.





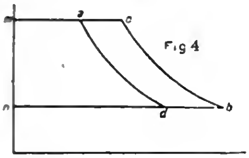


Fig. 2 Diagram of the Reversed Heat Engine

Fig. 3 Indicator Diagram of Reversed Heat Engine under Assumption that Expansion Is Isothermal

Fig. 4 Indicator Diagram of Reversed Heat Engine under Assumption that Expansion Is Not Isothermal

As a means of supplying the driving power, Lord Kelvin contemplated a steam engine capable of converting into work one-tenth of the heat generated by the combustion of coal, so that the effect of the whole combination would be that the heat imparted to the air would be 3.5 times the calorific value of the fuel. A modern steam plant of the best type, has, of course, a much higher overall efficiency than one-tenth, amounting to 16 to 17 per cent of even higher in especially good power stations, and internal-combustion engines have a still higher efficiency. Thus, after allowing for losses of power and heat in the warming machine arising from friction and imperfect heat transference, it would appear probable that, by the method described, useful heating effect in the warming of air could actually be obtained with the expenditure of much less fuel than would be required to obtain the same effect by direct heating, even with the absolute elimination of the losses. Though at first sight this result is paradoxical, further consideration will show that it is in no way in conflict with the laws of thermodynamics nor, of course, therefore, with the law of the conservation of energy. (*The Engineer*, vol. 133, no. 3450, Feb. 10, 1922, pp. 145–146, 3 figs., *tm*. In this connection attention may be called to the paper presented by A. Altenkirch at the International Congress of Pefrigeration in New York and Chicago, 1913 [Cp. *Eis- und Kaelte-Industrie*, vol. 6, no. 2, August, 1913, pp. 29–34], where an installation based on the same principles of operation was described and it was stated that several such units have been actually installed and put in operation on the continent of Europe.)

HYDRAULIC ENGINEERING (See Machine Design and Parts)

INTERNAL-COMBUSTION ENGINES

Flow of Gas into a Cylinder, A. Johnson. The article here abstracted deals with flow of air into a cylinder of an internal-combustion engine during operation. Under the circumstances adiabatic flow is out of the question and the air flowing into a hot cylinder is likely rather to gain than lose temperature. As a useful compromise it may be assumed that the temperature of the gas does not alter, so that PV is constant.

From a mathematical consideration of the subject the author arrives at the conclusion that, reckoned by weight, the rate at which air enters a cylinder (assuming no change of temperature) is greatest when the pressure inside the cylinder is little more than half the atmospheric pressure, or, to be accurate, that it would be so if the pressure within the cylinder were the same at all points, a condition inconsistent with the motion of the entering air but one which the author is compelled to assume for the purpose of approximate calculation.

From the point of view of the internal-combustion engineer dealing with an engine making many strokes in a second, the question of greatest interest is in what time he may expect his cylinder to fill, or what will be the density of the gas which it contains at the end of a given time.

This is again treated mathematically and the author arrives at the expression:

$$t = \frac{2}{R}\sqrt{\log p_0 - \log p_1}$$

where t is the time of filling the vessel completely; p_1 is the original pressure; p_0 final pressure, or the pressure in the cylinder when completely filled; and R in this case is a constant depending, however, on p_0. The author shows that under certain limiting conditions, expansion from $p = 15$ to $p = 3$ is about the range which permits the gas to flow in a stream of constant area. The remainder of the article, while of considerable interest, is not suitable for abstracting. (*The Automobile Engineer*, vol. 12, no. 160, Feb., 1922, pp. 41–43, 7 figs., *t*)

MACHINE DESIGN AND PARTS

Hydraulic-Power Transmission Gears, H. M. Sabine. In England, variable-speed hydraulic pumps and transmission gears have been found to be suitable for heavy-gun training, steering gears, winches, heavy-machine-tool and textile-machinery drives, rotary furnaces and tube mills, etc. The Williams and Janney gear has been chiefly applied as a transmission gear. The Carey and Hele-Shaw types have so far been chiefly employed as variable-delivery pumps, the latter system having, however, been applied also for transmission gearing. A hydraulic-transmission gear will also act as a clutch or brake.

What is wanted, and what certain of these transmission gears are being developed for, is a variable-speed pump, with a high speed of from 1000 to 1500 r.p.m., or even greater, and capable at this speed of delivering oil up to 1000 to 1500 lb. per sq. in., and about 4000 lb. per sq. in. pressure or more at about a quarter full speed. Overload pressures of 2500 lb. per sq. in. have been maintained already at slow speeds, and are being announced in the advertisements of the Carey and Hele-Shaw pumps and transmission gears. A Carey pump has actually worked at over 4000 lb. per sq. in. oil pressure for two hours on test, and as regards speed, 1000 r.p.m. is by no means too high a speed for certain medium-size pumps of the Carey type.

A great gain in efficiency will naturally ensue with the transmission gear or pump designed to run with air-filled case, owing to the elimination of the stirring losses which increase rapidly as the speed increases and which constitute the chief initial loss in

these machines. The temperature would be lessened, and therefore the oil would not get so thin, consequently the decreased leakage past the pistons and valve faces would result in greater efficiency. Further, the weight of the gear in working order would be less—a great consideration in automobile work—also the speed could be considerably increased.

An outline of some of the possibilities of variable-speed pumps and transmission gears, is followed by mention of some of their limitations. Transmission applications are classified under the following standard cases: (1) constant horsepower, with variable torque and speed; (2) constant torque, with variable horsepower and speed; (3) constant speed, with variable horsepower and torque. When dealing with inquiries from engineering and other manufacturing concerns, the author was frequently surprised at the apparent lack of knowledge regarding horsepower and power transmission. For instance, a firm would ask a quotation for a gear to transmit 10 hp. and to run between 500 and 20 r.p.m. If constant horsepower was required, the torque at 20 r.p.m. would necessitate using an extremely large pump, or alternately, an additional spur or worm reduction gear between the pump and the driven machine. Upon further inquiry, it would often happen that the full horsepower was not required at the slower speed. Again, a firm would ask for a gear to transmit, say, 50 hp. with a 5 to 1 speed range, and omit to give the maximum or minimum speeds, which, of course, would make all the difference in the size of the gear suitable. Many manufacturers seem quite unable to give the maximum and minimum torques together with the corresponding revolutions per minute for the machines they make. Sometimes a full questionnaire would have to be sent to a firm to get it to state particulars correctly.

The author gives a list of particulars required for designing a transmission set, and points out that usually the most important point is the torque range during which constant horsepower is being transmitted.

It is the maximum oil pressure which determines the torque or speed range, and the length of time the machine would be required to work at a maximum torque will determine the size to be employed. (*The Practical Engineer*, vol. 65, no. 1828, Mar. 9, 1922, pp. 151–154, 3 figs., to be continued, *dp*)

MACHINE TOOLS

Worm-Gear Generator

British Worm-Gear Generator. The generator described in the original article is suitable either for the accurate production of single wheels with a fly cutter or for the manufacture of gears on intensive lines by the use of hobs. The machine is of the tangent-feed type, with a special mechanism to impart an added movement to the wheel blank corresponding at the pitch line exactly with the tangential traverse of the cutter. This movement is obtained without the use of change gears, eliminating complicated calculations and difficulties in setting up.

Fig. 5 is a transverse section through the generating mechanism to illustrate the principles of action. The worm *A* which drives the work spindle *B* is supported between bearings on a slide parallel to the slide for the cutter arbor. The driving worm is of exceptional length, and it is possible to rotate the work spindle by an axial movement of the worm, in addition to the regular motion which is obtained by the rotation of the worm shaft. For this purpose the substantial lever segment *C* pivoted on a large vertical pin *D* is provided with radial slots having slide blocks which operate the respective slides.

To obtain the correct relative motion between the cutter slide and the wheel blank, it is then only necessary to make the distance from the center of the pivot for the lever segment to the lower sliding block equal to the pitch-line radius of the driving worm wheel for the work spindle, while the distance from the center of the pivot to the center of the upper sliding block is made equal to the pitch-line radius of the worm wheel to be cut. Further, by the provision of special measuring faces, this setting may be made accurately without difficulty, so that the arrangement for obtaining the correct relative movements between the cutter and the work may be said to represent a distinct advance on the previous methods employed.

The measuring faces for this purpose may be seen at *F*, in Fig. 5, and the method of adjusting simultaneously to the correct position will be clear when it is observed that the cutter slide is mounted on a second transverse slide, which is actuated by means of two guide screws through the medium of a hand-operated shaft and spiral gears. It should also be mentioned that the faces of the measuring blocks are a known distance apart when the pitch line radius of the hob is zero, so that the required distance may always be obtained by subtracting half the pitch diameter of the worm from the fixed distance given by the makers. This enables measuring rods or plug gages to be employed for setting purposes, a method which is calculated to give the greatest degree of accuracy with an unskilled or semi-skilled operator.

A simple form of gage is also fitted for setting fly cutters, the gage being shown above the cutter in Fig. 5. Briefly, it consists of a small bracket located against a suitable face on the slide, and carrying a sliding rod having a collar at the upper end. The length of the rod is then made equal to the distance between the upper face of the bracket and the center, so that the distance from the lower end of gaging point of the rod to the center of the cutter spindle is exactly equal to the distance between the face of the gage block and the collar on the rod. By this means, the correct setting of a fly cutter may be obtained readily by employing a plug gage equal in width to half the outside diameter of the hob represented by the fly cutter. The gage rod may then be clamped in position, so that, although the bracket is removed after setting the cutter, any future settings may be made with the minimum of trouble.

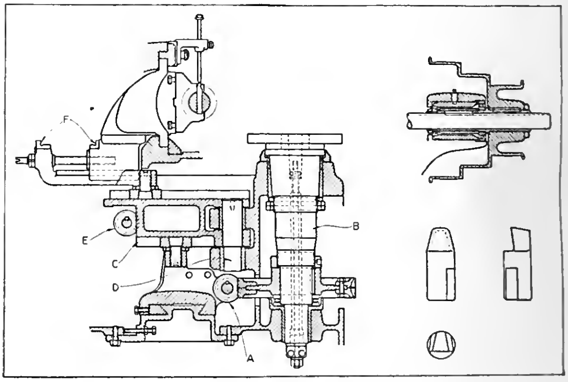


Fig. 5 Worm-Gear Generator

The method of mounting the fly cutter in the arbor also possesses features of interest, and as in the case of other setting operations the object has been to minimize the time required for setting. From the lower right-hand figures in Fig. 5, it may be seen that the cutter is formed out of cylindrical stock, the end being shaped to the normal section of the worm thread, while the shank is cut away at one side, as shown, to simplify the location of the cutter at the correct spiral angle of the arbor. Clamping may then be effected by means of an axial set screw passing through the cutter arbor, and bearing against the flat on the tool. This arrangement has the advantage that the stress on the arbor is central, so that there is no tendency to distortion, as is often the case when cutters or wedges are used for clamping purposes.

Regarding the drive for the tangential feed motion, the worm shaft is extended to a large capstan wheel, and this wheel in turn is frictionally driven from a worm wheel to which power is transmitted through the medium of a feed reverse and change box at the rear of the machine. This feed box provides for twenty feed changes, covering a range of more than 140 to 1. The trip mechanism is of the instantaneous type, the clutch being released in approximately one-eight of a revolution. Notwithstanding the fact that the worm slide which operates the trip mechanism may have a very slow movement. (*Engineering Production*, vol. 4, no. 73, Feb. 23, 1922, pp. 187–188, 4 figs., *d*)

A New British Chucking Machine

An Improved Automatic Chucking Machine. Description of a machine developed in England for work on intricate pieces. The machine, called the "Victor," is intended particularly to be used on locomotive-piston work. It is said also that it will handle all kinds of taper work and bevel-gear work without extra fixtures. In railway shops it may also be used for work on split rings, valve heads, valve followers, bull rings, piston-rod glands, valve-spindle glands, piston-valve covers, main-cylinder covers, eccentric liners, etc.

All automatic changes in this machine are actuated through positive-action friction clutches, and are obtained by the very simple mean of setting dogs on drums immediately under the headstock. The clutches adjust themselves automatically to the load, and require no attention whatever. The main spindle is of large diameter, fitted with ball thrust washers and supported by two substantial phosphor-bronze adjustable bearings. It is arranged to stop automatically before the withdrawal of any cutting tool, and to take up the drive again when the next tool is brought forward for cutting. The turret has four operative faces, and is fitted to the saddle on two coned surfaces. The locating ring is of larger diameter than the turret, the indexing plunger working between adjustable wedges. After locating, the turret is locked to the saddle by a central bolt and locking plate, the turning, locating and locking, all being performed automatically at a high constant speed, the turret and saddle being then securely locked. It is claimed that rigidity, together with absolute alignment, is secured by this arrangement.

Two independent cross-slides are provided, the top slides swivelling to any angle. Both cross-slides have longitudinal and cross automatic movement actuated by the saddle traverse, angular cuts being obtained in like manner. Adjustable micrometer stops are provided for all cross-slide movements, insuring great accuracy. Each cross-slide can be set to have a combined cross, or angular and longitudinal movement, thus enabling a tool to be fed up to its work against a transverse stop and then traversed longitudinally, or vice versa. Each cross-slide can be operated with any face of turret. Provision is made for profiling in conjunction with both cross and longitudinal traverse.

The feed is transmitted from the main spindle through a safety clutch and five-speed gear box to the cam drum shaft, the feed changes being operated by adjustable dogs attached to the change-feed drum. The quick motion of the saddle is taken from the first-motion shaft, which is fitted with a safety clutch, and runs at a constant speed independent of the spindle or feed changes. It is actuated by means of a trip lever, instantaneous in action, the movements from slow to fast or vice versa being operated within $^1/_4$ in. of saddle movement. A conveniently actuated hand motion to saddle and cross-slides is provided, and, by means of a hand lever, all cam gearings can be thrown out of action, leaving only the main spindle operative for chucking purposes. (*The Railway Gazette*, vol. 36, no. 9, Mar. 3, 1922, pp. 351–352, 2 figs., *d*)

PHYSICS

Velocity of Sound in Air and Hydrogen at 0 Deg. Cent. and 1 Atmos. Pressure, E. Grueneisen and E. Merkel. The subject is of considerable interest because velocity of sound appears in equations dealing with the design of steam and internal-combustion engines; in particular, in connection with the subject of critical velocity of flow of gases through nozzles. The authors carried out the measurements in connection with their investigation of velocity of sound in partially dissociated gases, and the present paper covers measurements on dry air free of carbon dioxide, and on pure hydrogen. The method of measurement is of the kind suggested by Thiesen; viz., with a closed resinator. The paper deals chiefly with the methods of measurements and the various precautions for eliminating sources of error. The final value the writers derive is that the velocity of sound in dry air, free of carbon dioxide at 0 deg. cent. and atmospheric pressure, is 331.57 m. per sec., and in pure hydrogen 1260.6 m. per sec. (*Annalen der Physik*, vol. 66, series 4, no. 5, 1921, no. 21, pp. 344–364, 4 figs., *eA*)

POWER PLANTS (See also Steam Engineering)

The Ruths Steam Accumulator

The Ruths Steam Accumulator, G. Schulz. All steam accumulators, of which there are a good many, are designed for the purpose of saving fuel by enabling the boiler to operate at its most economical load without (within certain limits) being affected by the demand at the prime-mover end. Thus, in an electrical plant the boiler would operate at its most economical load no matter whether the electrical load were near its peak or at a minimum. It is said that the Ruths accumulator successfully accomplishes this purpose.

The essential novelty in the Ruths accumulator is not the accumulator vessel itself but its connections: viz., the fact that it is inserted between the boiler room and the steam piping. The accumulator itself, Fig. 6, is merely a large boiler of simple design filled with water to about 90 per cent of its capacity. The steam enters through valves X_1, Y_1 into the distributing manifold Z and passes therefrom through nozzles P. These nozzles act like jet pumps, and their purpose is to produce a rapid and intimate mixture between the steam and the water. The exit of the steam takes place through nozzle F, shaped like a DeLaval nozzle. With this type of nozzle the steam flow is, up to a certain degree, independent of the back pressure. The nozzle permits the passage of only a limited amount of steam, and acts as a kind of safety valve in case of a rupture of a pipe. On one of the front walls of the accumulator is to be found a water level indicator W properly calibrated and intended to be used for maintaining the water level in the accumulator at a predetermined height. In actual practice it was found that it is only seldom necessary to add fresh water. The vessel is well insulated so that, practically, the heat losses therefrom need not be considered.

As stated above there is nothing strikingly new in the construc-

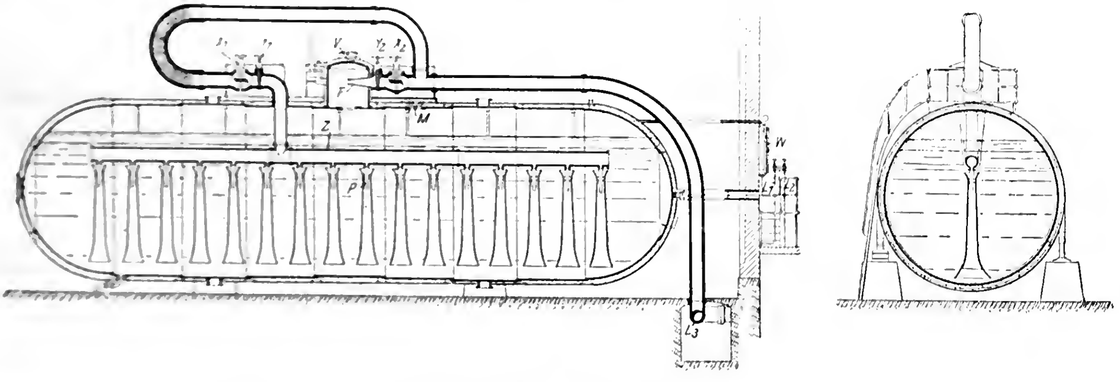


Fig. 6 Ruths Steam Accumulator

tion. What is new is the fact that the accumulator with its great content of water is so connected in the system that pressure variations of several atmospheres may be permitted in the steam piping. Furthermore, the operating range is set chiefly into the region of low pressures, which reduces the initial cost of the installation and increases the ability of the accumulator to handle large amounts of steam.

In the original article is given a curve showing the relation between the steam absorption of an accumulator and the various steam pressures. From this curve it appears that the steam given up by a cubic meter of water at a pressure drop of 1 kg. per sq. cm. varies for different pressures quite materially. For example, at 20 atmos. 5 kg. of steam are given up, but at 3 atmos. more than 20 kg. of steam are given up, which would indicate that the steam-absorption capacity of an accumulator rapidly increases with the lowering of the level pressures.

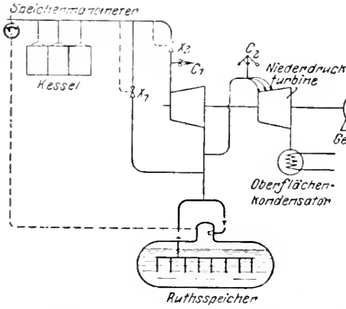


Fig. 7 Diagram of Connections for a Steam-Driven Central Station with a Ruths Accumulator

In the original article, reference is made to tests by Professor Josse showing the great advantage obtained with uniform demand on the boiler as compared to a variable demand, which is of interest as the aim of the Ruths accumulator is to create such a uniform demand. Furthermore, the original article shows several schemes of using the Ruths accumulator, for example, in connection with a central station or an electric plant operating in a blast-furnace plant.

One of these connections for use in a central station taking care of such a load as a city load is shown in Fig. 7. The figure is to a certain extent self-explanatory, though the following may be mentioned in connection with the operation of the plant. The stoking of the boiler is carried on at a uniform rate, and but little attention is paid to the manometer on the boilers.

If the boiler pressure exceeds a certain amount, the valve X_2 opens up and the steam flows to the high-pressure turbine, being further divided according to the position of the governor C_2 between the low-pressure turbine and the steam accumulator. If the boiler pressure goes down, the valve X_2 begins to close and less steam goes to the high-pressure turbine. As the speed of rotation of the turbine falls off the governor C_2 opens the main valve and the accumulator begins to give up steam, the low-pressure turbine taking up the load which has been taken off the high-pressure turbine. With such an arrangement, the pressure head on the steam is completely utilized with the exception of the liquid head on the accumulator which amount to about 0.1 atmos. and for practical purposes may be neglected. The bypass with valve X_1 permits the steam to go directly to the accumulator. This valve opens only, however, when X_2 is wide open, i.e., at very low loads, and the purpose of it is to send the steam to the accumulator where it may do some good instead of letting it into the atmosphere through the safety valve.

The only instrument in the boiler house shown on the figure is the accumulator manometer. If the accumulator pressure becomes either too high or too low, the fireman has to manipulate the dampers. With properly dimensioned accumulators, however, this would happen only very seldom under regular conditions of operation. (Paper before the Machinery Board of the Verein deutscher Eisenhuettenleute, abstracted through *Stahl und Eisen*, vol. 42, no. 5, Feb. 2, 1922, pp. 165-171, 9 figs., *dA*)

RAILROAD ENGINEERING (See also Machine Tools)

Hungarian Locomotives and Their Auxiliaries

Locomotives for Hungarian State Railways, Desider Ledacs Kiss. To meet local conditions the Hungarian State Railways adopted for their new locomotives a type with two simple cylinders in place of the four-cylinder compound arrangement, but provided the locomotives with several specialties.

Because of the scarcity of copper, the locomotives constructed soon after the armistice were equipped with boilers of the Brotan type. These boilers are provided with a water-tube firebox, though the boiler shell immediately in advance of the firebox tube plate is cylindrical instead of conical, which is a departure from the standard Brotan type. The firebox is placed above the last coupled wheels and is much wider than the frame. In order to protect the last pair of driving wheels from the radiant heat of the burning coal immediately above the wheels, protector plates were applied. Further, to avoid dead grate surfaces, it was found necessary to have built upon them a sort of multi-stage grate. The forward part of the firebox has a drop grate. There is also in the firebox a semi-automatic smoke consumer, operating on the principle of introducing air through four passages in the brick arch above the grate.

To provide for the circulation of water, the firebox ring of the Brotan-type boiler is connected with the last shell of the boiler barrel. The steam dome containing the balanced slide valve for throttling the steam is located on the first course of the boiler. Over the second course is located a feedwater purifier with eight cells, which has been applied to 3000 locomotives on the Hungarian System.

The locomotive equipment includes also a centrifugal water-intercepting device, or steam desaturator, placed in the dome; also several other specialties, such as a speed recorder, acetylene cab lamps, a feedwater-heating system, etc. The flanges of the forward driving wheels are lubricated by the condensation water from a feedwater pump included in the feedwater-heating system. This system (Knorr) consists of two preheating cylinders, one located on the right-hand side, and the other on the left-hand side of the locomotive. These are connected and serve for preheating the feedwater by the exhaust steam diverted from the exhaust passages of the locomotive. Experience on the Hungarian State Railways has proved that if one-fifth of the exhaust steam from the locomotive cylinders is diverted to the feedwater heater, it will have no appreciable effect on the draft of the locomotive. The exhaust steam is conducted separately into the preheating cylinders located on both sides of the locomotive. In addition to this, the right-hand heater received exhaust steam from the Westinghouse air compressor, and the left-hand heater receives the exhaust steam from the Knorr feedwater pump. The partially-condensed steam from these preheaters is drained underneath the boiler.

The feeding of the boiler is accomplished by the single Knorr feedwater pump and the two Friedman injectors. The left-hand injector and feed pump conveys the feed water through the preheating device, i.e., the water runs through the injector or feed pump first into the left-hand and then into the right-hand preheating cylinder and from there passes through the water purifier into the boiler. This method of operation is used because it has proved the most economical. When the right-hand injector is used, the feedwater runs only through the water purifier and then direct to the boiler.

With the Knorr duplex feed pump, the water cylinder has a steam heating jacket, wherein also the exhaust steam of the pump is conducted. On the up stroke of the piston the water enters through the right-side suction valve and at the same time pushes the water from the upper cylinder chamber through the left-side delivery valve into the delivery pipe. Vice versa, the left-side suction valve and the right-side delivery valve are actuated on the down stroke. The maximum capacity of the pump is 80 gal. per min. The preheating cylinders are filled entirely with straight tubes through which the feedwater makes two passes. The exhaust-steam chamber is also partitioned, so that the steam flows from one end of the heater to the other and back to a point where it is drained, but in an opposite direction to the course of

the feedwater. In order to eliminate the water of condensation, together with the mud which is found to eventually settle in the base of the heater, suitable valves and washout fixtures are provided. (*Railway Review*, vol. 70, no. 9, March 4, 1922, pp. 277–291, 6 figs., *d*)

The Passing of the Cross-Compound Engine. The Canadian Pacific Railway, at its Angus Shops, has converted a number of 10-wheel cross-compound locomotives into simple locomotives of the same type, equipped with superheaters and piston valves. These locomotives will work in sparsely settled sections where the number of passenger and local freight trains must be fairly large but heavy power is not required, and where at the same time severe operating conditions are encountered during the winter months. Under these conditions the modernization of certain classes of old locomotives involves a much lower capital charge than the purchase or construction of new locomotives, and furnishes the railroad with a type of motive power quite as suitable as new locomotives for this service.

Some of the New England railroads have done similar converting, and have even extended it to include small 8-wheel passenger locomotives which have been fitted with new boilers and superheaters for light local passenger service.

The original article gives the details of the alterations carried out in Canada. (*Railway Review*, vol. 70, no. 8, Feb. 25, 1922, p. 265, 2 figs., *d*)

Adhesion and Rack Locomotive for the Dutch State Railways in Sumatra. The adhesion and rack locomotive is designed to operate on very heavy grades on the west coast of Sumatra, a portion of the line being provided with a rackbar of the Riggenbach type. The rack portion has grades of from 5.1 per cent to 6.8 per cent and a total length of 22.5 miles. The radius of the sharpest curves on the rack portion of the line is in the neighborhood of about 500 ft.

Up to the present time, six types of locomotives have been built for service in this portion of the line. The former locomotives were of the 4-wheel coupled type. The design described here is of the 0–10–0 type and was built in Switzerland. The usual system of operation is for a train of, say, 360 tons to be handled by two locomotives, one in the middle of the train and the second at the rear.

The boilers are provided with Schmidt superheaters. The barrel of the boiler consists of two courses, and contains 64 tubes, 12 ft. $9\,^1/_2$ in. long and 18 flues of the same length for the superheater elements. The firebox is of copper. The working pressure is 205 lb. per sq. in.

The driving wheels are $39\,^3/_8$ in. diam., the leading and trailing drivers having a side play of about $^7/_8$ in. The rack wheel is driven from a separate set of cylinders, located above the main cylinders through a jackshaft across the top of the locomotive frame. On this jackshaft is mounted a spur gear which meshes with the gear on the cog-wheel axle. The pitch diameter of the driving rack wheel is $38^3/_8$ in. The gearing between the crank axle and the main cog-wheel axle has a ratio of 1 to 2.033. The gear teeth are of the helical type with the pitch angle of 23 deg.

The locomotive is of the 4-cyl. compound Winterthur type, with all four cylinders outside the frames, two on each side. The lower cylinders are high-pressure and drive the five coupled adhesion axles. The upper or low-pressure cylinders drive the main cogwheel, and are not in operation while the locomotive is running on the adhesion track. While the locomotive is on the adhesion track the exhaust steam from the high-pressure cylinders passes directly to the exhaust pipe. When it is desired to place into operation the low-pressure cylinders which run the rack wheel, the engineer by means of a steam-operated valve, changes the flow of the exhaust steam from the high-pressure cylinders into the steam chest of the rack or low-pressure cylinders. From these cylinders it passes to the exhaust. In this way the locomotive is propelled both by the five-coupled axles and the rack when ascending the rack grades. In order to insure starting with the load on the rack portion of the line, live steam can be admitted directly to the low-pressure or rack cylinders by means of a special valve, so that the locomotive works as a twin engine. The four cylinders are of the same diameter and have the same stroke. They are cast separately in order to facilitate removal and repairs.

Three of the fifteen locomotives are equipped with Caille-Potonie feedwater heaters and double-acting feedwater pump, illustrated in the article. (*Railway Age*, vol. 72, no. 4, Jan. 28, 1922, pp. 263–266, 8 figs., *d*)

SPECIAL PROCESSES (See also Fuels and Firing)

A Simplification in Making Sheet-Metal Pressings. The usual process of manufacturing such sheet-metal parts as automobile fenders involves the use of a male and female die, which means, of course, a considerable expense. A new process of making such articles has been worked out in Australia and is known as the Hydro-Press process.

In this process the female die is of cast iron and requires only to be tooled sufficiently to remove any roughness in the casting so as to give a smooth and even surface. The place of the male die is taken by another cast-iron die containing a "bag cavity." In place of an accurately fitting male die, however, there is placed in the cavity a reinforced rubber bag capable of being expanded by the injection of water under high pressure. The metal sheet to be pressed to shape is laid on the rubber bag. The metal female die which grips the edges of the sheet between itself and the edges of the bag cavity is lowered by the operation of the cams. Water pressure is then turned on by the operator and the resulting expansion of the bag forces the metal to the shape of the female die. The normal working pressures used in Australia vary from 300 to 750 lb. per sq. in. The pressing into shape of the metal sheet is a matter of moments and the release of water and the separation of the dies enables the completed work to be replaced by another sheet of metal. In addition to automobile body panels, aluminum kitchenware has been made by the same process. (*Automotive Industries*, vol. 46, no. 8, Feb. 23, 1922, p. 469, 1 fig., *d*)

STEAM ENGINEERING (See also Thermodynamics, Physics, and Power Plants)

Contribution Toward a Precise Method of Computing Steam-Turbine-Blade Wheels of Variable Thickness, Alex. Fischer. A mathematical article not suitable for abstracting, but the following summary presents the main points. In the first place, the author considers the differential equation given by Stodola for determining the radial displacement of rotating disk wheels. This equation has been hitherto applied only to disks of even thickness and hyperboloidal disks. The equation was only partially solved for the so-called disks of equal strength. The author attempts to give a solution for disks having a section of the form $y = (\pm 1)^n y_0 \left\{ 1 - k \left(\frac{x}{r_0} \right)^m \right\}^n$. Under this classification of disks fall besides disks of even thickness and of hyperboloidal cross-section, also those with trapezoidal and conical section as well as disks of equal strength. For this particular class, the Stodola differential equation may be transformed into the Gauss equation of hypergeometric series. The theory of the Gauss equation is briefly discussed and its application to the present problem shown. The author shows that while in general the solution of the Gauss equation appears in the form of a series, and more particularly hypergeometric series, under certain limited conditions it gives finite expressions for the radial displacements and stresses. The data thus obtained are tested by applying them on disk shapes where the solutions are known and finite. The results are also applied to the complete solution for the case of a disk of equal strength. It is shown in this connection that under the limited conditions prescribed by practical requirements this type of disk fully lives up to its name.

In the second part of the paper is discussed the connection between the differential equation of Stodola for radial displacement, and the differential equation of the stress function proposed by A. Foeppl, and also the differential equation of Stodola for the bending of a horizontal disk of uneven thickness under the influence of its own weight. (*Zeitschrift des Oesterr. Ingenieur- u. Architeken-Vereines*, vol. 74, no. 9–10, March 3, 1922, pp. 46–49, 2 figs., to be continued, *mpA*)

THERMODYNAMICS (See also Heating and Ventilation)

The Specific Heats of Air, Steam and Carbon Dioxide, W. D. Womersley. The author used apparatus of the recording-calorimeter type essentially similar to that designed by the late Prof. Bertram Hopkinson, but improved. Instead of using coal gas he mixed the less complex gases, hydrogen and carbon monoxide, with either air or oxygen. The actual range of the experiments is from 1000 to 2000 deg. cent., the parts in the curves in the original article referring to the lower temperatures being filled from the researches of Swann, and Holborn and Henning. The method of calculations is very completely described.

The results obtained are given in the form of curves. The figures for air and steam are about $7^1/_2$ per cent higher than those of Holborn and Henning at 800 deg. cent., and the author assumes that their values for carbon dioxide are a similar amount too low.

In connection with this investigation the effect of the state of the walls of the containing vessel on the rate of heat flow in a gaseous explosion has also been considered. The author carried out a series of experiments with the Hopkinson calorimeter to find the total heat passed to the walls after an explosion—first, with the walls polished, and then blackened. Coal gas was used in the combustible mixture and five experiments under different conditions were made. The same mixture strength was used throughout, viz., 12.35 per cent of coal gas by volume. The cooling curve and the total heat lost to the walls are shown by a curve in the original article, the maximum temperatures of which are 2123 deg. and 2089 deg. cent. abs., respectively, giving a difference of 34 deg. cent. At the end of one second the gases have cooled to 918 deg. and 859 deg. cent. abs., the difference then being 59 deg. cent. The heat lost to the walls in the two cases when cooling has proceeded to the same temperature is sensibly the same. At one second the heat passed to the walls per square centimeter per gram-molecule is 2.675 and 2.556 calories, respectively.

Another curve in the original article shows the rate of heat flow to the walls at various times during the cooling. From this it is seen that during the first half second the rate of flow is much greater with the walls black than when they are polished. After this time the rates seem to be practically the same in the two cases. The general rate of flow appears to be 16 per cent higher throughout with the blackened walls. From the temperature curves are derived the relations between the rate of heat flow and the difference of mean gas temperature and walls. (*Proceedings of the Royal Society*, Series A, vol. 100, no. A 706, Feb. 1, 1922, pp. 483–498, 10 figs., *et*)

Effect of Variable Specific Heat on Discharge of Gases Through Orifices and Nozzles, Wm. J. Walker. The paper questions the desirability of accounting for abnormal orifice or nozzle discharges by consideration of changes in the value of γ, the index in the equation pv^γ = constant, for adiabatic changes of state. This appears, generally, to have been the custom hitherto, but since the actual adiabatic equation under linear-variable specific-heat conditions is $pv^m e^{\kappa T}$ = constant, the analysis in this paper has been carried out on the latter basis for the purpose of determining, as nearly as possible, what effect such specific-heat variation has on discharges. An exact solution does not appear to be derivable, but the method of analysis adopted here may be carried to any degree of accuracy required. The method of analysis is somewhat similar to that adopted in a previous paper (The Effect of Variable Specific Heat on Thermodynamic Cycle Efficiencies, *Philosophical Magazine*, September, 1917), dealing with another effect of variable specific heat. The result obtained in the present paper brings out prominently the fact that the error in computing discharges (by the usual constant-specific-heat theory) increases as the density of the medium in the reservoir is diminished. This fact appears to have been neglected in previous considerations of the subject. It is pointed out, also, that by means of the discharge formulas obtained the method of orifice discharge may be used as a reliable and convenient one for the determination of specific-heat variations with temperature. (*The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, vol. 43, no. 255, March, 1922, pp. 589–593, *tm*)

Influence of Colors on Heat Absorption of Paints and Bricks, Maj. C. R. Satterthwaite. Data of experiments on influence of color and heat absorption of various materials in hot sunlight were carried out in the Soudan during the period of 1915–18 by G. W. Grabham. The experiments were on the properties of various materials and fabrics used for clothing, but tests were also carried out on painted surfaces and bricks.

For the purpose of the experiments, cylindrical tin flasks $12^1/_2$ cm. and $7^1/_2$ cm. in diameter were adopted. They were provided with necks and corks through which thermometers were inserted so that the bulbs were placed freely at about the center of the flasks.

In the principal experiments the flasks were laid out on a white sheet resting on a doubled woolen blanket, to eliminate as far as possible disturbing factors due to heat absorption by their surroundings. They were set at intervals of about 30 cm., and arranged in order of their apparent tints so that the lighter-colored flasks were next each other and distant from the darker ones. These precautions were taken to reduce effects due to radiation from one flask to another, such as might have interfered had a black flask been near a light-colored one. Standards of reference were provided by other flasks, the white being coated with a lime wash which gave a dead-white surface, while the other was coated with a mixture of lampblack and varnish which dried with a dull-black surface.

From the mean of several observations it was found that, with the "White Standard" (lime wash) at 115.9 deg. fahr., the following colors showed the excess temperatures given below.

	Deg. Fahr.
Cream paint	11.5
Khaki paint	22.5
Cement wash	26.8
Black paint	35.2

In experiments on bricks, a detailed procedure of which is given in the original article, it was found that burnt brick was much hotter than sun-dried brick, which may have been due both to direct heat absorption and also to texture. (*Journal of Hygiene*, vol. 19, no. 3, Jan., 1921, abstracted through *The Royal Engineers' Journal*, vol. 35, no. 3, March, 1922, pp. 129–132, *e*)

VARIA

Weighing by Substitution. Substitution weighing is of importance when it is desired to obtain very accurately the weight of some particular object and when calibrating or adjusting weights in the process of standardizing them.

The scheme of weighing by substitution is as follows: For standardizing weights the standard is first placed on the scale pan or platform designed to receive it and counterpoised by any convenient material. When the balance of the beam is obtained the standard is removed, the weight to be compared is substituted and the correction is determined from the small weights that have to be added or subtracted to establish the same balance as before.

Where the weight of an object is desired and its weight is not already known approximately, it is first placed upon the platform and balanced by a suitable counterpoise. It is then removed and standard weights substituted until the same balance is established as before. The weight of the object is then equal to the weights substituted for it. The method of substitution weighing is rendered precise by observing certain details explained in the original paper.

As explained by the Bureau of Standards, the process may be used for obtaining weighings of considerable refinement with ordinary forms of compound lever scales. (*Technologic Paper of the Bureau of Standards*, no. 208, Feb. 21, 1922, pp. 177–192.)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Metallic Corrosion Under Investigation

THROUGHOUT the country during the past year a considerable amount of research on the general subject of corrosion has been carried on. This activity, in spite of the general relaxation in chemical and metallurgical research, is due probably to the extreme importance of many of the problems and to the large savings in capital and labor that would result in their solution. The laboratories of the Government, private concerns and the colleges are participating in this work.

It was for the purpose of coördinating this research activity that The National Research Council recently appointed a committee on this subject to function under its Division of Research Extension. Mr. W. M. Corse, Gen. Mgr., Monel Metals Products Corporation, Bayonne, N. J., is Chairman and Dr. Colin G. Fink of 101 Park Avenue, New York, is Secretary of the Committee.

This Committee is, first, to serve as a general clearing house for information on the subject and, second, to devote its attention essentially to a fundamental scientific study of corrosion in all its aspects. It desires to get quickly in touch with the work which is being done on corrosion whether through societies, associations, institutes, universities, private laboratories, or industrial laboratories. It is known that the following thirteen organizations are at present interested in the general problem through committee activity.

American Society for Testing Materials
Bureau of Standards
American Institute of Electrical Engineers
American Gas Association
American Electric Railway Association
American Railway Engineering Association
American Water Works Association
National Electric Light Association
National Gas Association of America
Engineering Foundation
The American Electrochemical Society
Bureau of Mines
National Canners' Association

The corrosion problem is being attacked from two more or less different angles. In the one case every effort is being made to arrest the corrosion of the materials now in use, in the other new materials are substituted and tried out. A partial list of distinct problems of corrosion which demand investigation are listed below, each being centered around some specific material or article of manufacture.

Condenser Tubes
Automobile Radiators
Underground Cables
Buried Iron Pipes, Posts, etc.
Fence Wire
Flues, Stacks, Stove Pipes
Steel Ships and Ship Fittings
Roofing Materials
Mine Pumps and other Mine Equipment
Atmospheric Corrosion of Brass
Atmospheric Corrosion of Bronzes
Alloys Resistant to High Temperature
Corrosion of Zinc Cathodes
Contact Metals or Alloys
Catalyzer Metals or Alloys
Cutlery Steels
Acid Tank Linings
Corrosion of Nickel-Plated Ware
Boiler Tubes
Fire Boxes
Insoluble Anodes

Cast Iron when Affected by the Presence of Small Amounts of Other Elements. Three general problems involved in this research are (1) Velocity of corrosion as affected by (*a*) temperature fluctuations, (*b*) alternate dry and moist surface, (*c*) presence of foreign materials, (*d*) presence of oxide or carbonate of one or the other constituent of the alloy, (*e*) crystal structure and intercrystalline cement; (2) properties of the surface film: (*a*) coefficient of expansion as compared with that of the underlying metal; (*b*) its chemical composition; (*c*) porosity; (*d*) flexibility or ductility; (*e*) coefficient of adhesion; (*f*) speed of renewal of "healing;" (*g*) relative hardness; (*h*) how effected during mechanical working; and (3) corrosion and bacteria.

A more complete micrographic investigation of the changes taking place in the film and the metal underneath, during the process of corrosion, is very desirable. Furthermore, progress will come more rapidly as soon as it is agreed what shall constitute a standard test when used to determine the relative corrodibility of two samples. At present it is almost impossible to compare the results of one observer with those of another, even when both of them have work on the same materials in their tests.

Within the last year, however, decided progress has been made in the study of cutlery steels, metals and alloys for mine equipment, cable sheath, insoluble anodes, alloys resistant to high temperatures, and the corrosive action of molten metals such as zinc, tin, etc. But the solution of the corrosion problem, as a whole, in spite of its long past history, is still in its "infancy" and it is only through coöperative effort and a free discussion of results (those usually suppressed as well as those suitable for advertising purposes) that consistent forward strides are possible.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A2-22. WEIGHING BY SUBSTITUTION. This paper describes a plan for making substitution weighings which can be applied in using either equal-arm balances or compound lever scales. It is based upon the method developed by the Bureau of Standards in the test and standardization of the 10,000-lb. weights which form a part of its railroad track-scale testing equipments and in which a maximum accuracy is desired. The interest of the practical scale man coming in contact with the work of the Bureau has been aroused in its methods, and the present publication is prepared mainly in response to a general demand for an outline of a systematic method for carrying out substitution weighing. As the result of suggestions of these men engaged in the actual maintenance and testing scales, the procedure for taking data and conducting the routine of the test has been made to conform closely with that used by the Bureau of Standards in the precision test of railroad-track and grain-hopper scales; and the form for recording the data and making computations which is presented has been arranged to be as near to that used in the scale-testing work as is practical.

The general matters covered by the paper comprise, first, a general description of the theory of weighing by substitution; the preparation of the scale for weighing so that the swings of the beam can be read on the graduated scale; the method for obtaining the positions of the equilibrium of the beam from the readings taken on it while moving; the method of removing and substituting weights; and a description of the details to be observed in preparing the scale and making observations, and the practice to be followed in making the computations.

The method is of especial value in the calibration of a large number of weights of the same denomination. The method is equally applicable, however, for determining accurately the unknown weight of any object. Technologic Paper of the Bureau of Standards, No. 208, by C. A. Briggs and E. D. Gordon. The complete paper may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 5 cents.

Instruments and Apparatus A2-22. WEIGHING BY SUBSTITUTION. See *Apparatus and Instruments A2-22.*

Thermal Conductivity A1-22. THERMAL CONDUCTIVITY OF SOME WEARING MATERIALS. Thermal Conductivity of Woolen, Cotton, Linen and Silk Materials.—Measurements of the conductivity of samples of knitted and woven materials have been made by the disk method of Lees, corrected for variation of emissivity with temperature. From one to eight or more layers of one of the materials were held between two copper disks with a pressure of 6 gm./cm²., one disk being heated electrically by a coil between it and a third disk, and all three radiating to a constant-temperature enclosure. The temperature of the samples was 30 to 40 deg. The values obtained are greater for dense than for loosely woven or knitted samples, ranging from 76 for unspun silk,

94 to 120 for wool, 101 to 122 for silk, 131 for flannelette, 158 to 167 for linen, and 168 to 184 for cotton, all times 10^{-6}. The results come out greater for several layers than for a few, and greater for moist than for dry samples. When the materials are arranged according to conductivity for equal weight instead of equal thickness, the order depends largely on the looseness of texture, beginning with unspun silk, loosely woven wool and knitted artificial silk, and ending with closely woven silk cotton and linen.

The above is a synopsis of a paper which appeared in the November, 1921, issue of *The Physical Review*. Address E. S. Rood, Mount Holyoke College, Mass.

Thermal Conductivity A2-22. Variation with the Temperature of the Thermal Conductivity of Cast Iron. Variation with Temperature of the Thermal Conductivity of Soft Gray Cast Iron, 195 to 542 deg. cent.—The sample used contained 3.5, 2.2 and 0.64 per cent, of C, Si and Mn, respectively, and was cast into the form of a cylindrical shell 3 cm. thick, joined with a hemispherical bottom. The temperature differences between the liquids inside and outside the shell, which amounted to from 3 to 6 deg. with an input of from 0.24 to 1.6 kw., were measured with thermocouples silver-soldered in the ends of brass tubes. Since even though these tubes were pressed against the iron surfaces, the temperatures thus measured differed more or less from the actual temperatures of the surfaces, the absolute values found for the conductivity are too low; but the results indicate that the conductivity at 542 deg. is between 2 and 3 times its value at 195 deg. cent.

A brief but interesting report on this subject is printed in the March, 1922 issue of *The Physical Review*. It records the progress made thus far by Elmer E. Hall of the Department of Physics, University of California, Berkeley, California.

Cement and Other Building Materials A2-22. Method of Proportioning Concrete Materials—Screened and Unscreened Gravel. Bulletin No. 60 just received from the Engineering Experiment Station of Iowa State College. See Synopsis of the Process of Making Concrete.

The conclusions with respect to the theory of proportioning which may be drawn from the numerous strength tests reported in this Bulletin, are: (1) If the consistency remains the same the strength varies with the coarseness of the aggregate, or, for the same consistency, the finer the aggregate the more cement (to maintain the strength), is required: (2) The finer the aggregate the more water is required to produce the required consistency; (3) And, therefore, combining 1 and 2, the more water used in mixing, the more cement is required to maintain the strength. Address R. W. Crum, Iowa State College, Ames, Iowa.

Steel, Its Treatment and Products A2-22. Corrosion of Steels. Laboratory work relating to the determination of the relative resistance of certain alloy steels to corrosion when submitted to combined weathering and immersion in distilled water was completed during the month. Based on exposure of 19 days, the polished samples of steel showed the best resistance to corrosion in the order given below:

1 Annealed stainless steel (C–0.15%, Cr–13%)
2 Annealed high-chromium and high-nickel steels
3 Forged stainless steel
4 Cast-iron-chromium alloy (C–0.04%, Cr–6.5%)
5 Annealed chromium steel (C–0.20%, Cr–8.6%)
6 Annealed chromium steel (C–0.30%, Cr–5.72%)
7 Annealed chromium steel (C–0.28%, Cr–3.90%)
8 Pure iron
9 Iron-carbon alloy (C–0.45%).

These tests have been conducted in the laboratories of the Bureau of Standards, Washington, D. C. Address Dr. S. W. Stratton, Director.

Steel, Its Treatment and Products A3-22. Effect of Heat Treatment on the Mechanical Properties of 1 Per cent Carbon Steel. Technologic Paper No. 206 of the Bureau of Standards on this subject will be ready for distribution by the Superintendent of Documents, Government Printing Office, this city, during the month of March. The price is 15 cents per copy.

This gives the effects of varying time-temperature relations in heat treatment on tensile and impact properties, hardness, and structure of 1 per cent carbon steel, as follows: *(a)* Effect of temperature variations in hardening; *(b)* time of hardening temperatures above Acm between the Ac_1 and Acm transformation; *(c)* effects of tempering steels hardened in different ways and effects of "soaking" just under the lower critical range, and *(d)* comparison of oil and water hardening for production of definite strengths. Under the described conditions of treatment and test, the features observed are described in detail under eight headings.

B Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Paints, Varnishes and Resins B1-22. Paint on Wood. The National Research Council and the Engineering Foundation are completing arrangements for a thorough research into the protective covering of wood of all kinds. Owing to the nature of some of the tests involved this research will extend over a period of eight to ten years. The plans call for a study in laboratory and field by methods to be devised and improved from time to time, of paints, varnishes and other protectives now commonly used and others which may be suggested, to determine best materials for various purposes, conditions and woods and the most effective methods of application, durability and appearance.

Among objects sought are: *(a)* control of dimensional changes of wood due to absorption and loss of moisture; *(b)* preservation of wood for economic reasons, including conservation of forests; *(c)* economies in use of protective and finish coatings for wood and of the labor required for their application. It is proposed to carry this work forward with the full coöperation of the Forest Products Laboratory of the Department of Agriculture at Madison, Wis., the Bureau of Standards and the American Society for Testing Materials in addition to the lumber, woodworking and paint industries of the country. Address Alfred D. Flinn, Secretary, Engineering Foundation 29, West 39th Street, New York City.

Heat B1-22. Heat of Fusion and Specific Heat of Metals. The Committee on Grants of the American Association for the Advancement of Science has recently assigned one hundred and fifty dollars to Professor A. W. Smith, Ohio State University, Columbus, Ohio, in support of this work on the latent heat of fusion and the specific heat of metals.

Steel, Its Treatment and Products B2-22. Electric Furnace vs. Open-Hearth Silico-Manganese Spring Steels. It is more or less generally recognized that steels of the same composition in so far as the elements used are concerned require variations in heat treatment to produce similar properties. This applies to comparisons between heats made by the same type of process and steels produced by different processes. A series of tests was completed during the past month at the Bureau of Standards on samples of electric and open-hearth heats of silico-manganese spring steels carrying equal proportions of C, Mn, P, S, and Si. The tests included microscopic examination, tensile test, and determination of proportions of certain gases present, particularly nitrogen and hydrogen. In general, the microstructure of the electric steel was somewhat different from that observed in the open-hearth when both steels were subjected to the same heat treatment.

Under certain thermal treatments, distinct differences in tensile properties were observed, but these were largely obliterated by a preliminary normalizing quench from a high temperature. It was found that the proportion of oxygen present in these steels was practically the same, about 0.028 per cent, and independent of the heat treatment applied. The nitrogen in the original rolled samples of electric steel was approximately twice that of the open-hearth and independent of the heat treatment. However, in the case of the electric steel, the proportions of nitrogen were dependent upon the heat treatment.

Iron and Steel B1-22. Iron for Use in Manufacture of Car Wheels. A new investigation has been inaugurated to study the relation between the mechanical composition and physical properties of cast iron of the car-wheel type. In the preliminary work particular attention is to be paid to the question of sulphur and phosphorus content of the iron. The irons will be made in the Ajax-Northrup high-frequency furnace which permits a very close regulation to any desired composition. The following tests will be made on the cast material: Transverse, tensile, impact, hardness, and wear. The depth of the chill of the chilled specimens will also be noted.

This work should prove of great value in the drawing up of specifications for chilled iron car wheels. Address Dr. S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Welding B1-22. Welding of Street-Railway Joints. The American Electric Railway Association through its Committees on Way Matters initiated the formation of the Committee on Welded Rail Joints for the purpose of having an authoritative investigation made of the various types of welded rail joints now in commercial use. The American Bureau of Welding as the coördinating agency in the general field of welding research and standardization has organized a large Committee comprising over thirty experts on welded rail joints.

Welding is being very widely used in making street-railway joints and more or less trouble has been experienced in all types of welded joints from breakage. Little or no scientific data exists as to correct procedure to be followed in making welds by the various processes. Several of the larger companies are spending many thousands of dollars per year on such joints.

A small Executive Committee has prepared a thorough questionnaire on the four types of welded joints now in use, namely, cast iron, electric seam, resistance and thermit. These were sent out to the members of the Committee and replies are being forwarded to the Society. From the answers to this questionnaire it is expected that a critical summary will be prepared of our present knowledge based upon all the available experience in this field. A program of research will then be outlined and different parts of the program assigned to an appropriate laboratory or in the case of field experiments to one or more appropriate operating companies. These assignments would, of course, cover the men under whom the specific experiments will be conducted. Address Wm. Spraragen, Secretary, American Bureau of Welding, 29 West 39th Street, New York.

Corrosion B1-22. Metallic Corrosion. Realizing the great loss which industry experiences each year as a result of corrosion in its various forms, The National Research Council recently appointed a committee to correlate the activity already under way. It recognizes the start that has been made by committees which are composed of representatives of thirteen organizations associated with a number of large firms and it desires first, to be a clearing-house for research information, and second, to devote its attention to a fundamental scientific study of the subject. Address Dr. Colin G. Fink, Secretary of the Committee, 101 Park Avenue, New York.

Electrolysis B1-22. Metallic Corrosion. See *Corrosion B1-22.*

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

Iron and Steel D1-22. Titanium in Steel and Bronze. The facilities of the Physical Laboratories of the Titanium Alloy Manufacturing Company are now offered to manufacturers and others interested in metallurgical and mechanical lines.

Equipped primarily for research and experimental work of an exacting nature, the apparatus is such as to insure accurate results. The Physical Laboratories are comprised of four units: testing laboratory, metallographic laboratory, room for experimental heat-treating and small experimental foundry.

They are equipped for most of the usual physical tests, such as hardness, tensile, impact, alternating stress, electrical conductivity, etc., etc. In the heat-treating department they are able to do heat-treating of any character, but only on an experimental scale. The experimental foundry is equipped only for work on metals which can be satisfactorily melted in crucibles. The work of these laboratories was one of the prime factors in the development of Aluminum Bronze in this country. Address George F. Comstock, Physical Testing Laboratories, Titanium Alloy Manufacturing Company, Niagara Falls, New York.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Research Agencies E3-22. Research Laboratories in Industrial Establishments of the United States. This is the tile of a Bulletin of the National Research Council recently issued by the National Research Council. This publication is a revised and enlarged edition prepared by Ruth Cobb of the Bulletin originally compiled by Alfred D. Flinn, Secretary Engineering Foundation. Following a brief introduction the information is classified in four ways: (*a*) Alphabetical list of laboratories, (*b*) Index to subject classification of laboratories, (*c*) Subject classification of laboratories, (*d*) Address list of directors of research. Address The National Research Council, Washington, D. C.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Electrochemistry F1-22. Electrolytic Corrosion of Pipe Lines and Structural Materials. A bibliography of $8^1/_2$ pages. Search 3474.

Fuel Utilization F1-22. The Smoke Problem. An interesting review of the history and technical information relating to smoke abatement is contained in a brief report prepared by O. P. Hood, Chief Mechanical Engineer, U. S. Bureau of Mines. A bibliography on this subject forms part of this Report, No. 2323.

Properties of Engineering Materials F1-22. Platinum. In response to numerous inquiries the Bureau of Mines has prepared a report (No. 2326) on platinum, its properties, uses, occurrence, metallurgy, refining and its substitutes. This report also contains a short bibliography.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 384 to 390 inclusive, as formulated at the meeting of March 2, 1922, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 384

Inquiry: Is it permissible, under Par. 191, to straighten the edges of bottom plates of fired pressure vessels by hand hammering on an anvil which is bolted to the edges of the sheet where the bottom plate has been cold pressed with sectional dies to the correct radius?

Reply: It is the opinion of the Committee that the straightening of edges of bottom plates of fired pressure vessels by hand hammering is prohibited by Par. 191 of the Code. Attention is called to the fact that with proper dies and manipulation, it is possible to properly form the plate.

Case No. 385

Inquiry: Does the requirement in Par. 6 for the material to be used in braces apply to the structural members referred to in Pars. 201 and 225?

Reply: It is the opinion of the Committee that the structural members referred to in Pars. 201 and 225 come under the classification of braces in Par. 6 and should be of material that conforms to the specification for steel bars.

Case No. 386

Inquiry: Is it the intent of Par. 250 and 251 that expanders of the Prosser type may not be used for attaching tubes and nipples in fire-tube and water-tube boilers, and that expanders of the roller type are compulsory?

Reply: It was the intent of Pars. 250 and 251 to specify that the tubes be suitably expanded by other than a peening process and the exclusion of the use of a Prosser-type expander was not contemplated by the Committee.

Case No. 387

Inquiry: Does the tolerance of 20 per cent in the phosphorus and sulphur limits as given in Par. 84*b* of the Boiler Code permit the acceptance of steel castings with 0.06 per cent of phosphorus and sulphur?

Reply: The tolerance of the phosphorus and sulphur limits as given in Par. 84*b* of the Boiler Code, applies only to the check analysis from the casting, which check analysis is not compulsory, and which is not subject to the tolerance. The reason is that the ladle analysis gives a fair average of the constituents of the steel, whereas locally in the casting, the chemical constituents may vary slightly from the average; hence the tolerance permitted.

Case No. 388

Inquiry: Would a continuous feed pipe, which is connected so as to pass lengthwise through a boiler drum with feed valves at each end of the pipe, the pipe being drilled with a number of holes $^1/_2$ in. in diameter or over, spaced along its length for discharging the water into the drum, the combined area of the holes being at least equal to that of the cross-section of the pipe, be acceptable under the requirements of Par. 314 of the Code?

Reply: It is the intent of Par. 314 of the Code, that the feed pipe

of the boiler shall have an open end or ends inside the boiler, and it is the opinion of the Committee that the arrangement submitted is the equivalent of an open-ended pipe and should be allowed. (See Case No. 358.)

Case No. 389

Inquiry: Is it the intent of the last sentence of Par. 308 of the Code to restrict the use of globe valves of the angle type for blow-off connections? It was pointed out that angle globe valves have a practically straightway passage through them and offer no dam or obstruction to cause accumulation of sediment.

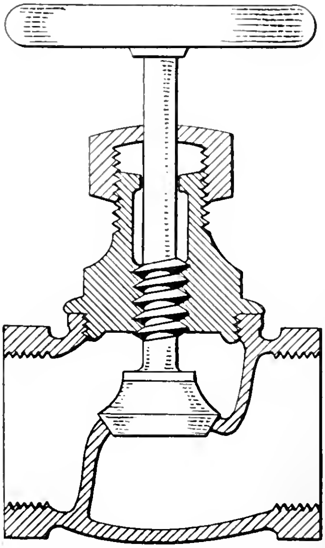
Reply: It was the intent of Par. 308 that straightway globe valves of the ordinary type or valves of such type that dams or pockets can exist for the collection of sediment, shall not be used on such connections. Accordingly, a revision of the last sentence of Par. 308 has been suggested to read as follows:

> Straightway globe valves of the ordinary type as shown in the accompanying illustration, or valves of such type that dams or pockets can exist for the collection of sediment, shall not be used on such connections.

Case No. 390

Inquiry: Would it be permissible, under the rules in the Code to construct an electrical steam generator formed of large electrodes immersed in water within an enclosed vessel, for producing steam at 100 lb. gage pressure from electrical energy? The generator is to have a circular shell of a size in excess of the miniature boiler limit in outside diameter, with flat cast-steel head having the necessary openings for access, bolted to cast-steel flanges riveted to the circular shell.

Reply: Such a construction is not fully covered by the Code. In view of the impossibility of computing these strains in the flat circular heads with exactness when it is desired to build boilers of this type, the Committee would recommend that a test to destruction be made on a full-sized generator as provided for in Par. 247 of the Code.



Type of Globe Valve Referred to in Par. 308 of Boiler Code

RULES FOR THE CONSTRUCTION OF MINIATURE BOILERS

FOR over two years a Sub-Committee of the Boiler Code Committee has been engaged in formulating Rules for the Construction of the so-called Miniature Boilers, which is to form Section 5, Part 1 of the A.S.M.E. Boiler Code. There has been considerable demand for such a Code embodying special rules for boilers of small size that come within this classification in which the requirements for power boilers of average size are scarcely necessary or justified. Several preliminary reports upon this Code have been considered by the Boiler Code Committee and two revisions thereof have been submitted to the steam boiler industry for purposes of discussion. In connection with the 1921 Annual Meeting of the Society, a public hearing on the proposed rules was held and the manufacturers were there invited to discuss the proposed regulations. The report is here published for the information of the membership. Anyone desiring to discuss the report is requested to address the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y.

A.S.M.E. Boiler Code

PART I SECTION 5

Rules for the Construction of Miniature Boilers

M-1 *Definition.* Boilers to which the classification "Miniature" applies, embrace fired pressure vessels which do not exceed the following limits:

16 in. inside diameter of shell
42 in. length of shell
20 sq. ft. total heating surface
100 lb. per sq. in. maximum allowable working pressure.

Where any one of the above limits is exceeded, the rules for Power Boilers shall apply.

M-2 Specifications are given in these Rules, Pars. 23–178 of Part I, Section 1 of the Code, for the important materials used in the construction of boilers, and the materials for miniature boilers, for which specifications exist, shall conform thereto, except that in lieu of definite specifications for boiler-plate material, there may be used for the shells or drums of miniature boilers, seamless drawn shells with integral heads, or seamless or extra heavy lap-welded steel or iron pipe or tubing, provided it is of open-hearth material and the weld is formed by the forging process. Owing to the small size of the parts of miniature boilers, stamping as required by Par. 36 of the Rules for Power Boilers need not be visible after completing the boiler, provided the manufacturer certifies on the data slip accompanying the boiler that the material is in accordance with the requirements of the A.S.M.E. Code for Miniature Boilers. Provisions shall be made by the manufacturer whereby he shall be able to supply complete information regarding the material and details of construction of any boiler built under the Miniature Boiler Code.

M-3 Steel plate when used for any part of a miniature boiler where under pressure, shall be of the firebox or flange grades, but in no case shall steel of less than $^{1}/_{4}$ in. thickness be used for riveted shells or less than $^{3}/_{16}$ in. thickness for seamless shells. The heads, if used as tube sheets with tubes rolled in, shall be at least $^{5}/_{16}$ in. thick.

M-4 The construction of miniature boilers, except where otherwise specified, shall conform to that required for power boilers. The factor of safety and method of computing the maximum allowable working pressure shall be the same as for power boilers.

M-5 Heads or parts of miniature boilers when not exposed to the direct action of the fire may be made of cast iron or malleable iron provided it complies with the requirements in Part I, Section 1 of the Boiler Code for the headers of water-tube boilers.

M-6 Steam-generator elements of not over 600 cu. in. in volume may be made of cast copper or bronze having a copper content of not less than 90 per cent and wall thickness of not less than $^{1}/_{4}$ in. Such generators shall be equipped with at least two brass washout plugs of not less than 1-in. iron-pipe size, and shall be tested to a hydrostatic pressure of 600 lb. per sq. in.

M-7 Circumferential riveted joints, where used, shall conform to the requirements in Par. 184 of Part I, Section 1 of the Code. Autogenous welding may be used for joints in miniature boilers where the strain is carried by other construction which conforms to

the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

M-8 Tubes may be made of wrought iron, steel, drawn copper or drawn brass. Fire tubes $1^1/_2$ in. and over shall have both ends substantially expanded into the tube sheet by rolling and beading. Fire tubes less than $1^1/_2$ in. shall be expanded and beaded, or expanded and welded. The gage of the tubes shall not be less than that specified for water-tube boilers and fire-tube boilers as specified in Pars. 21 and 22 of Part I, Section 1 of the Code.

M-9 All rivet holes shall be drilled full size, or they may be punched not to exceed $^1/_8$ in. less than full diameter and then drilled or reamed to full diameter.

M-10 The calking edges of plates, buttstraps and heads shall be beveled to an angle not sharper than 70 deg. to the plane of the plate, and as near thereto as practicable. Every portion of the sheared surfaces of the calking edges shall be planed, milled or chipped to a depth of not less than $^1/_8$ in. Calking shall be so done that there is no danger of scoring or damaging the plate underneath the calking edge, or splitting the edge of the sheet.

M-11 Every miniature boiler shall be fitted with not less than three brass washout plugs of 1-in. iron-pipe size, which shall be screwed into openings in the shell near the bottom, reinforced to give four full threads. All threaded openings in the boiler shell shall be provided with a riveted or welded reinforcement if necessary, to give four full threads therein.

M-12 Every miniature boiler shall be provided with at least one feed pump or other feeding device, except where it is connected to a water main carrying sufficient pressure to feed the boiler.

M-13 Each miniature boiler shall be fitted with feedwater and blow-off connections, which shall not be less than $^1/_2$-in. iron-pipe size. The feed pipe shall be provided wth a check valve and a stop valve. The feedwater may be delivered to the boiler through the blow-off connection, if desired. The blow-off shall be fitted with a valve or cock in direct connection with the lowest water space practicable.

M-14 Each miniature boiler for operation with a definite water level shall be equipped with a glass water gage for determining the water level. The lowest, permissible water level shall be at a point one-third of the height of the shell, except where boiler is equipped with internal furnace, when it shall be not less than one-third of the length of the tubes above the top of the furnace.

M-15 Each miniature boiler shall be equipped with a steam gage, having dial graduated to not less than one and one-half times the maximum allowable working pressure. The gage shall be connected to the steam space or to the steam connection to the water column, by a siphon tube or equivalent device that will keep the gage tube filled with water.

M-16 Each miniature boiler shall be equipped with a sealed spring-loaded pop safety valve, not less than $^1/_2$ in. diameter, connected direct to the boiler, independent of any other connection. The safety valve shall be plainly marked by the manufacturer with a name or an identifying trademark, the nominal diameter, the steam pressure at which it is set to blow, and A.S.M.E. Std. The minimum relieving capacity shall be determined on the basis of 3 lb. of steam per hour per square foot of boiler heating surface.

M-17 Each steam line from a miniature boiler shall be provided with a stop valve located as close to the boiler shell or drum as is practical.

M-18 Where miniature boilers are gas-fired, the burners used shall conform to the requirements of the American Gas Association, as given in the Appendix. The burners shall in such cases be equipped with a fuel-regulating governor, which shall be automatic and regulated by the steam pressure. This governor shall be so constructed that in the event of its failure, there can be no possibility of steam from the boiler entering the gas chamber or supply pipe.

M-19 All boilers referred to in this section shall be plainly marked with the manufacturer's name, the maximum allowable working pressure which shall be indicated in arabic numerals, followed by the letters "lb.," and the serial number. All boilers built according to these rules shall be marked A.S.M.E. Min. Std. Individual shop inspection is not required for miniature boilers.

A data sheet shall be filled out for each boiler and signed by the manufacturer, this data sheet to include the most important items and to be numbered. In addition to this, the complete data sheet required for power boilers shall be filled out and preserved by the manufacturer for each lot of steel and each lot of boilers manufactured therefrom. The complete data sheet shall be marked to indicate to which boilers it applies and the manufacturer shall furnish copies of this complete data sheet when requested to do so by the owner of any one of the boilers. In requesting the complete data sheet the owner should forward the number of the boiler which would be stamped thereon in order that the manufacturer may readily identify the complete data sheet applying to the boiler.

(Name of manufacturer)
....
60 lb.
A.S.M.E. Min. Std.

Sample of Marking

(As required by the Provisions of the A.S.M.E. Code Rules)

As Required by the Provisions of the A.S.M.E. Code Rules

1. Manufactured by..
(Name and address of the manufacturer)

2. Manufactured for.... ....
(Name and address of the purchaser)

3. Type.....Boiler No.(.........)(.........)(.........) Yr. built
(Manufr's. Serial No.) (State and State No.) (A.S.M.E. No.)

Diameter of Length of
4. Shell or Drums..........Drums......overall......ft......in.
(Inside of outside course)

Material for Shell, Straps
5. Heads and Furnace Sheets made by........ (If more than one make, give names of manufacturers in same order as parts referred to.)

Has material used in boiler been checked with mill test reports...
6. Built for maximum allowable working pressure..........lb.
7. Hydrostatic pressure applied.........................lb.

Note: The mill test reports of tests of material used in this boiler are preserved by the manufacturer as well as all data applying to the boiler called for in the data sheet for Power Boilers. This data will be supplied by the manufacturer at the request of the owner of the Boiler.

8. Openings: No...Size...in., No....Size.:.in., No....Size..in.
(Main Steam connections) (Safety valve) (Blow-off)

....
(Inspector of Boilers for State or Boiler Insurance Companies)

APPENDIX

Gas Burner Specifications—American Gas Association

Each burner shall be equipped as follows:

1 With a separate one-quarter-turn gas cock
2 With either an adjustable gas orifice or a removable brass orifice of a fixed drilling to meet the local condition
3 With an adjustable air shutter capable of giving complete shut off; a lock washer or screw should hold the shutter so securely that accidental shifting of the shutter is impossible
4 The mixing tube, should be at least six times as long as its minimum diameter
5 When the air mixer, mixing tube and burner are made in separate parts, they shall assemble so that there is no reduction in internal area at the point of their connection in the direction of the gas flow.

The burner proper shall preferably be of a one-piece cored casting.

The port openings shall be drilled, or if assembled, shall be of uniform size.

The burner shall be capable of operating satisfactorily without a wire gauze.

For satisfactory operation a burner should have sufficient flexibility to burn with a blue flame at full load and not flash back when shut down to the gas flow required to just maintain radiation losses.

A positive pilot-lighting burner shall be provided.

Sectional Committee on Standardization of Gears Proposes Five Standards

THE decision to organize this Sectional Committee under the Rules of the American Engineering Standards Committee was announced in the September, 1920 issue of MECHANICAL ENGINEERING. It was there stated that the American Gear Manufacturers Association and The American Society of Mechanical Engineers had been designated Sponsors for this Committee by the A.E.S.C.

At the first meeting held on June 23, 1921 Mr. Benjamin F. Waterman was elected chairman, Mr. Earle Buckingham, vice chairman, and Mr. John P. Kotteamp, secretary. The field in which this Committee is to work was looked over in a general way and Mr. Buckingham was asked to prepare for the use of the members of the Committee a review of the Present Status of Gear Standardization in the United States and Europe. A copy of this statement with reprints of all known gear standards was then placed in the hands of each member of the Committee before the next meeting which was called for October 27, 1921. A third meeting was held on January 19, 1922.

Owing very largely to the excellent preliminary work in this field which the American Gear Manufacturers Association has carried on for a number of years the Sectional Committee is now able to submit a Preliminary Report covering five sub-divisions of its work, namely, (a) Gears and Pinions for Electric Railway Service, (b) Gray-Iron Industrial Spur Gears, (c) Specifications for Forged and Rolled Gear Steels, (d) Specifications for Steel Castings for Gears and (e) Standard Specifications for Brass and Bronzes for gears.

Two reasons prompt the Sectional Committee to publish these proposed standards at this time: *First*, it desires at all times to keep the public fully informed concerning the progress of its work and *second*, it needs the constructive criticism and suggestions of those most interested in the subject. Kindly address the Secretary of the Committee Mr. John P. Kotteamp, care of Pratt Institute, Brooklyn, N. Y. After a reasonable time has elapsed the Sectional Committee will formally present these standards to the two sponsor bodies, who will, on approval, place them before the American Engineering Standards Committee.

Gears and Pinions for Electric Railway Service

CASE-HARDENED FORGED-STEEL GEARS

MANUFACTURE

1 *Material.* All blanks for gears shall be made from open-hearth steel which has been thoroughly worked to secure a homogeneous dense material, free from all injurious defects.

CHEMICAL PROPERTIES AND TESTS

2 *Chemical Properties.* The steel shall conform to the following requirements as to chemical composition.

Carbon.....0.20 per cent, not less than 0.12 per cent nor more than 0.28 per cent.
Manganese..0.50 per cent, not less than 0.40 per cent nor more than 0.60 per cent.
Phosphorus.....not over 0.05 per cent.
Sulphur........not over 0.05 per cent.

3 *Check Analysis.* A check analysis may be made by the purchaser or his representative from one or more gear blanks from each lot of 100 or fraction thereof ordered and this analysis shall conform to the requirements specified above. Sample for check analysis to be taken at the pitch line so that the blank will not be destroyed.

PHYSICAL PROPERTIES AND TESTS

4 *Hardness.* The hardness as shown by the scleroscope shall not be less than eighty, taken at the center of the top of the tooth after treatment.

5 *Treatment.* All gears, after the teeth are cut, shall be carbonized to a depth approximately one-sixth of the thickness of the teeth on the pitch line.

DIMENSIONS AND FINISH

(See Fig. 1)

6 *Diameter.* The outside diameter (A) over the teeth as machined must not vary from that specified by a more than plus zero (0) inch or minus one thirty-second (1/32) inch.

7 *Face.* (*a*) The face (B) of the gears must not vary from the specified width by more than plus one thirty-second (1/32) in. or minus one thirty-second (1/32) in.

(*b*) The minimum thickness of the rim (C) under the teeth shall be as follows, measured one-eighth (1/8) in. from the edge of the rim:

Pitch	Thickness of Rim
3	3/8 in.
2½	7/16 in.
2	½ in.

8 *Web.* The Web (D) of all gears shall have four $3^1/_2$ in. holes on $7^1/_4$ in. radius spaced with a tolerance of one-eighth (1/8) in. in center of webbed section, whenever the space will permit.

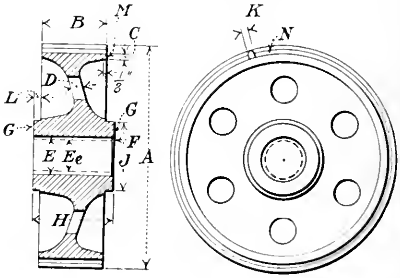


FIG. 1

9 *Bore.* (*a*) The diameter of finished bore (E) shall not vary from that specified by more than plus one-thousandth (0.001) in. or minus one and one-half thousandths (0.0015) in.

(*b*) The diameter of rough bore (Ee) shall not vary more than one-sixteenth (1/16) in. over or one-eight (1/8) under that specified.

(*c*) The ends of finished bores shall be chamfered (F) one-sixteenth (1/16) in. on motor side to avoid injury to shaft when mounting.

(*d*) Bore shall be measured with a pin gage or inside micrometer.

10 *Hub.* (*a*) The face (G) of hub (H), next to lining, shall have a smooth-bearing finish and run true with bore.

(*b*) The variation from the specified dimensions of hub (H) and hub extension (L) shall not exceed the following:

Length of hub (H) overall plus zero (0) in. to minus two-hundredths (0.02) in.
Length of hub extension (L) plus one thirty-second (1/32) in. to minus one thirty-second (1/32) in.
Diameter of hub extension (J) plus zero (O) in. to minus three hundredths (0.03) in.

11 *Teeth.* (*a*) The thickness (K) of teeth at the pitch line must be to specified dimensions as a maximum or to specified dimensions minus ten-thousandths (0.010) in. as a minimum.

(*b*) The teeth shall be of the Brown and Sharpe standard $14^1/_2$ degree involute form unless otherwise specified.

MARKING

12 *Marking.* The information indicated by the following list shall be plainly stamped on motor side of rim (N) of all gears; (*a*) Grade; (*b*) Month, (*c*) Year; (*d*) Serial Number of Manufacturer, (consecutive for each month); (*e*) Name, (initials or trade mark of manufacture).

INSPECTION AND REJECTION

13 *Inspection.* (*a*) All gears shall be tested for smooth running.

The teeth must be equally spaced so that the gear will run smoothly in both directions with a master pinion.

(*b*) Records of all chemical analysis and physical tests shall be kept by the manufacturer and shall be available to the purchaser for a period of one year.

14 *Rejection.* The purchaser should reserve the right to reject any portion of or all of the material which does not conform to the above specifications in every particular.

QUENCHED AND TEMPERED FORGED CARBON-STEEL GEARS

Manufacture

15 *Material.* All blanks for gears shall be made from open-hearth steel which has been thoroughly worked to secure a homogeneous dense material, free from all injurious defects.

Chemical Properties and Tests

16 *Chemical Properties.* The steel shall conform to the following requirements as to chemical composition.

Phosphorus	not over 0.05 per cent.
Sulphur	not over 0.05 per cent.

17 *Check Analysis.* A check analysis may be made by the purchaser or his representative from one or more gear blanks from each lot of 100 or fraction thereof ordered and this analysis shall conform to the requirements specified above. The sample for check analysis to be taken at the pitch line so that the blank will not be destroyed.

Dimensions and Finish

(See Fig. 1)

18 *Diameter.* The outside diameter (A) over the teeth as machined must not vary from that specified more than plus zero (0) in. or minus one thirty-second (1/32) in.

19 *Face.* (*a*) The face (B) of the gears must not vary from the specified width by more than plus one thirty-second (1/32) in. or minus one thirty-second (1/32) in.

(*b*) The minimum thickness of the rim (C) under the teeth shall be as follows, measured one-eighth (1/8) in. from the edge of the rim:

Pitch	Thickness of Rim
3	3/8 in.
2½	7/16 in.
2	½ in.

20 *Web.* The web (D) of all gears shall have four 3½ in. holes on 7¼ in. radius spaced with a tolerance of one-eighth (1/8) in. in center of webbed section, whenever the space will permit.

21 *Bore.* (*a*) The diameter of finished bore (E) shall not vary from that specified by more than plus one-thousandth (0.001) in. or minus one and one-half thousandths (0.0015) in.

(*b*) The diameter of rough bore (Ee) shall not vary more than one-sixteenth (1/16) in. over or one-eight (1/8) under that specified.

(*c*) The ends of finished bores shall be chamfered (F) one-sixteenth (1/16) in. on motor side to avoid injury to shaft when mounting.

(*d*) Bore shall be measured with a pin gauge or inside micrometer.

22 *Hub.* (*a*) The face (G) of hub (H) next to lining shall have a smooth-bearing finish and run true with bore.

(*b*) The variation from the specified dimensions of hub (H) and hub extension (L) shall not exceed the following:

Length of hub (H) overall plus zero (0) in. to minus two-hundredths (0.02) in.

Length of hub extension (L) plus one thirty-second (1/32) in. to minus one thirty-second (1/32) in.

Diameter of hub extension (J) plus zero (0) in. to minus three hundredths (0.03) in.

23 *Teeth.* (*a*) The thickness (K) of teeth at the pitch line must be to specified dimensions as a maximum or to specified dimensions minus ten-thousandths (0.010) in. as a minimum.

(*b*) The teeth shall be of the Brown and Sharpe standard 14½ degree involute form unless otherwise specified.

Marking

24 *Marking.* The information indicated by the following list shall be plainly stamped on motor side of rim (N) of all gears; (*a*) Grade; (*b*) Month; (*c*) Year; (*d*) Serial Number of Manufacturer, (consecutive for each month); (*e*) Name (initials or trade mark of manufacturer).

Inspection and Rejection

25 *Inspection.* (*a*) All gears shall be tested for smooth running. The teeth must be equally spaced so that the gear will run smoothly in both directions with a master pinion.

(*b*) Records of all chemical analysis and physical tests shall be kept by the manufacturer and shall be available to the purchaser for a period of one year.

26 *Rejection.* The purchaser reserves the right to reject any portion of or all of the material which does not conform to the above specifications in every particular.

CASE-HARDENED FORGED-STEEL PINIONS

Manufacture

27 *Material.* All blanks for pinions shall be made from open-hearth steel which has been thoroughly worked to secure a homogeneous dense material, free from all injurious defects.

Chemical Properties and Tests

28 *Chemical Properties.* The steel shall conform to the following requirements as to chemical composition.

Carbon.....0.20 per cent, not less than 0.12 per cent nor more than 0.28 per cent.
Manganese..0.50 per cent, not less than 0.40 per cent nor more than 0.60 per cent.
Phosphorus.....not over 0.05 per cent.
Sulphur........not over 0.05 per cent.

29 *Check Analysis.* A check analysis may be made by the purchaser or his representative from one or more pinion blanks from each lot of 100 or fraction thereof ordered and this analysis shall conform to the requirements specified above. The sample for check analysis to be taken at the pitch line so that the blank will not be destroyed.

Physical Properties and Tests

30 *Hardness.* The hardness as shown by the scleroscope shall not be less than eighty, taken at the center of the top of the tooth after treatment.

31 *Treatment.* All pinions, after the teeth are cut, shall be carbonized to a depth approximately one-sixth (1/6) of the thickness of the tooth on the pitch line.

Dimensions and Finish

(See Fig. 2)

32 *Diameter.* The outside diameter (A) of the pinion shall not vary from that specified by more than plus zero (0) in. or minus one thirty-second 1/32) in. measured at the center of the face.

33 *Face.* The face (B) of the pinion must not vary from the specified width by more than plus or minus one thirty-second (1/32) in.

34 *Bore.* All bores (C–E) must be finished after treatment. The diameter of the bore must be such that the standard plug gauge will not project less than one thirty-second (1/32) in. or more than one-sixteenth (1/16) in. measured at the large end of bore (C) and have bearing the full length of (D) of bore (C–E).

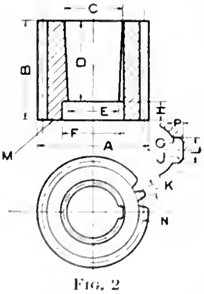


Fig. 2

35 *Counterbore.* (*a*) The depth (H) of the counterbore must not vary from that specified by more than plus zero (0) in. or minus one thirty-second (1/32) in.

(*b*) The diameter (F) of the counterbore must not vary from that specified by more than plus one thirty-second (1/32) in. or minus zero (0) in.

36 *Keyway.* (*a*) The sides (G) of the keyway must be cut parallel with the centerline of pinion.

(*b*) The width (L) of the keyway must not vary from that

specified by more than plus three thousandths (0.003) in. or minus zero (0) in.

(*c*) The depth (P) of the keyway must not vary from that specified by more than plus one sixty-fourth (1/64) in. or minus zero (0) in.

(*d*) The fillet (J) at the bottom of the keyway shall have one-sixteenth (1/16) in. radius. With this specification one-sixteenth (1/16) in. clearance shall be provided between bottom of keyway and pinion key.

37 *Teeth.* (*a*) The thickness (K) of teeth at the pitch line must be to specified dimensions as a maximum or to specified dimensions minus ten thousandths (0.010) in. as a minimum.

(*b*) The teeth shall be of Brown and Sharpe standard $14\frac{1}{2}$ degree involute form unless otherwise specified.

Marking

38 *Marking.* The information indicated by the following list shall be plainly stamped, preferably on the outer end (M), of pinions; (*a*) Grade; (*b*) Month, (*c*) Year, (*d*) Manufacturer's Serial Number (consecutive for each month), (*c*) Name (initials or trademark of manufacturer).

Inspection and Rejection

39 *Inspection.* (*a*) All pinions shall be tested for smooth running. The teeth must be equally spaced so that they will run smoothly in both directions with a master gear.

(*b*) All pinions shall be gaged with a standard taper plug gage, which shall be the same size as the nominal size of the bore at the large end.

(*c*) All pinions shall be free from any seams, cracks or other defects that would in any way affect their service.

40 *Rejection.* The purchaser should reserve the right to reject any portion of or all of the material, which does not conform to the above specifications in every particular.

QUENCHED AND TEMPERED FORGED CARBON-STEEL PINIONS

Manufacture

41 *Material.* All pinions shall be made from blanks of open-hearth steel which have been thoroughly worked to secure a homogeneous dense material, free from all injurious defects.

Chemical Properties and Tests

42 *Chemical Properties.* The steel shall conform to the following requirements as to chemical composition:

Phosphorus.....not over 0.05 per cent.
Sulphur........not over 0.05 per cent.

43 *Check Analysis.* A check analysis may be made by the purchaser or his representative from one or more pinion blanks from each lot of 100 or fraction thereof ordered and this analysis shall conform to the requirements specified above. The sample for check analysis to be taken at the pitch line so that the blank will not be destroyed.

Dimensions and Finish

(See Fig. 2)

44 *Diameter.* The outside diameter (A) of the pinion shall not vary from that specified by more than plus zero (0) inch. or minus one thirty-second (1/32) in. measured at the center of the face.

45 *Face.* The face (B) of the pinion must not vary from the specified width by more than plus or minus one thirty-second (1/32) in.

46 *Bore.* All bores (C–E) must be finished after treatment. The diameter of the bore must be such that the standard plug gage will not project less than one thirty-second (1/32) in. or more than one-sixteenth (1/16) in. measured at the large end of bore (C) and have bearing the full length of (D) of bore (C–E).

47 *Counterbore.* (*a*) The depth (H) of the counterbore must not vary from that specified by more than plus zero (0) in. or minus one thirty-second (1/32) in.

(*b*) The diameter (F) of the counterbore must not vary from that specified by more than plus one thirty-second (1/32) in. or minus zero (0) in.

48 *Keyway.* (*a*) The sides (G) of the keyway must be cut parallel with the centerline of pinion.

(*b*) The width (L) of the keyway must not vary from that specified by more than plus three thousandths (0.003) in. or minus zero (0) in.

(*c*) The depth (P) of the keyway must not vary from that specified by more than plus one sixty-fourth (1/64) in. or minus zero (0) in.

(*d*) The fillet (J) at the bottom of the keyway shall have one-sixteenth (1/16) in. radius. With this specification one-sixteenth (1/16) in. clearance shall be provided between bottom of keyway and pinion key.

49 *Teeth.* (*a*) The thickness (K) of teeth at the pitch line must be to specified dimensions as a maximum or to specified dimension minus ten thousandths (0.010) in. as a minimum.

(*b*) The teeth shall be of Brown and Sharpe standard $14\frac{1}{2}$ degree involute form unless otherwise specified.

Marking

50 *Marking.* The information indicated by the following list shall be plainly stamped, preferably on the outer end (M), of all pinions; (*a*) Grade; (*b*) Month; (*c*) Year; (*d*) Manufacturer, Serial Number of (consecutive for each month); (*e*) Name (initials or trademark of manufacturer).

Inspection and Rejection

51 *Inspection.* (*a*) All pinions shall be tested for smooth running. The teeth must be equally spaced so that they will run smoothly in both directions with a master gear.

(*b*) All pinions shall be gaged with a standard taper plug gage, which shall be the same size as the nominal size of the bore at the large end.

(*c*) All pinions shall be free from any seams, cracks or other defects that would in any way affect their service.

52 *Rejection.* The purchaser should reserve the right to reject any portion of or all of the material, which does not conform to the above specifications in every particular.

Gray-Iron Industrial Spur Gears

Dimensions

1 *Face.* The width of face for industrial spur gears shall be determined by dividing the diametral pitch into 10.

It is recommended that the values given in the following table be used as standard since they agree closely with those obtained by the formula.

Diametral Pitch	Face (In.)	Diametral Pitch	Face (In.)
1	10	4	2½
1¼	8	5	2
1½	7	6	1¾
1¾	6	7	1½
2	5	8	1¼
2¼	4½	10	1
2½	4	12	¾
2¾	3¾	14	¾
3	3½	16	⅝
3½	3	18	½
		20	½

2 *Rim.* The thickness of rim for spoked spur gears of gray iron for industrial work shall be determined by dividing the diametral pitch into 4, or by multiplying the circular pitch by 1.3.

Standard Specifications for Forged and Rolled Steels for Gears

The fifteen steels whose specifications are here proposed for adoption as standards for the gear industry cover the full range of requirements, since, with suitable modifications of heat treatment, it will not be found necessary to go outside this list to secure the physical properties that may be required in the manufacture of gears.

While the table gives all the essential information the following explanatory notes will serve to describe briefly the properties and special uses of the various steels. The specifications are in general similar to those prepared by the Society of Automotive Engineers.

The silicon in all cases is within the limits of 0.10 to 0.25 per cent, while the vanadium for the last three steels listed carries no upper limit. The desired amount is 0.18 per cent.

Where the open-hearth process is specified it is understood that the electric process is an acceptable alternative, but the reverse is not true.

STANDARD SPECIFICATIONS FOR ROLLED AND FORGED STEELS FOR GEARS

No.	Carbon	Manganese	Phosphorus	Sulphur	Nickel	Chrome	Vanadium	Process
								Open Hearth
1015	0.10-.20	0.30-.60	Max 0.045	Max 0.05				O. H.
1020	0.15-.25	0.30-.60	" 0.045	" 0.05				O. H.
1030	0.25-.35		" 0.045	" 0.05				O. H.
1046	0.40-.50	0.30-.50	" 0.045	" 0.05				O. H.
2315	0.10-.20	0.30-.60	" 0.04	" 0.045	3.25-3.75			O. H.
2345	0.40-.50	0.50-.80	" 0.04	" 0.045	3.25-3.75			O. H.
2350	0.45-.55	0.50-.80	" 0.04	" 0.045	3.25-3.75			O. H.
3115	0.10-.20	0.30-.60	" 0.04	" 0.04	1 -1.5	0.45- .75		O. H.
3215	0.10-.20	0.30-.60	" 0.04	" 0.04	1.5—2	0.90-1.25		O. H.
3245	0.40-.50	0.30-.60	" 0.04	" 0.04	1.5—2	0.90-1.25		O. H.
3312	Max -.17	0.30-.60	" 0.04	" 0.04	3.25-3.75	1.25-1.75		Electric
3340	0.35-.45	0.30-.60	" 0.04	" 0.04	3.25-3.75	1.25-1.75		E.
6120	0.15-.25	0.50-.80	" 0.04	" 0.04		0.80-1.10	0.15 min.	O. H.
6145	0.40-.50	0.50-.80	" 0.04	" 0.04		0.80-1.10	0.15 min.	O. H.
6150	0.45-.55	0.50-.80	" 0.04	" 0.04		0.80-1.10	0.15 min.	O. H.

No. 1015 is a low-carbon machinery steel for use in the case-hardened state only, as it is too soft for durable gears unless carbonized. A combination of low carbon and low manganese in this steel also give a core too soft to support heavy loads unless the case is thick. This steel is intended for use particularly in gears of small light sections.

No. 1020 is a low-carbon machinery steel of good quality and low enough in carbon to case harden well. While this is one of the most widely used of gear steels, warning is given to users that a combination of carbon near the high limit and manganese also near the high limit gives a steel which is not desirable for case-hardening use in small cross sections. To avoid this danger, and as the carbon generally tends toward the upper limit, the previous steel No. 1015 is preferable for the small sections and No. 1020 for heavy sections.

No. 1030 is medium-carbon machinery steel of extra good quality, too high in carbon to be case hardened and intended primarily for use in its untreated state, so far as gear work is concerned. For pinions it is suitable to mate with cast-iron gears.

No. 1046 is machinery steel of high enough carbon to be satisfactorily hardened, yet not so high in carbon and manganese as to cause risk when water quenching. This is a development from and an improvement on S.A.E. No. 1045 for gear purposes.

No. 2315 is a low-carbon, 3½ per cent nickel steel for case hardening.

No. 2345 is a 3½ per cent nickel steel of high enough carbon to be hardened directly. This and its companion steel, No. 2315, are very widely known and need no comment.

No. 2350 is a similar 3½ per cent nickel steel with higher carbon, giving better hardening qualities on gears of heavy section. For light sections No. 2345 is preferable.

No. 3115 is a low-carbon chrome-nickel steel suitable for case hardening. It is cheaper and easier to machine than those which follow.

No. 3215 is medium-chrome-nickel steel suitable for case hardening.

No. 3245 is medium-chrome-nickel steel, the companion to the above, but with high enough carbon to harden directly. This is an excellent steel which has recently been adopted by the S.A.E. at the suggestion of the A.G.M.A.

No. 3312 is a high-chrome-nickel steel suitable for case hardening. It is peculiar in having no low limit on carbon, but practically the carbon runs 0.09 per cent at the lowest. Both this and its companion steel, No. 3340, are capable of very fine results, but require careful handling. Note that they are limited to the electrical process of manufacture, though, of course, no exception would be taken to the crucible process.

No. 3340 is a high-chrome-nickel steel similar to the above, but with carbon enough to harden directly. It is subject to the same comments.

No. 6120 is a low-carbon-chrome vanadium steel suitable for case hardening. In this and the two following the desired vanadium is 0.18 per cent, with no definite maximum, only the minimum being rigidly specified.

No. 6145 is similar steel, with carbon enough to harden directly, and recommended for light sections.

No. 6150 is a similar steel with 0.05 per cent more carbon, which enables it to be hardened to give somewhat higher physical properties, especially needed on gears of heavy section.

Standard Specifications for Steel Castings for Gears

For Steel Castings the Section Committee recommends the adoption of the specifications previously developed by the American Society for Testing Materials (A-27-21) with the following modifications:

(1) Paragraph 5 (a):—Add the sentence, "All gear castings must be properly annealed."

(2) Paragraphs 20 to 24 be omitted, as they apply only to ship and railway castings.

Class A castings under this specification are ordinary castings for which no physical requirements are specified. The great majority of gear castings fall in this class. These castings must, however, conform to the requirements of the following chemical composition:

Carbon	not over 0.30 per cent
Phosphorus by acid process	0.07 per cent
Phosphorus by basic process	0.06 per cent
Sulphur	not limited

Standard Specifications for Brass and Bronze for Gears

1 *Spur and Bevel Gears.* For Spur and Bevel Gears, hard-cast bronze, S.A.E. specification No. 62 of the well-known 88 copper-10 tin-2 zinc mixture to the following limits:

Copper	86 to 89 per cent
Tin	9 to 11 per cent
Zinc	1 to 3 per cent
Lead, max	0.20 per cent
Iron, max	0.06 per cent

Good castings made from this bronze should give the following minimum physical characteristics:

Ultimate strength	30,000 lb. per sq. in.
Yield point	15,000 lb. per sq. in.
Elongation in 2 in	14 per cent

2 *Worm Gears.* For Bronze Worm Gears, two alternative analyses of phosphor bronze, both S.A.E. specifications, Nos. 65 and 63, are recommended.

S.A.E. No. 65 (CALLED PHOSPHOR-GEAR BRONZE)

Copper	88 to 90 per cent
Tin	10 to 12 per cent
Phosphorus	0.1 to 0.3 per cent
Lead, zinc and impurities, max.	0.5 per cent

Good castings made of this alloy should give the following minimum characteristics:

Ultimate strength	35,000 lb. per sq. in.
Yield point	20,000 lb. per sq. in.
Elongation in 2 in	10 per cent

S.A.E. No. 63, CALLED LEADED GUN METAL

Copper	86 to 89 per cent
Tin	9 to 11 per cent
Lead	1 to 2.5 per cent
Phosphorus, max	0.25 per cent
Zinc and impurities, max	0.50 per cent

The following minimum physical characteristics may be expected from good castings of this alloy:

Ultimate strength	30,000 lb. per sq. in.
Yield point	12,000 lb. per sq. in.
Elongation in 2 in	10 per cent

3 *Bronze Bushings.* For Bronze Bushing the recommended practice is S.A.E. No. 64, a strong phosphor bronze with excellent anti-friction qualities, and capable of sustaining heavy loads and severe usage. The composition is as follows:

Copper	78.5 to 81.5 per cent
Tin	9. to 11. per cent
Lead	9. to 11. per cent
Phosphorus	0.05 to 0.25 per cent
Zinc, max	0.75 per cent
Other impurities, max	0.25 per cent

Good castings of this alloy should give the following minimum physical characteristics:

Ultimate strength	25,000 lb. per sq. in.
Yield point	12,000 lb. per sq. in.
Elongation in 2 in	8 per cent

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie
Ralph E. Flanders John T. Wilkin
O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Problems Encountered in the Design of High-Pressure Machinery

THE term "high-pressure" is merely a relative one, and as manufacturing processes progress and the methods of handling become more familiar, undoubtedly pressures will increase and the word "high" in this connection become less significant. Two generations ago one hundred pounds steam pressure was relatively high, but as soon as designers and users mastered the problems of higher pressures, the pressures of that day became insignificant.

No doubt as design of apparatus to produce pressure, material, and methods for handling pressure improve, we shall see higher pressures. The present generation of engineers have seen pressures of a thousand pounds, which early in their experience seemed high, placed in the obsolete class, and pressures of two to four thousand pounds are beginning to lose importance on account of improved designs and familiarity with handling.

Pressures of fifteen thousand pounds are now produced and used, but it should not be inferred that any pressure near that amount will become general, for it could not be applied except in special instances; but with the design of apparatus to produce this pressure successfully and the selection of material to handle it safely, many of the pressures now used will lose their designation as "high."

The pressures and problems referred to are some of those encountered in compressing gases for manufacturing and industrial purposes, and in speaking of gases the term is used broadly and intended to include air, oxygen, hydrogen, acetylene, carbonic acid gas, nitrous oxide, ammonia, sulphur dioxide, helium and mixtures of gases.

There are, however, pressures which are still high and which present complex problems to both designer and user, problems in which the character of the gas figures most prominently in designing pressure-producing apparatus and at present controls the pressures within certain limits. In some cases excessive pressures accompanied by sufficient changes in temperature will alter the condition of the gas. The ultimate use of the gas often controls the pressure and design.

In some instances the pressure must be produced without an appreciable increase in temperature, in others the temperature does not figure so prominently, while in still others increases in temperature are necessary during the production of pressure.

The gas itself is a determining factor, for even before design in regard to volumes and pressure, in many instances materials must be considered. Materials which can be used when handling one gas with perfect safety may in the presence of another gas and even at a lower pressure form an extremely explosive compound. Metals that serve satisfactorily in the handling of heavy and dense gases may not be sufficiently close-grained to handle light gases. Sometimes metals cannot be used at all. Where neither of two gases will corrode ordinary materials, sometimes their mixture in certain proportions, even though it is physical and not chemical, will in a comparatively short time ruin anything except special materials.

New combinations of gases are appearing and old combinations which heretofore have not been generally employed have been made available for new uses through the proper design of high-pressure machinery and materials.

The power problem enters prominently, for some gases, like some materials, are very much heavier than others, the heavier gases requiring more power than the light ones, all other conditions being equal.

The leakage of gas during compression and handling also influences the kind of power selected and its application. Some gases when mixed with air will make an explosive mixture and engine-room conditions then become dangerous. Leakage is also dependent to some extent on the lightness of the gas. A light gas will leak faster than a heavy one, and precautions in design must be taken as this leakage might prove a financial loss for certain gases are quite costly.

Lubrication of the compressor is very important, not only in amount but as regards quality and place of injection. In some instances too much lubricant or poor quality causes trouble in the compressor or pipe line. One gas requires a lubricant with water at its base, for if oil were used it would explode. With another gas, which ordinarily would not be affected by oil, a water lubricant must be used on account of the use of the gas after compression. There are gases where no lubricant is required, the gas itself containing sufficient lubricant, while other gases absorb some kinds of lubricant and their subsequent efficiency is impaired. A lubricant may combine with a gas during compression and entirely change the gas. In still another case the ultimate use of the gas determines the lubricant, for ordinary oil would make the gas unfit for use.

After considering the gas, its physical and chemical properties, and the pressures to which it can be safely compressed, the volume to be handled in individual units must be determined. There may be gases which can be handled to high pressures safely in comparatively small volumes, which in large volumes might cause trouble.

The purity of gas entering the compressor is important. Certain gases if pure are safe to compress, but if polluted with other gases may not be dangerous at atmospheric pressure but will explode when compressed. Two gases which when combined in a certain way form part of our bodies and food, when combined in another way will burn steel, and in still another way, though harmless, at atmospheric pressure and temperature, cannot be compressed together without a frightful explosion resulting.

The pressure of the gas at the intake of the compressor is extremely important, for this very materially influences the design of the compressor and is also an important item in determining the power required. Atmospheric pressures varying according to altitude change the design of a compressor often very radically, especially if the final pressure is high.

The particular use of the gas under pressure, whether it is to be used at a constant pressure through comparatively wide limits, or whether the pressure is to be built up from the intake to a certain definite pressure, materially influences the design. Certain features of design are affected if the compressor is to stop and start again during the building up of pressure in the line, particularly if no gas is to be lost. Varying capacities but at constant pressure and varying pressures with varying capacities also require special attention. The nature of the power available or most convenient sometimes changes the whole design. Location of compressor and transportation facilities have been known to control design.

The foregoing are by no means all of the problems existing, and no doubt as new uses for gases are devised new problems will present themselves.

Ebenezer Hill.

The South—A Field for Great Engineering Development

IN Mr. Adsit's paper on Power Development in the Southeast, printed in this issue of Mechanical Engineering, the author takes occasion to emphasize the dependability of the water power of the South. He further states that the resources are available for ample provision of power for the growing industries of that section. In another paper in this issue Mr. F. H. Neely treats of the desirable characteristics of southern labor.

These two statements regarding fundamentals for sound industrial development have led us to look farther into the present status of the South in industry and to ascertain something of its natural resources. Space does not permit a tabulation of facts, but a few statements that show trends will undoubtedly be of interest.

In 1920, nearly one-sixth of the manufactures of the country were produced in the South. In the same year nearly one-half of the active cotton spindles and three sevenths of the active cotton looms were in southern mills and five-eighths of the cotton used in the country was processed in these mills. One-ninth of the country's pig iron and one-half of the lumber came from the South.

We find that all of the bauxite, turpentine and resin of the country is in the limits of the southern states. They also have 60 per cent of the natural gas, 50 per cent of the lumber, 45 per cent of the lead, 42 per cent of the zinc, 30 per cent of the lime, 26 per cent of the coal and 10 per cent of the iron ore.

Furthermore, and contrary to general understanding, there is a large section of the South at an elevation of about 1000 ft. above sea level with a pleasant climate and reasonably constant temperature.

All of the foregoing point to an industrial future for the South which is of great interest to the entire country, for the prosperity and industrial activity of a country must be well distributed to insure the prosperity of the nation. This industrial future must be of even greater import to the engineering profession and especially to the mechanical engineer, the "engineer of industry."

The holding of the Spring Meeting of The American Society of Mechanical Engineers in Atlanta this year will therefore be of great value, not only in stimulating engineering interest in the South but in setting up a contact between southern engineers and those of the rest of the country.

Recognition of Independent Status of the British Royal Air Force

AS the result of a discussion on March 16, 1922, in the House of Commons, the status of the Royal Air Force with respect to the other branches of the British War Establishment has been defined. According to a statement by Mr. Austen Chamberlain as leader of the House, the Government has arrived at the following conclusions:

First, That the Air Force must be autonomous in matters of administration and education.

Second, That in the case of defense against air raids the Army and Navy must play a secondary role.

Third, That in the case of military operations by land or naval operations by sea, the Air Force must be in strict subordination to the general or admiral in supreme command.

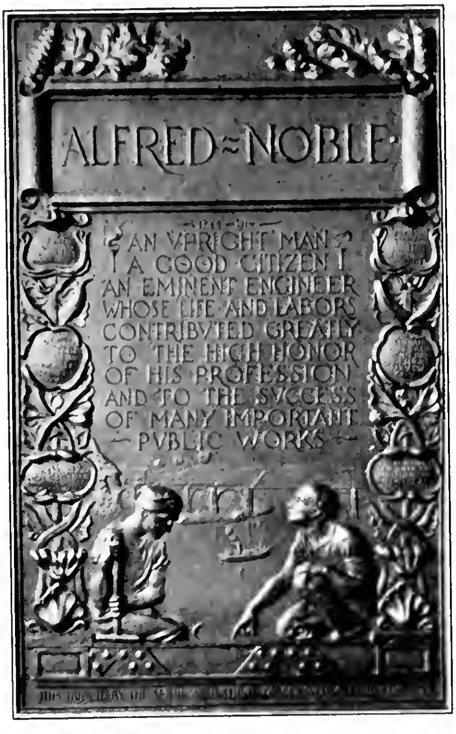
Fourth, That in other cases, such as protection of commerce and attacks on enemy harbors and inland towns, the relations between the Air Force and the other Services shall be regarded rather as a matter of coöperation than of the strict subordination which is necessary when airplanes are acting merely as auxiliaries to other arms.

Lastly, the Government has decided to appoint a committee to examine carefully into the system of naval and air coöperation and to advise how best to insure that the Air Force be enabled to render to the Navy, and also to the other Services, the aid that they may require.

For Great Britain this means definitely that the Royal Air Force becomes henceforth the first line of defense, for obviously the only possible means of attack on the British Isles is by air. The decision of the Government in this connection is in many respects revolutionary, as it subordinates old-established and immensely wealthy services to what is practically a newcomer in the field. Its importance, however, should not be exaggerated, because while the Royal Air Force has been given such prominent tasks to perform, its whole budget barely equals the cost of two capital ships under present conditions.

Alfred Noble Memorial Tablet Unveiled

Impressive addresses marked the unveiling of the Alfred Noble Memorial Tablet in the Engineering Societies Building, New York City, on the afternoon of Wednesday, March 15. The tablet was presented by the American Institute of Consulting Engineers. The American Society of Mechanical Engineers together with the other national engineering societies joined in the tribute to Mr. Noble who had held office in the A.S.M.E. and several of the professional societies, and was a recipient of the John Fritz Medal awarded for achievement in engineering work.



Alfred Noble Memorial Tablet

The ceremonies took place in the entrance hall of the Engineering Societies Building, where the tablet has been placed. Charles Wellford Leavitt, chairman of the Alfred Noble Memorial Committee, delivered the principal address; Dr. Alexander C. Humphreys, president of the American Institute of Consulting Engineers, presented the custody of the tablet to the United Engineering Society, and J. Vipond Davies accepted the tablet, the work of Willard Paddock, on behalf of the Board of Trustees of the United Engineering Society.

Mr. Noble became a member of The American Society of Mechanical Engineers in 1907. From 1912 to 1916 he was one of the managers of the Society, and for the year 1913–1914 he was a member of the Executive Committee of the Society's Council.

The tablet contains this inscription:

"Alfred Noble, 1844–1914. An Upright Man, A Good Citizen, An Eminent Engineer, Whose Life and Labors Contributed Greatly to the High Honor of His Profession and to the Success of Many Important Public Works."

The more important of Mr. Noble's public services are outlined

on the tablet which lists his work from 1904 to 1909 as engineer of the Pennsylvania Tunnels, East River Division, and his services in 1895 with the Nicaragua Canal Commission. Other feats of Mr. Noble's included are his work from 1897–1899 with the U. S. Board of Deep Water Ways; 1872–1882 as engineer of the construction locks at St. Ste. Marie; 1909–1914, consulting engineer of the Catskill aqueduct; Pearl Harbor dry dock in Hawaii; 1899 to 1902, Isthmian Canal Commission; and as resident engineer on the Washington, Memphis and Cairo bridges from 1872 to 1882 He served in the Iron Brigade as a United States soldier from 1861 to 1865.

Edwin Allen Fessenden Accepts Professorship at Rensselaer Polytechnic Institute

Announcement has been made by the Rensselaer Polytechnic Institute that Prof. Edwin A. Fessenden of Pennsylvania State College will become, at the beginning of the next collegiate year, professor and head of its department of mechanical engineering.

Professor Fessenden was born 40 years ago in Butler County, Ohio, but spent his boyhood in St. Louis, Mo. where he attended the St. Louis Manual Training School. Later he entered Washington University and then the University of Missouri, securing at the latter institution the degree of bachelor of science in mechanical engineering in 1906 and two years following, the degree of mechanical engineer. From 1905 to 1907 he was an instructor in mechanical engineering in the University of Missouri and for the next nine years served there as assistant professor and associate professor of mechanical engineering. For one and a half years of this latter period he was in charge of the department of mechanical engineering and also served for a similar period as Acting Dean of the School of Engineering and Director of the Engineering Experiment Station.

From 1916 to the present he has been professor of mechanical engineering and head of the department at Pennsylvania State College and during the last two years has designed and constructed a new mechanical-engineering laboratory for this institution.

His research work at the University of Missouri Engineering Experiment Station included the study of coal weathering and heat transfer in boilers, while he has been the author of various articles in engineering journals, papers and discussions in the proceedings of the A.S.M.E., American Society of Refrigerating Engineers, and Society for the Promotion of Engineering Education, as well as bulletins of the Engineering Experiment Station of the University of Missouri.

Professor Fessenden was elected to full membership in the Society in 1914. He is also a member of the Society for the Promotion of Engineering Education, Sigma Xi, Tau Beta Pi, Sigma Tau and Alpha Tau Omega. He will undertake his new duties in the Fall when the present incumbent of the position, Dr. A. M. Greene, Jr., becomes Dean of Engineering at Princeton University.

Tufts College Giving Lectures by Radio

Probably the first instance of an American college giving instruction by radio is the course of fifteen lectures prepared by the faculty of Tufts College and being broadcasted by the American Radio & Research Corp. from its station at Medford Hill, Mass., twice a week beginning April 6 and concluding May 27.

By tuning the wireless telephone receiving instrument to 360 meter wave length and listening for signal WGI, these lectures, which cover a variety of topics, can be heard any Monday or Saturday evening.

The Word "Symposium" Misused

To the Editor:

I notice that your Society uses the word "symposium" very frequently to indicate a series of meetings to discuss some particular section of our activities, but I think that, if you looked up the meaning of the word, you will agree with me that it is hardly suitable for a "—— country."

Daniel Adamson.

Hyde, Cheshire, England.

Henry Hess, Former A.S.M.E. Officer, Dies

Mr. Henry Hess, Past Vice-President of The American Society of Mechanical Engineers, died at his home in Atlantic City on March 23, 1922. He had been in failing health for the past two years but had been so much improved that he had visited his office in Philadelphia several days before his death.

Henry Hess

Henry Hess was born in Darmstädt, Germany, in March, 1864, and came to the United States when a small boy. His education was received in the New York schools, and was supplemented by several years of additional schooling in Germany. After his return to the United States he was employed at the Watervliet Arsenal, Troy, N. Y., and later at the Niles Tool Works, Hamilton, Ohio. While in the employ of the latter concern he was sent to Germany to erect the German Niles Tool Works at Oberschoeneweide, near Berlin. He remained to have charge of the operation of this plant for two years after its erection. Upon his return to the United States in 1902 he organized the Hess-Bright Manufacturing Co. In 1912 he sold his interests in this company and organized the Hess Steel Corporation of Baltimore, with which organization he was connected at the time of his death.

Mr. Hess became a member of The American Society of Mechanical Engineers in 1906. From 1911 to 1914 he served the Society as Manager, and from 1914 to 1916 as Vice-President. In 1915 he presented to the Society a gift of $2000, the income from which is given annually as the Junior and Student Prizes for the best technical papers by Junior and Student Members. Mr. Hess was past-president of both the Society of Automotive Engineers and of the Philadelphia Engineers' Club; he was a member of the American Institute of Mining Engineers, the American Society for Testing Materials, the American Iron and Steel Institute, the American Electrochemical Society, the American Academy of Political and Social Science, The Franklin Institute, the New York Engineers' Club, the Art Club of Philadelphia and the Economics Club.

During his lifetime Mr. Hess was a contributor to various technical publications. He was a special lecturer at Columbia University on subjects on which he was an authority. Of late years he had been greatly interested in color photography and had lectured on this subject before various organizations.

Mr. Hess is survived by his wife, two daughters and a son, Mr. H. Lawrence Hess of Philadelphia, a member of the Society.

Industrial Teachers' Scholarships for New Yorkers

Within the near future the University of the State of New York will award twenty-five scholarships to qualified trade and technically trained men who desire to prepare themselves for teaching. Each person selected for a scholarship will receive at least $1000 for one school, year period and be required to attend for ten months the Industrial Teacher Training Department of the State Normal School at Buffalo. Upon satisfactory completion of this training course the scholarship holder will be licensed for life to teach his specific occupation in the vocational schools of the state, and under the present schedule will be paid a salary ranging from $1800 to $3500 per annum. The Director of Vocational and Extension Education, State Department of Education, Albany, N. Y. will furnish detailed information and application blanks upon request.

William Newton Best Dies

William Newton Best, one of the very well-known members of the Society in the field of liquid-fuel burning, died in Brooklyn on April 11, 1922. Mr. Best was born at Clayton, near Quincy, Illinois, on June 3, 1860, and attended the public schools there and the Gem City Business College. He then went into railroad work and continued in various capacities until 1901, when he resigned his position as superintendent on the Los Angeles and Salt Lake Railroad to begin the manufacture of his own inventions. At the time of his death he had U. S. letters patent covering forty-four devices, most of them relatting to the oil-burning industry, and was president and consulting engineer of the W. N. Best Furnace and Burner Corporation at 11 Broadway, New York.


William Newton Best

Dr. Best was the author of the book Science of Burning Liquid Fuel, and in 1917 the honorary degree of Doctor of Science was conferred on him by the Lincoln Memorial University, Cumberland Gap, Tenn., of which he was for some time a member of the Board of Trustees.

He became a member of the A.S.M.E. in 1912; he was one of the committee appointed in 1918 to revise its Boiler Test Code, and served for some time as its representative on the Board of the Engineering Societies Library. He was also a Fellow of the Royal Society of Arts, London, and a member of the American Institute of Mining and Metallurgical Engineers, the American Institute of Metals, the International Railway Fuel Association, American Railway Master Mechanic's Association, The Franklin Institute, the Aero Society of America and of the New York Academy of Sciences.

He was also a member of the Long Island Lodge 382 F. and A. M., vice-president of the Board of Directors of the Goodwill Industries of Brooklyn, Inc., vice-president of the Board of the Williamsburgh Rescue Mission, Inc., and a member of the Board of Governors of the Neponsit Club of Long Island.

Dr. Best will be missed by a host of friends, as well as in the many activities in which he was interested.

Meeting of the Taylor Society

One of the best-balanced and most successful meetings that the Taylor Society has ever held took place at the City Club, Philadelphia, March 16 to 18. The City Club and the Engineers' Club of Philadelphia extended guest privileges to both members and guests and approximately 450 were in attendance.

At the opening session on Thursday morning Dr. H. S. Person, Managing Director of the Society, presided and John M. Holcombe, Jr., manager Sales Research Division, Phoenix Mutual Life Insurance Company, Hartford, Conn., read a paper entitled A Case of Sales Research. Studies in territory analysis, the selection of salesmen, rating scales, personal-history blanks, and in general somewhat the same system of investigation used for classifying their risks was outlined as applied to the sales force.

In the afternoon, with Richard A. Feiss, President of the Society, in the chair, The Problem of the Chief Executive was presented by Henry P. Kendall, of Boston. Mr. Kendall's position as one of our younger captains of industry who has developed scientific management in one plant after another in accordance with a consistent policy for a number of years, lent additional interest to his paper. On Friday Mrs. L. M. Gilbreth, due to Mr. Gilbreth's absence abroad, read a paper on Super-Standards which won much approval. The general use of the title word was deplored as limiting, since the super-standard of today is the standard of tomorrow. At the afternoon session George E. Frazer of Frazer and Torbet, Chicago, read a paper on Budget Control in which the necessity in industry for coöperation on financial considerations throughout the departments was emphasized.

The current series of articles in the *Atlantic Monthly* by Arthur Pound attracted particular attention to his address, which he entitled Mills and Minds. His statement that the industrial problem of today is that of labor rather than material and that the principles of psychology should be applied to industrial management, was most favorably received.

The closing session was devoted to two papers in the field of operating technique. The first, by Percy S. Brown, works manager of the Corona Typewriter Company, was called String-Board Graphics, and described an effective method of this type of control at his plant. The second, The Work of the Balance-of-Materials Clerk, by Thomas W. Mitchell, management engineer, Philadelphia, described the standard Taylor method in the particular field considered, and was the first of a series which he is preparing on standard Taylor practice.

Power Show to Follow 1922 Annual Meeting

The tentative program for the 1922 A.S.M.E. Annual Meeting calls for a Session of the Fuels Division on Wednesday, December 6, and a session of the Power Division on Thursday morning December 7. At noon on Thursday the Exposition of Power and Mechanical Engineering will be opened in the Grand Central Palace. This exposition will include apparatus employed in the generation, distribution and use of power. The managers of the show have had considerable experience in the conduct of various chemical, flower and automobile shows, in which they have been successful in developing large, highly educational exhibitions of proven value to technicians and industries.

An advisory committee has been appointed to assist in determining the policies of the exposition. This committee includes the names of the presidents of The American Society of Mechanical Engineers, The National Electric Light Association, and the National Association of Stationary Engineers.

"Luminaire"—a Good Substitute for a Bad Combination

The coming into vogue of appliances which can be removed from place to place and to which the misnomer "movable fixtures" has been attached has brought the matter particularly to the attention of the lighting people. The Illuminating Engineering Society referred the consideration of this question to its Committee on Nomenclature and Standards with the suggestion that a term be recommended. Requests for suggestions of suitable terms were sent out to the membership of the Society and a considerable number of such suggestions were received. It was found, however, that most of the terms proposed were manufactured or coined words which had no legitimate ancestry and were therefore objectionable. Among the terms suggested, however, was one which met with the approval of the Committee; namely, the word "luminaire." This word is used in this connection in the French language. Its construction and ancestry are such that it can be adopted into the English language as readily as "garage," "hangar," etc., which have recently been taken in. The significance of the word is evident on the face of it. It is believed that this word could and should be introduced into the English language and that it would be a distinct advantage so to do.

The Committee on Nomenclature and Standards recommended the use of this generic term for "lighting unit" in its report as presented to the annual convention of the Society at Rochester last September.

The Council of the Illuminating Engineering Society at the March meeting formally approved and adopted the use of the word "luminaire."

An expression of opinion favorable to the adoption of this term has been received from Engineering Societies and other organizations.

Engineering and Industrial Standardization

Agreement Near on Machine-Screw-Thread Standardization in This Country

FOR the past eight months the Sectional Committee on the Standardization and Unification of Screw Threads, Luther D. Burlingame, Chairman, has been making a careful review of the Progress Report of the National Screw Thread Commission published in the Spring of 1921. The Working Sub-Committee of seven, to which the detailed study was assigned, reported its findings to the Section Committee on March 15. This report is in the form of a working manual on the American machine-screw thread and is based entirely on the N.S.T.C. Report. It omits, however, all reference to the loose fit, pipe thread, methods of gaging, and fire-hose couplings, all of which are treated by the Commission.

The Sectional Committee examined this manual very thoroughly, and after making numerous suggestions referred it for final revision to a special committee consisting of Messrs. Elwood Burdsall, Ralph E. Flanders, and Earle Buckingham. The Sectional Committee also instructed Messrs. Wells, Ehrman, Flanders, and Buckingham, who are members of the N.S.T.C. as well as members of the Sectional Committee, to confer informally with the Commission on certain points. This was done on March 17 in Washington at a regularly called meeting. The results of this informal conference were very satisfactory to all concerned. Within a very short time, therefore, American screw-thread practice will be completely unified on paper at least, and a working manual will be ready for printing and distribution. All those interested in securing copies of this manual are requested to communicate with the Secretary to the Committee, C. B. LePage, 29 West 39th Street, New York.

Building Construction and Standardization

It has been estimated that the suspension of building during the war has produced a national shortage of dwelling houses of close on to a million, and due to high costs post-war building operations have been too limited to bring about any material change in the situation.

Herbert Hoover, Secretary of the Department of Commerce, has given this problem some attention during the past few months and is devoting the resources of his department to its solution. It is his opinion, however, that on each community rests the responsibility of solving its housing problem. He holds that we are, or should be, a country of local community action and that the province of the Federal Government is to stimulate and assist local action.

Each local community must in a large measure solve its housing problem since the three principal factors entering into it have, at present at least, large local significance. Cost of materials, cost of labor, and available home-building capital are of necessity different in the various localities. If the local community develops its own resources in each of these items, high railroad rates need not be considered.

In this activity the Department of Commerce is working through a broadly representative central Building Code Committee with Dr. Ira H. Woolson as its chairman. Its first effort was to bring about local conferences on the housing situation in the different cities with a view to ameliorating conditions. These conferences have been held in over one hundred cities with the coöperation of many unofficial bodies. The latter comprised chambers of commerce, labor organizations, building and other trade associations, bankers, material manufacturers, and contractors. Through these conferences and through other forms of local initiative a very considerable amount of good has been accomplished, although the results have varied a great deal between cities. Positive plans have been worked out in many of them and great stimulation to home building has ensued. Where they have gone upon the rocks it has been due to corrupt conditions of the building trades or to wage questions.

The Building Code Committee has, in addition to its local effort, created a number of agencies for the purpose of securing constructive solution to some of the more general problems. Various special committees have been formed and are engaged in sincere efforts in the following fields: Standardization of Contractor's Specifications; Simplification of Plumbing Requirements and Practice; Standardization of Clay Products, Lighting Fixtures, Lumber, Paint and Varnish and Standardization of the elements in House Design. These efforts at standardization and simplification are directed against the high cost of material; it is hoped, however, that they will also have their effect in reducing the labor cost of buildings.

The Committee on Plumbing Specifications is making good progress and is directing a considerable amount of experimental work which is being carried on at the Bureau of Standards. It, as well as the general committee, is also in close touch with the American Engineering Standards Committee, through which they receive the support and assistance of its member-bodies.

Bolt, Nut and Rivet Proportions

On Thursday, March 16, the Sectional Committee on Bolt, Nut and Rivet Proportions held its organization meeting in New York. Though the personnel of this Sectional Committee is not yet complete, 23 of its members attended this meeting. The manufacturers were represented by 12, the Consumers by 9, and the General Interests by 2. The Consumers' group consisted of representatives of nine societies and associations.

After attending to certain organization matters the scope of the committee's work was informally but very fully discussed. As a result of which, it was decided to divide the field into seven more or less distinct parts. Through the medium of a special Committee on Committees the personnel of the corresponding seven sub-committees was tentatively determined and, in the afternoon following the meeting of the Sectional Committee, four of these Sub-Committees organized and made plans for the preliminary collection of data and information. The names of the seven Sub-Committees with their officers are given below.

1 *Sub-Committee on Large and Small Rivets*
    G. W. NELSON, *Chairman*
    F. W. FRITCHEY, *Secretary.*
2 *Sub-Committee on Wrench Heads and Nuts*
    G. F. JENKS, *Chairman* and *Secretary.*
3 *Sub-Committee on Slotted Heads*
    E. WINSOR REED, *Chairman*
    E. M. WHITING, *Secretary.*
4 *Sub-Committee on Track Bolts*
5 *Sub-Committee on Carriage Bolts*
6 *Sub-Committee on Special Bolts and Nuts for Agricultural Machinery*
    E. P. STAHL, *Chairman.*
7 *Sub-Committee on Body Dimensions and Material*
    S. F. NEWMAN, *Chairman.*

Code for Electricity Meters

The National Electric Light Association and the Association of Edison Illuminating Companies have submitted to the American Engineering Standards Committee for approval as American Standard the Code for Electricity Meters, known as the "Meter Code."

Nine of the ten sections of the present code were prepared in 1912 by a joint committee of the two associations and representatives from the Electrical Testing Laboratories, from the leading meter-manufacturing companies and from public-service commissions and other regulatory bodies organized for the purpose of supervising electric service.

The code contains a tenth section, Parts A, B, and C of which were brought out in 1916 and Parts D and E in 1920. The organizations presenting the code for approval state that it represents in crystallized form standard American meter practice as nearly as it has been possible to determine it by impartial consideration and criticism.

The American Engineering Standards Committee would be very glad to learn from those interested of the extent to which they make use of this Standard and this Code. It desires also to receive any other information regarding the code in meeting the needs of the industry.

LIBRARY NOTES AND BOOK REVIEWS

Library in Need of Proceedings

The Engineering Societies Library requires the Proceedings of the American Railway Engineering Association for 1918, 1919 and 1920 to complete its file, but due to the fact that these issues are out of print it has been unsuccessful in securing them through the regular channels.

Any member of the Society having these copies and presenting them to the Library, would be coöperating in the proper preservation of engineering records for reference use and the benefit of the profession.

Work of Recataloging Engineering Library Steadily Progressing

Members of the Society will be interested to learn that the work of recataloging the vast number of volumes composing the Engineering Societies Library is progressing so well that to date about 65 per cent has been completed. This means that since the task was started in July, 1919, 52,111 volumes, representing 14,745 titles, have been cataloged; 33,513 subjects have been made available and author entries for all books have been added to the catalog while 103,809 cards have been filed.

The great care and accuracy required in compiling a catalog of books is beyond the comprehension of most persons unfamiliar with such work. A catalog is not merely a list of books. Unless it discloses the purpose of each book and reveals its contents in such a way as to inform the research worker, it is not presenting the resources of the library. It must be made with both the reader and the book in mind and should be so suggestive as to lead the man to all available references. The catalog cannot be an exhaustive index but rather it is a sign board to point the way to detailed material which the reader can follow up and exhaust for himself. The proposed catalog of the Engineering Societies Library, through its detailed subject index, will reveal much more specific references than would be possible in any other type of catalog.

In the preparation of the catalog, the books must first be classified and book classification is a science. Under the subject of railroads, for example, it is not enough to know that there are books on locomotives, terminal stations, signals, road beds, rolling stock, etc., but the classifier must first realize that the two main divisions of this subject are the engineering or construction and the transportation and economy, and that the literature on the subject will naturally fall into one of these groups. By the use of classification charts the limitations of groups are clearly defined, important points that it is necessary to keep in mind when analyzing the books are determined, and a sensible general guide established.

The next step is to decide the correct subject of each book, not simply by the title page, but through a careful perusal of the text. One book can stand in only one place on the shelves, but the same book can appear in any number of places in the catalog, and the great advantage of a catalog which gives an analysis of a book from all angles must be developed to the highest degree.

Then follows indexing under authors and perhaps contributing editors, and finally the assignment of a symbol by which it can be identified. A record of these symbols is kept, together with the author and title they represent, and it serves as an inventory of the books as they stand on the shelves.

The whole undertaking requires the most careful and painstaking work, with each book being handled from fifteen to twenty times after its receipt from the publishers until it is placed on the shelves. However, the results justify the time, labor and funds expended. With less than three-quarters of the books completely analyzed, it has been found that the efficiency of the library has increased in amazing proportions, as is apparent to the members of the library staff who daily answer many inquiries covering a great variety of subjects.

Book Notes

Aggregation and Flow of Solids. By Sir George Beilby. Macmillan and Co., Ltd., London, 1921. Cloth, 6×9 in., 256 pp., illustrated with plates, 20s.

The molecular structure and physical properties of matter in the solid state have engaged the author's attention for many years, and from time to time papers embodying the results from particular researches have been published. The entire series of investigations has now been collected and sifted, and the results appear in the present volumes as a consecutive whole. The book is an interesting record of actual experimental observations, many of which have important industrial applications, and a summary of the conclusions reached by the author as to the meaning of the phenomena observed. A large number of excellent photomicrographs are included.

Blue Printing and Modern Plan Copying. By B. J. Hall. Sir Isaac Pitman & Sons, Ltd., New York, 1921. Cloth, 5 × 8 in., 130 pp., illus., $2.

Of interest to engineers who have plans to be copied, to installers of copying plants and to operators. The first section of the book discusses the capabilities of contact photography and allied processes for copying drawings, as well as the proper preparation of drawings for reproduction. Section two describes the machinery and apparatus used in blueprinting plants. The concluding section deals with the layout of blueprinting rooms and methods of working. The treatment includes both contact and camera processes.

Cotton Facts. Compiled and edited by Alfred B. Shepperson. Revised and enlarged by C. W. Shepperson. Shepperson Publishing Co., New York, 1921. Cloth, 4 × 7 in., 180 pp., portraits, map.

A convenient compilation of commercial and financial information required by those engaged in the cotton industry, which has appeared annually for forty-six years.

Descriptive Geometry. By George Young and H. E. Baxter. The Macmillan Co., New York, 1921. Cloth, 5 × 8 in., 310 pp., diagrams, $3.25.

Believing that the chief value of descriptive geometry lies in its imaginative quality, these authors present it so as to develop the imagination; and therefore they encourage intuitive rather than rigidly formal methods. The treatment has been kept purely abstract, in order to avoid the tendency of the subject to degenerate into practical rules and formulas; introductory matter showing the relation of the principles under discussion to structural work is provided, and exercises to show the application of the abstract ideas to concrete, practical problems are included.

Distribution of Gas. By Walter Hole. Fourth edition. Benn Brothers, Ltd., London, 1921. Cloth, 7×10 in., 699 pp., illustrated with diagrams, 50s.

This book is uniform in size with Mead's Modern Gasworks Practice, to which it forms a fitting companion. That work treats of gas manufacture; this takes up the account at the gas holder and discusses the distribution to the consumers' appliances. The scope of the volume is a wide one. The opening chapter discusses the rights and duties of gas undertakings. Succeeding chapters treat of discharges from pipes, station governors, districting, pipes and joints of iron and steel, mainlaying, valves and cocks, conduits, service pipes, meters, internal fitting, internal lighting, gas stoves and heaters, gas engines, industrial uses of gas, pressures, complaints and repairs, street lighting, high-pressure distribution, high-pressure lighting and heating, leakage, electrolysis and fusion. The information given is thoroughly representative of current practice. All obsolete matter has been deleted in preparing this new edition and much that is new in connection with this work has been added.

Dynamic and Static Balancing. By Edward K. Hammond. First edition. Industrial Press, New York, 1921. Paper, 6×8 in., 58 pp., illus., $0.50.

A discussion of the principles of balancing, with a description of machines and methods, written in simple language. Intended for shopmen. Avoids mathematical theory.

Die Eisenkonstruktionen. By L. Geusen. Third edition, revised. Julius Springer, Berlin, 1921. Cloth, 8×11 in., 282 pp., diagrams, tables, 384 marks.

This textbook for students of structural engineering is divided into three sections, treating respectively of the principles, of steel buildings, and of bridges. By this arrangement the general rules and methods governing steel structures are taught first and emphasized by suitable problems, taken from practice. The application of these methods in framing buildings and bridges is considered in the later sections. The text is concise and illustrated by numerous drawings. An appendix contains the necessary tables of the properties of structural shapes.

Die Wasserversorgung der Staedte. By O. Smreker. Fifth edition. Wilhelm Engelmann, Leipsig, 1914. Cloth, 7×10 in., 522 pp., illus., diagrams, tables, 57 Marks.

This work forms the third of the twelve volumes upon hydraulic engineering which constitute the third section of the Handbuch der Ingenieurwissenschaften, and is concerned with municipal water supplies. The present edition has been thoroughly revised, both with respect to arrangement and contents. The arrangement follows the course of operations used in securing a water supply, discussing first the preliminary studies of the amount, quality and occurrence of the available sources, then the design of the plant in general. Succeeding chapters discuss the winning and purification of water, pumping and conveying, and the operation of waterworks. Attention is directed toward general principles, rather than to the details of specific installations.

Electric Arc Welding. By E. Wanamaker and H. R. Pennington. Simmons-Boardman Publishing Co., New York, 1921. Cloth, 6×9 in., 254 pp., illus., $4.

This manual is based largely on a series of articles published in the *Railway Electrical Engineer*. It contains a large amount of practical information on many phases of the subject; descriptions of systems and their installation, phenomena of metallic and carbon welding arcs, training of welders, sequence of metal deposition for various types of joints and building-up operations, electrodes, thermal disturbances due to welding, properties of welds, efficiency of equipments and costs. The book is confined to autogenous arc welding.

Electric Ship Propulsion. By S. M. Robinson. Simmons-Boardman Publishing Co., New York, 1922. Cloth, 6×9 in., 274 pp., illus., diagrams, $6.

This volume treats of the special questions relating to steam turbines, electric generators, induction motors and other machines, which arise in connection with the propulsion of ships by electricity, and compares this method with others. The various systems are explained and compared. The installations on several ships of the Navy and on the *Wulsty Castle*, which illustrate the application of various systems, are described in detail.

Elements of the Differential and Integral Calculus. By William S. Hall. Second edition, revised. D. Van Nostrand Co., New York, 1922. Cloth, 6×9 in., 250 pp., $2.75.

This textbook is an endeavor to present the calculus and some of its important applications simply and concisely, yet fully enough to make possible the study of subjects that call for knowledge of it. In this new edition chapters 1, 4 and 5 have been rewritten, other revisions have been made and many new problems added.

L'Ether Actuel et ses Precurseurs. By E. M. Lémeray. Gauthier-Villars et Cie, Paris, 1922. (Actualités scientifiques.) Paper, 5×7 in., 141 pp., 6 fr.

The author of this book, an early student of the investigations of Lorentz and Einstein, is a master of the theories of relativity and has written several summaries of them. In the present work he traces the development of the idea of the ether, which these theories tend to modify anew. The book is the result of an extensive examination of the history of science. Beginning with the ideas of the Chaldeans and Egyptians concerning a universal spirit, the modifications due to the Greeks and Romans, the ether of Huyghens, phlogiston, caloric, the ether of Fresnel and that of later students are described.

Factory Administration in Practice. By W. J. Hiscox. Sir Isaac Pitman & Sons, Ltd., New York, 1921. Cloth, 6×9 in., 214 pp., $2.50.

Most of the books on factory administration seem to have been written by accountants for accountants, our author thinks, and as a consequence have disregarded factory conditions to some extent. The present work is written from the factory viewpoint, and is intended for the works manager, the foreman and all members of the factory administrative staff. The views and schemes set forth are the results of sixteen years' practical experience with engineering firms in Great Britain. Special prominence is given to the progress system.

Giesserei-Handbuch. Herausgegeben vom Verein Deutscher Eisengiessereien Giessereiverband in Düsseldorf. R. Oldenbourg, München, 1922. Cloth, 7×10 in., 264 pp., tables, 300 M.

This handbook has been prepared by the German Iron Founders' Association as a convenient compendium of data used by foundry men. It includes the standards adopted by many European railroads, by associations and societies, methods for the analysis of cast iron, coal, coke, slags and flue gases, physical data for iron and other materials, the German standards for cast-iron pipe, tariff and statistical data concerning the trade, trade associations, and directors of German foundries and foundry-supply dealers.

Grundlagen der Flugtechnik. By H. G. Bader. B. G. Teubner, Leipzig, 1920. Paper, 6×9 in., 194 pp., $2.90.

A work for designers of airplanes, dealing with the calculations required and the proper methods and formulas. Covers all the calculations that are needed in practical design and illustrates their uses by application to the calculation of a concrete example. Contains a brief bibliography.

Heating and Ventilation. By John R. Allen and J. H. Walker. Second edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 332 pp., illus., diagrams, tables, $3.50.

A textbook for use in engineering and architectural schools, intended also for use as a handbook by engineers and architects. A second edition has become desirable because of the advances in the art made recently, such as the establishment of standards for ventilation and the results obtained in the research laboratory of the American Society of Heating and Ventilating Engineers. The text has been thoroughly revised and enlarged to include recent developments.

Hydraulics of Pipe Lines. By W. F. Durand. D. Van Nostrand Co., New York, 1921. (Glasgow textbooks.) Cloth, 6×9 in., 271 pp., diagrams, $4.50.

Intended to give a discussion, in engineering form, of the more important hydraulic problems which arise in connection with pipe lines and pipe-line flow. No attempt is made to treat the subject structurally or descriptively. The successive chapters discuss general hydraulic principles, surge, water ram or shock, stresses in pipe lines, materials, construction, design, and oil pipe lines.

Jigs and Fixtures. By Albert A. Dowd and Frank W. Curtis. First edition. McGraw-Hill Book Co., Inc., New York, 1922. (Tool engineering.) Cloth, 6×9 in., 293 pp., diagrams, $2.50.

This book, the first of three upon the principles underlying the design of production tools, deals with the design of jigs and fixtures for drilling, indexing, milling, profiling, broaching, riveting, etc. A chapter is devoted to vises and vise fixtures. The work deals with principles, although many interesting fixtures are shown to

illustrate their use. The important points connected with the design and the relative desirability of various designs are discussed.

Modern Gasworks Practice. By Alwyne Meade. Second edition. Benn Brothers, Ltd., London, 1921. Cloth, 7×10 in., 815 pp., illus., diagrams, 55s.

The first edition of this book appeared in 1917 and quickly became out of print, through the immediate recognition of its worth as the most complete, authoritative account of modern practice extant. The new edition, while retaining all the merits of the first, has undergone an increase in bulk of 50 per cent through the addition of new matter, and has also been largely rewritten to take account of the upheaval in the technique of gas-works practice in England, caused by the substitution of a calorific standard for the former candlepower standard. Every phase of the works side of gas engineering is covered, from the planning and construction of gas works to the storage of the gas and recovery of the by-products. As a general work of reference, the book is of the greatest value to all engaged in the gas industry.

Operating Engineer's Catechism of Steam Engineering. By Michael H. Gornston. D. Van Nostrand Co., New York, 1922. Fabrikoid, 5 × 8 in., 428 pp., diagrams, $4.

An elementary textbook upon the construction and operation of boilers, steam engines and turbines, heating apparatus and pumping machinery, prepared for operating engineers. Covers the problems that confront the engineer with unusual fullness and is well indexed. Should be of assistance to those preparing for examination and as a pocket reference book.

Petroleum. By Sir Boverton Redwood. Fourth edition. J. B. Lippincott Co., Philadelphia, 1922. Cloth, 6 × 9 in., 3 vol., maps, plates, illus., tables. $21.

Sir Boverton Redwood's classic work is the product of a long professional career as a petroleum technologist, during which he acquired first hand knowledge of oil production, oil fields and oil men in all the important fields of the globe. He was, until his death, in touch with every source of information on petroleum. The material collected, after being critically sifted in the light of his broad experience, has resulted in a book that for twenty-five years has been recognized as an authoritative reference work. The present edition was in preparation when the author died, in 1919, and certain portions had received his final revision. The remaining portions have been revised by his friends, and the work has been seen through the press by A. W. Eastlake and Robert Redwood.

The general plan of previous editions is retained, although the entire work has been reset. Commencing with a historical account of the industry, the distribution, physical and chemical properties, and origin of petroleum are discussed in volume one. Volume two is devoted to production, refining, transportation, storage and distribution, and to the shale oil industry. Volume three treats of testing, uses, and laws; it also contains statistics, import duties and an extensive bibliography. This contains nearly nine thousand references; unfortunately, few, if any, are later than 1911.

Principles and Design of Foundation Air Brake Rigging. Air Brake Association, New York, 1921. Boards, 6×9 in., 121 pp., diagrams, $1.

In the interest of higher air-brake education, the Air Brake Association has secured from the Westinghouse Air Brake Company the right to publish this study of some of the finer points that contribute to the efficiency of air brakes. The book is the joint product of experienced engineers and should be useful to all users and designers of brakes.

Probenahme und Analyse Von Eisen und Stahl. By O. Bauer and E. Deiss. Zweite auflage. Julius Springer, Berlin, 1922. Cloth, 7×10 in., 304 pp., illus., 472 M.

This work presents methods for sampling and analyzing iron and steel adopted by the authors for their work at the National Testing Laboratory in Berlin. The first section, by Prof. Bauer, discusses sampling, emphasizes the importance of proper sampling and gives much information upon proper methods of taking, polishing and etching samples for microscopic examination. The metallographic characteristics of the constituents of iron and steel are described and directions given for securing representative samples of iron and steel for examination. The second section, by Prof. Deiss, gives reliable methods for the accurate chemical determination of the various constituents of iron and steel. This edition has been carefully revised and enlarged.

Questions and Answers Relating to Diesel, Semi-Diesel and Other Internal-Combustion Engines; Air Compressors, etc. By John Lamb. J. B. Lippincott Co., Philadelphia, 1922. Cloth, 4×5 in., 209 pp., $2.50

A small pocket book of practical information for steam engineers and others preparing for license examinations.

Real Mathematics. By Ernest G. Beck. Henry Frowde and Hodder & Stoughton, London, 1922. (Oxford technical publications.) Cloth, 5×8 in., 306 pp., diagrams, 15s.

This book is intended to assist in the acquisition of a real, serviceable, sound mathematical equipment, by augmenting standard textbooks and orthodox methods of study. The author hopes it will contribute toward the adoption of a change of attitude toward mathematics by those who require it as a part of their working equipment, by showing it as an actual, tangible reality, instead of a collection of rigid and unrelated rules and formulas. The method given assists the student to visualize the various operations and processes used in mathematical calculation.

Textbook of Fire Assaying. By Edward E. Bugbee. John Wiley & Sons, Inc., New York, 1922. Cloth, 6 × 9 in., 254 pp., illus.

Based upon the course at the Massachusetts Institute of Technology and intended as a college textbook; but will also be useful, the author hopes, to more mature students. An endeavor has been made to give the scientific reasons underlying the phenomena that occur and the rationale of the processes and manipulations, and to avoid the character of a mere receipt book.

Theory of the Induction Coil. By E. Taylor-Jones. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. Cloth, 5×8 in., 217 pp., illus., $3.50.

Until recently there has been much divergence of view as to the manner in which the high potential is generated at the secondary terminals of an induction coil when the primary current is interrupted, and it cannot be said even now that opinion on the subject is quite undivided. In this book an account is given of a theory of the action of induction coils first put forward by the author in 1909. The theory was originally intended to apply only to the case of an air-core induction coil having a condenser connected with its secondary terminals. Subsequent investigations have shown that it is also applicable to an ordinary induction coil.

Valuation of American Timberlands. By K. W. Woodward. John Wiley & Sons, Inc., New York, 1921. Cloth, 6×9 in., 246 pp., maps, $3.

Gives the principal facts regarding the timber resources of the continental United States and its outlying territories, excepting Hawaii and the Canal Zone, in a form suited to the needs of investors, timber cruisers and students of forestry. Contains descriptions of the forest types of the country, and comparisons of their values.

Vervollkommnung der Kraftfahrzeugmotoren Durch Leichtmetallkolben. By Gabriel Becker. R. Oldenbourg, München, 1922. Paper, 7×11 in., 97 pp., illus., 75 M.

The first section of this work discusses the possibilities for improving automobile construction by reducing wind resistance and weight, increasing the size and efficiency of the engines, or by perfecting the engines thermodynamically and structurally. The second and longer section gives the results of an interesting series of tests upon light metal pistons, made in 1921 at the automobile testing laboratory of the Berlin Technical High School, under the direction of the author, with the assistance of the German Engine Manufacturers' Association. Extensive tests of 16 different aluminum- and magnesium-alloy pistons are presented and compared with tests of cast-iron and pure copper pistons.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVES

Properties and Uses. Grinding Wheels (Les Meules Artificielles), E. Assié. Arts et Métiers, vol. 74, no. 12, Sept. 1921, pp. 265–270, 7 figs. Discusses abrasives, carborundum, corundum, melting points, resistance to acid, use as refractories, etc.

ACCELEROMETERS

Auclair and Boyer-Guillon. Auclair and Boyer-Guillon Accelerometers (Les accéléromètres Auclair et Boyer-Guillon), A. Boyer-Guillon. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 9, Nov. 1921, pp. 1167–1191, 19 figs. Describes weight, spring and triple-recording accelerometers, and their application in determining acceleration and periodical movements.

ACCIDENTS

Placing Responsibility. Placing Responsibility for Accidents, H. L. Keely. Management Eng., vol. 2, no. 3, Mar. 1922, pp. 149–152, 3 figs. Through classifying according to kind and cause and by estimating cost of remedies.

ACCOUNTING

Pig-Iron Production. Accounting for Pig-Iron Production, Nathaniel B. Bergman. Jl. of Accountancy, vol. 33, no. 2, Feb. 1922, pp. 90–99. Discusses blast-furnace operations and how to deal with them in accountancy.

AERODYNAMICS

Resistance of Bodies. Influence of Model Surface and Air Flow Texture on Resistance of Aerodynamic Bodies, A. F. Zahm. Nat. Advisory Committee for Aeronautics. Report no. 139, 1922, 6 pp. Deals with resistance of smooth models in a smooth stream; resistance as a function of surface texture and of flow texture. More general resistance formulas.

Standardization. Standardization in Aerodynamics, W. Margoulis. Aerial Age, vol. 14, no. 26, Mar. 6, 1922, pp. 614–615. Agrees with article of same title by W. Knight, published in Aerial Age, June 20, 1921, as to standardization on basis of experiments of American, British, French and German quasi-official laboratories.

AERONAUTICS

Hydrodynamics, Application of. Applications of Modern Hydrodynamics to Aeronautics, L. Prandtl. Nat. Advisory Committee for Aeronautics, Report no 116, 1921, 61 pp., 62 figs. Discusses the theoretical underlying principles, theory of aerofoils, and application of aerofoil theory to screw propellers.

AIR COMPRESSORS

Explosions. Explosions in Air Compressors, A. D. Risteen. Sugar, vol. 24, no. 2, Feb. 1922, pp 99–100. Deals with presence of lubricating oil and carbon deposits, and suggests that all accumulation of deposits be prevented. From address before Nat. Safety Council.

AIR CONDITIONINO

Air Drying. The Volume of Air Required in Air Drying, C. T. Mitchell. Chem. & Met. Eng., vol. 25, no 21, Dec 14, 1921, pp. 1088–1090, 3 figs. Factors affecting atmospheric evaporation; cooling of air during evaporation; distinction between wet bulb temperature and dew point; calculation of volume of air required; etc. Charts for 100, 85, and 70 per cent ultimate humidity.

AIRCRAFT

Military, Limitation of. Report of the Sub-Committee on the Limitation of Aircraft. Aerial Age Weekly, vol. 14, no. 23, Feb. 13, 1922, pp. 543–545. Discusses commercial, civil, and military aircraft; impossibility of limitations; gives general summary of conclusions.

AIRCRAFT CONSTRUCTION MATERIALS

Wire Cable, Elasticity of. A Study of the Elastic Properties of Small-Size Wire Cable, R. R. Moore. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 105–106 and 111. Results of series of tests carried out at McCook Field, Dayton, Ohio, in which it is shown that modulus of elasticity of small-sized wire aircraft cable varies from 15,000,000 to 28,000,000, depending upon size and type of cable. It was also found that modulus of elasticity may be raised by loading cable below elastic limit and that resting the cable does not seem to have any definite effect on modulus.

AIRPLANE ENGINES

Air-Cooled. Air-Cooled Engine Development, Charles L. Lawrence. Soc. Automotive Engrs. Jl., vol. 10, no. 2, Feb. 1922, pp. 135–141 and 144, 13 figs. Describes British experiments to improve performance of air-cooled engines for aircraft, which lead eventually to development of aluminum cylinders with steel liners and aluminum cylinder heads with steel cylinder screwed into head. Advantages of these and disadvantages of other types.

Gasoline Tests. Tests of Aeroplane Motor with Different Gasolines, O. J. May and Howard Cooper. Sci. Lubrication, July 1921, pp. 9–13, 4 figs. Describes tests made to show effect of using different grades of gasoline in aeronautical engine operation.

AIRPLANE PROPELLERS

Blade Interference. The Fan Propeller and Blade Interference, M. A. S. Riach. Aeronautical Jl., vol. 26, no. 134, Feb. 1922, pp. 63–80, 7 figs. Considers the special case of a propeller working without axial advance in a fluid, i.e., what has been called the "static" case.

Thrust and Torque Characteristics. Tests on Air Propellers in Yaw, W. F. Durand and E. P. Lesley. Nat. Advisory Committee for Aeronautics Report, no. 113, 1921, 37 pp., 26 figs. Results of tests to determine thrust (pull) and torque characteristics of air propellers in movement relative to air in a line oblique to line of shaft, and specifically when such angle of obliquity is large, as in case of helicopter flight with propeller serving for both sustentation and traction.

AIRPLANES

Fighting. Development of the Fighting Aeroplane, F. M. Green. Aeronautical Jl., vol. 26, no. 131, Feb. 1922, pp. 46–55 and (discussion) 56–62, 7 figs. Developments during war; single- and two-seater planes; particulars as to armament, ability to withstand damage, performance and maneuverability, size, and view.

Flying Boats. See FLYING BOATS.

Gliders. See FLIGHT, Soaring.

Helicopters. See HELICOPTERS.

Model Construction. Construction and Testing of Model Airplanes, Walter S. Diehl Aviation, vol. 12, no. 9, Feb. 27, 1922, pp. 262–263, 3 figs. Shows that construction of airplane model can be simplified, in order to obtain most reliable test data. N.A.C.A. Technical Note No. 82.

Paris Show. Seventh International Exposition of Aerial Locomotion (VII Exposition internationale de locomotion aérienne) André Lesage. Génie Civil, vol. 79, nos. 22, 23 and 24, Nov. 26, Dec. 3 and 10, 1921, pp. 464–468, 477–485 and 510–515, 41 figs. Discusses exhibit of French official services, materials, testing laboratories, French meteorological and aerial navigation service. Describes different types of airplanes and airplane engines exhibited.

Passenger. The Problem of the Passenger Aeroplane W. D. Beatty. Aeroplane, vol. 22, no. 2, Jan. 11, 1922, pp. 27–28, 1 fig. Deals with comfort of passengers on commercial aircraft. Discusses desirable attributes not yet incorporated in modern machines; military development of airplane; beginning of commercial development; design of detail; noise; ventilation; heating; etc. Paper read before Roy. Aeronautical Soc.

AIRSHIPS

R 38 Disaster. The Loss of the "R 38." Engineering vol. 113, no. 2931, Mar. 3, 1922, pp. 265–266. Editorial discussion of report of Accidents Investigation Sub-Committee of Aeronautical Research Committee. Fundamental error of judgment made in design appears to have been that calculations of staff failed to take into account the aerodynamic forces to which ship would be subjected in flight, and considered only forces and moments due to distribution of weight and buoyancy, including gas pressures.

ALLOY STEELS

Chrome-Molybdenum. Chrome-Molybdenum-Steel Applications From the Consumer's Viewpoint, C. N. Dawe. Forging & Heat Treating, vol. 8, no. 2, Feb. 1922, pp. 109–113. Results of physical tests, comparing medium-carbon, chrome-molybdenum, chrome-vanadium, chrome-nickel and chrome steels, expressed by means of a merit index. Paper read before Soc. Automotive Engrs.

High Elastic Limit. Some Alloy Steels of High Elastic Limit, Their Heat Treatment and Microstructure, Charles M. Johnston. Am. Soc. for Steel Treating Trans., vol. 2, no. 6, Mar. 1922, pp. 500–506, 13 figs. Describes non-high-speed series which are said to be most promising by reason of tensile values given in tables, and by reason by uniform, tough and dense microstructure of heat-treated condition.

Structural, Tensile Properties of. Tensile Properties of Some Structural Alloy Steels at High Temperatures, H. J. French. U. S. Bur. of Standards Technologic Papers, no. 205, Dec. 21, 1921, pp. 77–92, 8 figs. Results of determination of tensile strength, proportional limit, elongation, reduction of area, and strength at fracture throughout range 20 to 550 deg. cent. for four steels containing about 0.38 per cent carbon. Brief reference is made to type of fractures obtained in testing steels at various temperatures, and particular attention is paid to comparison of tensile properties of these alloys at 550 deg. cent.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Bearing-Metal. See BEARING METALS.

Chromium. See CHROMIUM ALLOYS.

Copper. See COPPER ALLOYS.

Lead-Thallium. The Constitution of Lead-Thallium Alloys (Réflexions sur la constitution des alliages Plomb-Thallium), Léon Guillet. Révue de Métallurgie, vol. 18, no. 12, Dec. 1921, pp. 758–760,

Note.—The abbreviations used n indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

4 figs. Describes tests with alloys of various percentages. Gives liquidus curve and micrographs.

Zinc. See ZINC ALLOYS.

ALUMINUM ALLOYS

Calite. Calite—A New Heat Resisting Alloy, G. R. Brophy. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 384–388, 1 fig. Describes properties of new ternary alloy of aluminum, nickel, and iron. See also Iron Trade Rev., vol. 70, no. 10, Mar. 9, 1922, pp. 679–680, 1 fig.

AMMONIA

Vapor Tables. New Ammonia Vapor Tables (Neue Dampftabellen für Ammoniak), E. Altenkirch. Zeit. für die gesamte Kälte-Industrie, vol. 28, no. 12, Dec. 1921, pp. 173–177, 1 fig. Author presents and extends American table prepared by Bur. of Standards, values being changed from Fahrenheit into Celsius and from English into metric units.

AMMONIA COMPRESSORS

Losses in. Analysis of Losses in Ammonia Compressors, S. F. Smith. Ice & Refrigeration, vol. 62, no. 2, Feb. 1922, pp. 154–155. Discusses losses as they occur and conditions which control same.

APPRENTICES, TRAINING OF

Plant vs. Continuation Schools. The Training of Workers in Manufacture, J. V. L. Morris. Am. Mach., vol. 56, no. 7, Feb. 16, 1922, pp. 249–251. General conditions of apprenticeship; problems arising from school, plant school vs. part-time and continuation schools.

AUTOMOBILE ENGINES

Acoustic Volumeters for. The Charron-Godet Acoustic Volumeter (Le volumètre acoustique Charron-Godet), R. Villers. Nature, no. 2493, Jan. 14, 1922, pp. 26–28, 3 figs. Describes apparatus made by Soc. des Accessoires Routiers, used among other things, for detecting unequal combustion chambers in multi-cylinder engines.

Carburetors. See CARBURETORS.

New York Show. Powerplant Trends as Seen at the Show, Herbert Chase. Automotive Industries, vol. 46, no. 2, Jan. 12, 1922, pp. 62–65, 3 figs. Discusses cooling systems, aids to starting, lubrication and piston design, valves, gearing and crankshafts, etc.

Weidely Six-Cylinder. Weidely Producing a New Engine, J. Edward Schipper. Automotive Industries, vol. 46, no. 10, Mar. 9, 1922, pp. 551–553, 5 figs. Is six-cylinder overhead-valve type, intended for light and medium-weight cars; force-feed lubrication used throughout, crankcase and cylinders cast in block; develops 63 hp. at 3000 r.p.m.

AUTOMOBILES

Body-Seating Dimensions. Body Seating-Dimensions, George E. Goddard. Soc. Automotive Engrs. Jl., vol. 10, no. 2, Feb. 1922, pp. 117–120, 1 fig. Considers features conducive of comfort. Factors influencing seat dimensions, and recommendations regarding different desirable dimensions.

Brakes. Automobile Brakes, Sydney V. James. Armour Engr., vol. 13, no. 1, Nov. 1921, pp. 1–21, 9 figs. Discusses mechanics of motion as applied to brakes and braking, actual brake mechanisms and typical braking systems, including both external contracting and internal expanding types, and brake lining materials.

German Maf. The German Maf Automobile (Markranstädter Automobilfabrik, vorm. Hugo Ruppe G.m.b.H., Markranstädt bei Leipzig). Wirtschaftsmotor, no. 9, Sept. 10, 1921, p. 15, 3 figs. on pp. 14 and 16. Describes automobile chassis and engine constructed by the Markranstadt Automobile Factory, near Leipzig, said to be only German car with air-cooled engines. Constructed as sport two-, three- and four-seated car, sport phaeton, landaulet and delivery wagon.

Manufacturing Plants. A Modern Automobile Plant, Paul L. Battey. Management Eng., vol. 2, no. 3, Mar. 1922, pp. 167–172, 8 figs. Arrangement of departments, routing of product, and means of transportation. (Abstract.) Paper presented to Metropolitan Section of Am.Soc.Mech.Engrs.

The New Plant of the Fisher Body Ohio Co. (Cleveland). Power Plant Eng., vol. 26, no. 4, Feb. 15, 1922, pp. 201–209, 13 figs. Largest single-unit automobile-body manufacturing plant in world. Exemplifies modern construction in its highest degree.

New York Show. Trends in Chassis Design at the New York Show, P. M. Heldt. Automotive Industries, vol. 46, no. 2, Jan. 12, 1922, pp. 58–62, 8 figs. Discusses various improvements, including changes in clutch, transmission locks, gear shifting, and steering wheel.

Pressed-Steel Parts. Making Pressed Steel Automobile Parts. Iron Trade Rev., vol. 70, no. 9, Mar. 2, 1922, pp. 601–604, 8 figs. Details of plant of the Sharon Pressed Steel Co., Sharon Pa.

Repair-Shop Practice. Automobile Repair Shop Practice. Machy. (N. Y.), vol. 28, nos. 5, 6 and 7, Jan., Feb. and Mar. 1922, pp. 359–362, 468–470, 7 figs. and 567–568, 2 figs. Describes methods and equipment commonly employed. Feb.: Machining pistons. Mar.: Regrinding crankshaft bearings.

Shock Insulators, Rubber. Rubber Shock Insulators. Rubber Age, vol. 2, no. 12, Feb. 1922, p. 503, 4 figs. Describes tests carried out in London and New York to demonstrate efficiency of rubber insulators in damping vibration and producing easy riding.

Spring-Bolt Lubrication. The Lubrication of Joint Pins, Especially Automobile Spring Bolts (Die Schmierung von Gelenkbolzen insbesondere der Automobil-Federbolzen), R. Bussien. Motorwagen, vol. 25, no. 3, Jan. 31, 1922, pp. 46–47, 9 figs. Describes new type of spring bolt, with use of which problem of lubrication is satisfactorily solved. Oil is fed directly to place of lubrication and dead space between place of lubrication and grease chamber is reduced to a minimum.

Statistics. Automobile Statistics. Automotive Industries, vol. 46, no. 7, Feb. 16, 1922, pp. 309–429. Special number giving statistical data concerning registrations, production, specifications, exports, and general automotive statistics.

Transmission Case. The Wills Sainte Claire Transmission Case, Fred H. Colvin. Am. Mach., vol. 46, no. 9, Mar. 2, 1922, pp. 323–325, 8 figs. Is of "bell" type and bolts direct to end of crankcase. After cleaning and inspecting, it is water-tested for blowholes or leaks and then spotted in three places for locating in future operations.

AVIATION

Commercial. Air Lines and Some of Their Problems, R. B. C. Noorduyn. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 107–109 and 111. Detailed account of progress of commercial aviation in Europe, tracing development from time of post-war experimental work with military machines and fields, to present successful operation with proper machines and schedules and with Government subsidies.

Dead Reckoning, Checking. Methods of Air Navigation, Herbert V. Thaden. Aviation, vol. 12, no. 9, Feb. 27, 1922, pp. 252–255, 6 figs. Formula and instruments for checking dead reckoning.

Requirements and Difficulties. The Requirements and Difficulties of Air Transport, Frank Searle. Aeronautical Jl., vol. 26, no. 133, Jan. 1922, pp. 3–10 and (discussion) 10–20. Discusses requirements of engine, as a source of power, and the plane, both as a device for rising into air, staying in air, and descending from air to land in a satisfactory way; accommodation of travelers; and rapidity and certainty of service at a proper price.

Research. The Progress of Research, R. K. Bagnall-Wild. Engineer, vol. 133, no. 3450, Feb. 10, 1922, pp. 161–162. Research work for air service in Great Britain comprises specific researches at establishments under control of Air Ministry, and in addition an important series of studies carried out in universities by arrangement with the Ministry. Notes on aero-engine research, navigation, and machines. See also Engineering, vol. 113, no. 2929, Feb. 17, 1922, pp. 214–216. Paper read at Air Conference, London.

B

BEAMS

Continuous. Calculation of Continuous Beams (Beitrag zur Berechnung des kontinuierlichen Trägers), Josef Vinzens. Bauingenieur, vol. 2, no. 24, Dec. 31, 1921, pp. 695–698, 6 figs. Calculating method is developed showing how, with aid of known or determined moments of support for uniform load of bays of continuous beam, the influence of another bay-symmetrical load can be directly ascertained without special intermediate calculation.

BEARING METALS

Arsenical. Arsenical Bearing Metals, Harold J. Roast and Charles F. Pascoe. Min. & Metallurgy, no. 182, Feb. 1922, pp. 63–64. Investigation for purpose of comparing arsenical antimony-lead alloy with some of the regular bearing-metal alloys. (Abstract.) See also Am. Inst. Min. & Met. Engrs. Trans., no. 1136-N, Feb. 1922, 10 pp. 7 figs. (complete paper).

BEARINGS, THRUST

Improved Types. Progress in the Construction of Thrust and Journal Bearings (Neuerungen im Bau von Druck- und Traglagern), H. Schneider. Oel- u. Gasmaschine, vol. 18, no. 12, Dec. 1921, pp. 196–199, 9 figs. Describes new types and improvements, including the single-pulley thrust bearings developed by Fried. Krupp Germania Shipyards, which have given such good experimental results that they are to be installed in submarines of the German navy.

BELTING

Leather, Specifications. Outline of U. S. Specifications for Leather Belting, R. C. Bowker. Belting, vol. 20, no. 2, Feb. 1922, pp. 30–31. To be used by all government departments, but designed also for all consumers; now before Bureau of the Budget for consideration. (Abstract.) Address before Nat. Assn. Leather Belting Manufacturers.

Power Transmission by. Transmission of Power in Plant of Mid-West Glass Co., H. Hilman Smith, Jr. Belting, vol. 20, no. 2, Feb. 1922, pp. 26–28, 4 figs. System characterized by line-shafts supported from floor stands driving direct to all machines, latter equipped with tight and loose pulleys.

Width, Determining. Charts for Determining Belt Widths, Thomas J. Cook. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 562–564, 3 figs. Presents charts devised by author which, it is claimed, should enable any one to ascertain at a glance the most efficient size of belt to be used for any condition which may arise.

BLOWERS

Turbo. Turbo-Blowers for Mechanical-Draft Applications. Power, vol. 55, no. 8, Feb. 21, 1922, pp. 307–308, 2 figs. Four blowers are worked in parallel and directly connected to turbine operating at 5000 r.p.m. These machines are applied to both forced- and induced-draft purposes.

BOILER FEEDWATER

Automatic Regulation. Automatic Feed Regulation. Mar. Engr. & Naval Architect, vol. 45, no. 533, Feb. 1922, p. 53, 1 fig. on p. 52. Describes the Mumford automatic feedwater regulator now being fitted on White Star liner "Majestic."

Treatment. Critical Discussion of the Different Methods of Boiler Feedwater Treatment (Kritik der verschiedenen Methoden der Reinigung von Kesselspeisewasser), B. Preu. Dinglers polytechnisches Jl., vol. 337, nos. 1 and 2, Jan. 14 and 29, 1922, pp. 1–4 and 11–13. Discusses criteria for obtaining best possible purification and advantages and disadvantages of different processes.

BOILER OPERATION

Automatic Draft Regulation. Automatic Draft Regulation in Steam Boiler Rooms (La régulation automatique du tirage das les chaufferies de générateurs à vapeur), Jean Delestrade. Technique Moderne, vol. 13, no. 12, Dec. 1921, pp. 510–518, 14 figs. Describes complete operation of a battery of four Babcock boilers, of which one is auxiliary, producing 10,000 kg. steam per hr. at 14.5 kg. pressure.

Present-Day. Present-Day Boiler-Room Operation, I. E. Moultrop and R. E. Dillon. Power, vol. 55, no. 10, Mar. 7, 1922, pp. 384–386, 6 figs. Discusses economical loading of turbines and boilers. Paper read before Metropolitan Sections of Am.Soc.Mech. Engrs. and Am.Inst.Elec.Engrs.

BOILER PLANTS

Design. Common Faults in Boiler-Plant Design, George C. Cook. Power, vol. 55, no. 7, Feb. 14, 1922, p. 251. One of most frequent faults is said to be failure to provide sufficient space. Valves should be accessible. Influence of fuel on design.

Supervision. Supervision of Steam Boiler Plants, H. Germer. Eng. Progress, vol. no. 2, pp. 42–43, 4 figs. Deals with constant-volume, piston disk, Woltmann, venturi and Venturi steam meters.

BOILER ROOMS

Flue-Dust Blowers and Catchers. Flue-Dust Blowers and Catchers, Particularly for Flue Boilers (Flugaschenbläser und Flugaschenfänger, insbesondere für Flammrohrkessel), H. Pradel. Braunkohle, vol. 20, no. 36, Dec. 10, 1921, pp. 564–569, 11 figs. Describes new types by German firms.

BOILERS

Marine. See MARINE BOILERS.

Oil in. Lubrication and the Steam Boiler, Edward L. Gross. Sci. Lubrication, Oct. 1921, pp. 8–9. Discusses oil in steam boiler, and foaming and priming, and the remedies.

Scale Removal with CO_2. Removing Boiler Scale with CO_2, R. J. Cross and Roy Irvin. Power, vol. 55, no. 11, Mar. 14, 1922, pp. 422–423, 1 fig. Some scales are removable by carbonated water. Work done with ordinary "soda-fountain" cylinders of liquid carbon dioxide. Preliminary tests easy to make.

Setting. Large Combustion Chamber in Rear of Boiler, to Which Heated Air Is Admitted, Increases Efficiency, Alphonse F. Brosky. Coal Age, vol. 21, no. 7, Feb. 16, 1922, pp. 288–289, 1 fig. Air heated in flue passing under combustion chamber, is emitted through passages in bridge wall, causing combustion of unburned hydrocarbons and carbon monoxide.

Triple-Riveted Butt Joint. The Designing of a Triple Riveted Butt Joint, L. T. Rutledge. Can. Machy., vol. 27, no. 6, Feb. 9, 1922, pp. 17–19, 1 fig. Strength of boiler shell; sketching proposed joint; resistance against tearing and crushing.

Up- vs. Down-Draft Smokeless. Up-Draft Versus Down-Draft Smokeless Boilers. Heat. & Vent. Mag., vol. 19, no. 2, Feb. 1922, pp. 29–30, 1 fig. Air over fire needed only part of time; rate at which air is demanded; value of preheating air.

BOILERS, WATER-TUBE

Marine. Emergency Fleet Corporation Water-Tube Boilers for Wood Ships, F. W. Dean. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 99–102 and (discussion) p. 104, 6 figs. Results of evaporative tests of four-pass boiler, having heating surface of 2518 sq. ft., furnace volume of 408 cu. ft. and a commercial horsepower of 435 on basis of marine rating of 6 lb. of water to square foot of heating surface per hr.

BONUS SYSTEMS

Heat-Treating Department. A Successful Bonus System Applied to Heat Treating, A. A. Blue. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 430–436, 2 figs. Summarizes general principles and practical details of a successfully tried-out bonus system.

BORING

Spherical Housing. Boring a Spherical Housing on an Automatic Machine, P. J. Tomkins. Machy. (Lond.), vol. 19, no. 488, Feb. 2, 1922, pp. 541–542, 4 figs. Describes the difficulties and how they were overcome.

BRAKES

Bus, Hydraulic. Four-Wheel Hydraulic Brake Tried on California Bus. Elec. Ry. Jl. (Bus Transportation), vol. 50, no. 6, Feb. 11, 1922, p. 123. Brake installed in 18-passenger Pierce-Arrow bus by Pickwick Stage Co., Los Angeles, has proved highly satisfactory so far.

BRONZES

Manganese. The Effect of Solders on Beta Brasses. Eng. Rev., vol. 35, no. 7, Jan. 1922, p. 233. Account of investigations made by J. H. S. Dickenson, commenced in order to account for failure of a manganese bronze, or Beta brass forging of a turbo-alternator.

C

CABLEWAYS

Electric Suspension. Electric Suspension Railways with Self-Acting Grippers, P. Stephan. Eng. Progress, vol. 3, no. 2, Feb. 1922, pp. 34–37, 13 figs. Design and method of working. Describes a Bleichert electric grab suspension railway and a conveying plant for coal and coke.

CAR LIGHTING

Electric. Electric Illumination for Trains, Richard Hanchen. Eng. Progress, vol. 3, no. 1, Jan. 1922, pp. 1–3, 6 figs. Notes on continuous electric train lighting for individual cars; drive of dynamo; voltage control; charging and life of battery, etc.

Principles of Car Lighting by Electricity—XVII, Charles W. T. Stuart. Ry. Elec. Engr., vol. 13, no. 1, Jan. 1922, pp. 9–17, 15 figs. Describes the Gould simplex system of car lighting, consisting of a generator driven by a belt from car axle, a generator regulator panel, a lamp regulator panel mounted in a cabinet inside or under car body, and a storage battery suspended in a box under car body.

CARBON DIOXIDE

Pressure-Total-Heat Diagram. Pressure-Total-Heat Diagram For Carbon Dioxide, H. J. MacIntire. A.S.R.E. Jl., vol. 8, no. 3, Nov. 1921, pp. 211–215, 1 fig. Describes diagram, said to be accurate, clear and workable. Drawn with rectangular coördinates, using pressures for ordinates and total heat in B.t.u. above 32 deg. fahr. as abscissae.

CARBURETORS

Triple-Emulsion Automatic. A New Triple-Emulsion Automatic Carburetor (Un nouveau carburateur a triple emulsion et economiseur automatique), Ach. Delamarre. Outillage, vol. 242, no. 2, Jan. 14, 1922, pp. 48–49, 4 figs. Describes the Paget patent carburetor "Eclipse."

CARS

Hose Connectors. Recent Changes in American Hose Connectors. Ry. Age, vol. 72, no. 6, Feb. 11, 1922, pp. 375–377, 4 figs. Describes connector manufactured by Am. Automatic Connector Co., Cleveland, Ohio, and tests made.

The Development of the Robinson Connector. Ry. Mech. Engr., vol. 96, no. 2, Feb. 1922, pp. 77–81, 9 figs. Latest type incorporates improvements suggested by extensive service of earlier design.

CARS, PASSENGER

Articulated Dining. Articulated Units Feature Recent English Car Design. Ry. Rev., vol. 70, no. 4, Jan. 28, 1922, pp. 109–113, 6 figs. Describes new dining-car train, showing advantages of articulated design and use of electricity for cooking.

Sleeping and Compartment. New Sleeping and Compartment Cars for the C. P. R. Ry. Rev., vol. 70, no. 3, Jan. 21, 1922, pp. 77–81, 8 figs. Designed for service on transcontinental trains with special regard for comfort of women travelers.

CASE-HARDENING

Cyanamide for. Cyanamide in Liquid Case Hardening, P. W. and E. B. Shimer. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 403–408. Account of experiments made with and description of the Shimer case-hardening process, making use of special lump calcium cyanamide and easily fusible mixture of salts.

Steel, Effect of Quality on. Effect of Quality of Steel on Case-carburizing Results, H. W. McQuaid and E. W. Ehn. Min. & Metallurgy, no. 182, Feb. 1922, pp. 60–61. Writer seeks to prove that presence of excess dissolved oxides in steel, as made in melting furnace, affects permanently results obtained in carburizing and hardening and that it is possible that presence of dissolved oxide can result in total unfitness of low-carbon steel for case hardening purposes. (Abstract.) See also Am. Inst. Min. & Met. Engrs. Trans., no. 1135–S, Feb. 1922, 22 pp. 46 figs. (complete paper.)

CAST IRON

Desulphurization of Liquid. The Desulphurization of Liquid Cast Iron (Entschwefelung von flussigem Gusseisen), Ludwig Scharlibbe. Giesserei-Zeitung, vol. 19, no. 3, Jan. 17, 1922, pp. 43–46 and (discussion) pp. 46–51, 6 figs. Describes new process for removal of sulphur from molten liquid, resulting in a desulphurization up to 60 per cent of original sulphur content.

Gray, Metallography of. Apply Metallography to Gray Iron, J. W. Bolton. Foundry, vol. 50, nos. 2 and 3, Jan. 15 and Feb. 1, 1922, pp. 52–55 and 109–112, 23 figs. Jan. 15: Describes methods of making photomicrographs, including sampling, polishing, etching and photographing. Shows means for identifying the different structures. Feb. 1: Metallurgical control of cupola.

Piping. The Piping of Cast Iron (Ueber das Lunkern von Gusseisen). Giesserei-Zeitung, vol. 19, no. 5, Jan. 31, 1922, pp. 75–81. Discussion of nature and causes of piping. Abstracts of three papers presented before South German Group of Assn. German Foundrymen, followed by discussion.

Welding Without Studding. Welding Cast Iron Without Studding, F. L. Paertch. Welding Engr., vol. 7, no. 2, Feb. 1922, pp. 28–29 (includes discussion). A process which is feasible in some cases but not recommended for strength members and live loads. Paper read before Am. Welding Soc.

CASTING

Centrifugal. Centrifugal Casting, L. Cammen. Chem. & Met. Eng., vol. 26, no. 8, Feb. 22, 1922, pp. 354–358, 4 figs. Describes process of centrifugal casting of hollow metal objects. Mechanics of centrifugal casting.

Steel Mill Rolls. Rolls Molded in Sectional Flasks, J. R. Hadsum. Foundry, vol. 50, no. 5, Mar. 1, 1922, pp. 206–207, 2 figs. Alternative method to sweep molding. Mold finished in sections and clamped together.

Tunnel Segments. Tunnel Segment Casting Methods. Foundry, vol. 50, no. 4, Feb. 15, 1922, pp. 137–141, 6 figs. Discusses technical difficulties in producing castings for lining of vehicular tunnel under Hudson River.

CENTRAL STATIONS

Operating Expenses. Operating Expenses of Six Plants. Elec. World, vol. 79, no. 3, Jan. 21, 1922, pp. 131–132. Study of Massachusetts stations emphasizes advantages of electrical equipment from upkeep standpoint. Data indicate changes which are taking place as result of transition to new industrial basis.

CENTRIFUGES

Draining Crystals in. Draining Crystals in a Centrifugal Machine, Thomas James Drakeley and George Frank Martin. Soc. Chem. Industry Jl., vol. 40, no. 24, Dec. 31, 1921, pp. 308T–310T, 1 fig. Results of a series of experiments conducted on a large Watson-Laidlaw centrifuge to extract mother liquor from crystals.

CHARTS

Engineering. Practical Engineering Charts, K. F. Smith. Am. Soc. Naval Engrs. Jl., vol. 34, no. 1, Feb. 1922, pp. 56–72, 4 figs. Describes charts for graphical solution of equations with x and y, or z and w given.

CHUCKS

Magnetic. Direct Current or Alternating Current for Magnetic Chucks (Gleichstrom oder Wechselstrom für Spannfutter), B. Wittkuhns. Elektrotechnik u. Maschinenbau (Anzeiger), vol. 40, no. 5, Jan. 29, 1922, pp. 21–22. Results of tests made on magnetic chuck for alternating current to determine its properties when compared with d.c. chucks. It is shown that only advantage of a.c. chuck is the instant demagnetization attained with its use, but there are a great many insurmountable disadvantages.

CHROMIUM ALLOYS

Expansibility. Expansibility of Chromium and Nickel-Chromium Alloys in a Large Interval of Temperature (Dilatabilité du chrome et des alliages nickel-chrome dans un intervalle étendu de températures), P. Chevenard. Comptes Rendus des Séances de l'Académie des Sciences, vol. 174, no. 2, Jan. 9, 1922, pp. 109–112, 2 figs. Describes experiments carried out by means of dilatometer and gives curves resulting.

COAL HANDLING

Equipment. Car Dumper and Coal Conveyors at Coke Oven Plant. Eng. News-Rec., vol. 88, no. 10, Mar. 9, 1922, pp. 407–409, 4 figs. Rotary cradle serves conveying belts. Traveling bridge has belt for storing coal and grab bucket to reclaim it.

Locomotive Loading Plant. Locomotive Coal and Ash Handling Plant. Eng. Rev., vol. 35, no. 7, Jan. 1922, pp. 226–228, 3 figs. Describes plant of Lond. & North Western Ry. Co., capable of loading locomotive in 30 sec.

Unloading Railway Trucks. The Unloading of Bulk Goods (Zur Frage des Umschlages von Massengütern), Hubert Hermanns. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 5, Feb. 4, 1922, pp. 112–114, 7 figs. Description of the Heinzelmann elevator discharger for the unloading of railway trucks; comparison with tipping devices from economic standpoint.

COMBUSTION

Control. Gas and Air Mixers for Combustion Control, T. L. Hiles. Forging & Heat Treating, vol. 8, no. 2, Feb. 1922, pp. 124–125. Discusses difficulties in producing a perfect combustible mixture of gas and air at burner outlet of a gas furnace.

CONDENSERS, STEAM

Spray-Nozzle Cooling of Condenser Water. Spray-Nozzle Cooling Theory and Practice, B. H. Coffey and G. S. Dauphinee. A.S.R.E. Jl., vol. 8, no. 3, Nov. 1921, pp. 177–202, 6 figs. Discusses the three varieties of variables affecting spray cooling, viz.: independent natural variables which we cannot control; independent artificial variables which we can control; and the final temperature, produced by the mutual reactions of the others and, consequently, the dependent variable.

Testing Apparatus. Testing Condenser Apparatus, R. N. Ehrhart. Power, vol. 55, no. 7, Feb. 14, 1922, pp. 248–250, 7 figs. How commercial tests are made on ejectors, circulating and condensate pumps.

Tubes. British Standard Specification for Condenser Tubes and Screwed Glands for Condensers for Marine Purposes. British Eng. Standards Assn., no. 145, Oct. 1921, 7 pp., 3 figs. Specifications for quality of material, manufacture, dimensions, weight, hydraulic and mechanical tests, inspection and testing facilities.

Properties of Condenser Tubes. Power, vol. 55, no. 9, Feb. 28, 1922, pp. 343–344. Muntz and Admiralty metals are discussed. Discusses the effects of internal strains, crystalline structure and thickness of tubes.

CONNECTING RODS

Bearing Machine for. Universal Bearing Machine for Connecting Rods. Western Machy. World, vol. 13, no. 2, Feb. 1922, pp. 48–52, 15 figs. Designed for use in pouring and boring of bearings for automotive connecting rods. Manufactured by Automatic Bearing Machine Co., San Jose.

CONVEYORS

Advantages. The Influence of Mechanical Conveyors Upon Financial and Operating Policies, W. L. Churchill. Management Eng., vol. 2, no. 3, Mar. 1922, pp. 133–136, 7 figs. It is pointed out that a completely conveyorized plant automatically secures advantage of cost reduction, speedy delivery to customers, minimum capital investment, and a highly stimulated industrial organization.

Steel-Band. Novel Applications for Thin Steel Bands, Bernard Kruger. Iron Age, vol. 109, no. 10, Mar. 9, 1922, pp. 640–642. Special advantages are said to follow their use for power-transmitting and conveying purposes. Question of tension important. Paper presented before West. Soc. of Engrs.

COOLING LIQUIDS

Recooling Plants. Modern Types of Recoolers (Neuere Bauarten von Ruckkühlanlagen), F. Seufert. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 51, Dec. 17, 1921, pp. 1307–1310, 16 figs. Disadvantages of older types are said to be: excessive delivery head of the hot water, dead air space in lower part of cooling tower, and insufficient atomization of dripping water. These disadvantages are eliminated in modern types. Results of tests.

COOLING TOWERS

Recooling of Water in. The Recooling of Water in Self-Ventilating Tower Coolers (Ueber die Wasserrückkühlung mit selbstventilierendem Turmkühler), Carl Geibel. Zeit. des Vereines deutscher Ingenieure vol. 66, nos. 2 and 4, Jan. 14 and 28, 1922, pp. 31–36 and 88–91, 49 figs. (Abstract.)

COPPER ALLOYS

Copper-Tin-Zinc. Copper—88, Tin—10, Zinc—2, R. R. Clarke. Metal Industry (N. Y.), vol. 20, no. 2, Feb. 1922, pp. 56–57, 1 fig. Analysis of properties, idiosyncrasies and methods of producing this mixture.

Phosphor-Copper. Phosphor-Copper, J. L. Jones. Metal Industry (Lond.), vol. 20, no. 7, Feb. 17, 1922, pp. 145–146. Its uses and methods of obtaining best results.

COST ACCOUNTING

Chemical. Some Phases of Chemical Cost Accounting, C. B. E. Rosén. Chem. Age (N. Y.), vol. 29, no. 12, Dec. 1921, pp. 501–504. Discusses the question of process costs and their management.

Machine-Rate. Machine Rate Costing in Engineering Manufacturing Works, G. W. Beale. Jl. Indus. Administration, vol. 1, no. 8, Dec. 1921, pp. 246–253. Series of arguments leading to the conclusion that it is not commercially profitable to include machine rate costs in the routine-recorded system of cost accounts of an engineering manufacturing works, but that it finds its true place in estimated costs.

CRANES

Electrical Apparatus for. Selection of Electrical Apparatus for Cranes, R. H. McLain. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 3, Mar. 1922, pp. 249–256. Paper is intended to assist crane designers and electrical engineers in mills and factories to select proper size and kind of motor by mathematical calculation from given data, and refers particularly to electric overhead traveling crane. It is shown how to calculate power required of motor for hoisting and how to select particular kind of motor needed.

Locomotive. Getting the Maximum Performance Out of Locomotive Cranes. Ry. Maintenance Engr.; vol. 18, no. 2, Feb. 1922, pp. 49–53, 3 figs. Describes the many purposes for which Lehigh Valley R. R. has found it profitable to use them in maintenance-of-way work.

CRANKPINS

Lubrication. An Analysis of a Point in Crank Lubrication. Automotive Industries, vol. 46, no. 8, Feb. 23, 1922, pp. 462–463, 10 figs. Analytical investigation to determine best location for crankpin oil holes.

CRANKSHAFTS

Balancing Machine. A New Crankshaft Balancing Machine, P. M. Heldt. Automotive Industries, vol. 46, no. 9, Mar. 2, 1922, pp. 518–519, 3 figs. Obviates need for preliminary static balance and permits of quickly determining magnitudes and proper angular positions of correcting moments required to insure accurate dynamic balance.

CUPOLAS

Operation and Control. Operation and Control of Cupolas (Conduite et Contrôle des Cubilots), Maurice Bouffart. Fonderie Moderne, no. 12, Dec. 1921, pp. 372–377, 10 figs. Discusses the various chemical and physical measurements, including temperature measurements in melting zone and in charge. Paper read before Congrès de Fonderie de Liége.

CURVES

Polytropic. The Plotting of Polytropic Curves (Ueber Polytropen-Konstruktionen), Emil Wellner. Dinglers Polytechnisches Jl., vol. 336, nos. 24 and 25, Dec. 3 and 17, 1921, pp. 337–339 and 347–350, 13 figs. Method of plotting curves based on the Ebner construction, which permits the finding in a purely geometrical way of curve points at any given ordinate points. Constructions are given for representation of the mechanical work in linear form and for finding mean indicated pressure.

D

DIE CASTING

Uses and Machines for. Die Casting, A. G. Hopkins. Instn. Mech. Engrs. Proc., no. 1, 1922, pp. 23–33 and (discussion) 36–40, 7 figs. Deals with uses and advantages, permanent molds, lead base, zinc base, tin base, aluminum base and copper base alloys, design of dies, die casting machines.

DIESEL ENGINES

Compressors for. The Use of Compressed Air in Diesel Engined Ships, William Reavell. Engineering, vol. 113, no. 2928, Feb. 10, 1922, pp. 179–183, 26 figs. partly on p. 170. (Abstract.) Paper read before North-East Coast Instn. Engrs. & Shipbuilders.

Efficiency. Efficiency of the Diesel Oil Engine, L. H. Morrison. Power, vol. 55, no. 9, Feb. 28, 1922, pp. 340–341, 3 figs. Diesel engine, unlike all other prime movers, is thermally more efficient at part loads, reason for which is explained.

Marine. Some Problems of Marine Diesel Engine Design, P. Belyavin. North-East Coast Instn. Engrs. & Shipbuilders, advance proof, no. 2211-Q, for meeting Feb. 24, 1922, 29 pp., 23 figs. Discusses important points which have a substantial influence on size, cost and weight of multi-cylinder, two-stroke-cycle Diesel engine.

DROP FORGINGS

Heat Treatment. Heat-treatment of Drop-forgings. Machy. (Lond.), vol. 19, no. 488, Feb. 2, 1922, pp. 554–557, 5 figs. Practice followed and equipment employed, with special reference to furnace design and suitable fuels.

Perfecting. Perfecting a Drop Forging, J. H. G. Williams. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 390–395, 13 figs. Includes photographs showing how metal did not flow in manner originally planned, and discusses methods used for removing conditions promoting formation of defects.

DURALUMIN

Gear Material. Duralumin and Its Use as a Gear Material, Robert W. Daniels. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 542–543. Notes on physical properties and general characteristics of duralumin; process of manufacture. It is said to be an ideal material for worm wheels. (Abstract.) Paper read before Am. Gear Mfrs. Assn.

DYNAMOMETERS

Hydraulic Traction. The Polak Hydraulic Traction Dynamometer. Engineering, vol. 113, no. 2931, Mar. 3, 1922, p. 256, 4 figs. Describes instrument designed by M. W. Polak, Holland, for testing agricultural machinery. It does not draw a curve, but measures average drawbar pull during certain periods, mostly of 20 sec.

E

EDUCATION

American, Foreign Criticism of. Foreign Criticism of American Education, W. J. Osburn. U. S. Dept. of Interior, Bur. of Education Bul., no. 8, 1921, 156 pp. Contains extracts of reports made by educators and critics of education from other countries who have visited American schools, usually for purpose of gaining such information and ideas as would be helpful to them in improvement of schools of their countries.

EDUCATION, ENGINEERING

Industries. Professional Engineering Education for the Industries, Francis, C. Pratt. Eng. Education, vol. 12, no. 5, Jan. 1922, pp. 227–233. Discusses American methods of engineering education, based on result of careful study of large number of college graduates at works of Gen. Elec. Co. Writer is against too early specialization of student, resulting in turning out a disproportionate number of men of mediocre ability and narrowly specialized education.

Metallurgical Course. A University Course in Metallurgical Engineering, W. P. Wood. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 423–425. Presents curriculum prepared by author having in mind preparation of students for those industries which are concerned with final shaping and preparing of metal for use.

Mining Curriculum. The Mining Curriculum at Lehigh University, George J. Young. Eng. & Min. Jl., vol. 113, no. 6, Feb. 11, 1922, pp. 239–242, 8 figs. partly on p. 238. Discusses curriculum.

EDUCATION, INDUSTRIAL

Industries and Railroads. A Review of Industrial Education and Training. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 87–92. Education and Training in the Industries, R. L. Sackett. Education and Training on Railroads, D. C. Buell. Discussion.

ELECTRIC DRIVE

Machine-Tool Shop. Individual Electric Drive in a Machine Tool Shop (La commande électrique individuelle dans un atelier de machines-outils), R. Michean. Arts et Métiers, vol. 74, no. 10, July 1921, pp. 203–212, 25 figs. Deals with single-pulley drives, cone-pulley drives, and multiple-shaft drives, and their difficulties.

ELECTRIC FURNACES

Electromagnetic Motions in. Electromagnetic Motions in Electric Furnaces, Carl Hering. Am. Electrochem. Soc. advance paper, no. 2, for meeting Apr. 27–29, 1922, pp. 7–14. Describes how new proposed law given in former paper may be applied to production, by the current, of certain desired motions such as those for circulating or stirring liquid conductors in a furnace.

Future Applications. The Electric Furnace Situation. Blast Furnace & Steel Plant, vol. 10, no. 2, Feb. 1922, pp. 137–139. Deals with widening of sphere of electric furnace's operation, including production of cast iron.

Gray-Iron Castings. Electric Furnace Strengthens Iron, D. Wilkinson. Foundry, vol. 50, no. 4, Feb. 15, 1922, pp. 143–145. Reviews work on production of synthetic pig iron, and describes an inexpensive type of electric furnace for gray-iron castings.

Iron Smelting. Electric Iron Smelting. Pacific Mar. Rev., vol. 19, no. 2, Feb. 1922, pp. 126–128, 2 figs. Describes "Elektrometalls" process as carried out at Tröllhattan Falls, Sweden, based on inventions made by Gronwall, Lindblad and Stalhane.

Italian Design. Italian Firm Designs An Electric Furnace. Foundry, vol. 50, no. 5, Mar. 1, 1922, p. 177, 1 fig. Describes electric furnaces placed on market by Fiat Corp., Italian automobile builder, producing 1,000 metric tons of finished steel per month.

ELECTRIC LOCOMOTIVES

Chile. Passenger Locomotives for Chilean State Railways. Elec. Ry. Jl., vol. 59, no. 8, Feb. 25, 1922, pp. 309–314, 18 figs. partly on p. 308. Describes electric locomotives for express and local service on line under electrification between Valparaiso and Santiago. See also Ry. Age, vol. 72, no. 9, Mar. 4, 1922, pp. 527–528, 3 figs.

Driving Gears. New Driving Gear for Electric Locomotives (Neuer Antrieb für elektrische Lokomotiven), H. Hoepner. Verkehrstechnik, vol. 38, no. 35, Dec. 15, 1921, pp. 547–548, 2 figs. Describes new transmission system, tests on a model of which are being conducted by the Campagnie Paris-Lyon-Mediterannée in their Paris workshops; results thus far are very satisfactory.

The Driving Gear of Electric Locomotives (Het mechanische gedeelte van het drijfwerk van electrische locomotieven en motorwagens), H. S. Hallo. Ingenieur, vol. 37, no. 2, Jan. 14, 1922, pp. 24–37, 27 figs. Discusses the Batchelder, Chicago-Milwaukee-St. Paul, Westinghouse flexible, General Electric spring gears, and other types.

ELECTRIC WELDING

Cyc-Arc. The "Cyc-Arc" Process of Automatic Electric Welding, L. J. Steele and H. Martin. Instn. Elec. Engrs. Jl., vol. 60, no. 305, Jan. 1922, pp. 136–157 and (discussion) 158–162, 14 figs. Detailed description of the processes, by which metals of widely differing character and section can successfully be welded electrically.

Steel Construction. Electric Welding Applied to Steel Construction, with Special Reference to Ships, A. T. Wall. Engineering, vol. 113, no. 2930, Feb. 24, 1922, pp. 241–244, 14 figs. Writer calls attention to various ways in which electric welding is being applied to ship construction, and indicates further possibilities in this connection for steel structures. Paper read before Instn. Mech. Engrs.

ELECTRIC WELDING, ARC

Cast Iron. Arc-welding of Cast Iron. Machy. (Lond.), vol. 19, no. 490, Feb. 16, 1922, pp. 593–596, 6 figs. Use and application of methods for welding cast iron by electric arc.

Practical Points. Practical Points in Arc Welding, J. A. Wilson. Am. Mach., vol. 56, no. 10, Mar. 9, 1922, pp. 357–358, 4 figs. Notes on keeping work clean; beveling edges; allowing for expansion and contraction; guarding against injury; making solid welds.

Refrigerating Machinery. Arc Welding of Refrigerating Machinery, A. M. Candy. Welding Engr., vol. 7, no. 2, Feb. 1922, pp. 21–23, 9 figs. Advantages in repair and production work. Paper read before Am. Soc. Refrig. Engrs.

ELECTRICAL MACHINERY

Manufacturing Plant. The Works of the General Electric Company at Witton. Engineering, vol. 113, no. 2928, Feb. 10, 1922, pp. 166–167, 4 figs. Recent extensions at Witton comprise new switchgear shops and shops for manufacture of standard sizes of electric motors, molded insulation works and enameling and plating shops, etc.

ELEVATORS

Motor Controller. Operation of a Drum-Type, Elevator-Machine Alternating-Current Motor Controller, William Zepernick. Power, vol. 55, no. 8, Feb. 21, 1922, pp. 295–298, 9 figs. Functions of different parts and circuits of a one-speed elevator controller. Tracing out circuits for one direction of machine.

Passenger, Safeguarding. Passenger Elevator Protection, J. J. Lamb. Power Plant Eng., vol. 26, no. 4, Feb. 15, 1922, pp. 231–234, 3 figs. Arrangement and safeguarding to prevent accidents and reduce fire hazard to a minimum.

EMPLOYEES' REPRESENTATION

Shop Committees. How Shop Committees Function Under Depression, Lionel D. Edie. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 92–95. Account of what happened to shop committees of Int. Harvester Co., and how these committees have handled lay-offs and wage reductions. Record includes wage cut of 20 per cent decided entirely by shop committees.

EMPLOYEES, TRAINING OF

Manufacturing. The Training of Workers in Manufacture, J. V. L. Morris. Am. Mach., vol. 56, no. 9, Mar. 2, 1922, pp. 320–322. Apprenticeship practices regarding indenture, age, payment and certificates. Public school substitutes. Evening, part-time and coöperative schools.

Methods. Making Industrial Improvements Permanent, Paul M. Atkins. Management Eng., vol. 2, no. 3, Mar. 1922, pp. 153–158, 4 figs. Through patient teaching based on written instructions. Two classes of employee instruction. Specific forms of training.

EMPLOYMENT MANAGEMENT

Eye Examinations. Better Work and More Work per Man Through Better Sight, E. LeRoy Ryer and Willard B. Fisher. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 111–117, 2 figs. Industrial eye examinations and their importance in management.

Principles Involved. Increasing Man Power Through Management, L. W. Olson. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 88–91. Writer discusses cardinal principles involved in management of men.

Testing Motormen. Psychological Tests for Motormen, Alfred Gradenwitz. Elec. Ry. Jl., vol. 59, no. 4, Jan. 28, 1922, pp. 143–146, 13 figs. Discusses physical and psychological tests which must be passed by candidates for position of motormen in Berlin.

ENGINEERING

Economics of. The Economics of Engineering, H. W. Pitt. Eng. Production, vol. 4, nos. 73 and 74 Feb. 23 and Mar. 2, 1922, pp. 173–175 and 197–199 Feb. 23: Deals with design economics; production and consumption cost; designing for a given market; standardization and accuracy as cost reducers; designing and costing. Mar. 2: Designer and consumer; production and factory economics; division of labor; economics of purchasing and of selling and using.

ENGINEERING SOCIETIES

German, Alliance of. The Alliance of the Engineering and Scientific Associations of Germany (Zusammenschluss der technisch-wissenschaftlichen Vereine Deutschlands). Gewerbefleiss, vol. 100, no. 12, Dec. 1921, pp. 344–346. Account of alliance of nearly all of the German technical and scientific societies into an organization known as Deutscher Verband (German Federation).

ENGINEERS

Licensing. Licensing and Engineering Ethics, C. E. Waddell. Professional Engr., vol. 7, no. 1, Jan. 1922, pp. 8–9. Status of the expert witness, contractor, manufacturer, salesman, college graduate and practicing engineer.

EVAPORATORS

Basic Principles. Evaporators—What They Are and How They Operate. Power, vol. 55, no. 8, Feb. 21, 1922, pp. 292–294, 3 figs. Writer seeks to present clear idea of basic principles of evaporators as used in power plants to produce distilled makeup water.

F

FACTORIES

Fire and Burglary Protection. Protection against Burglary in Factories by Means of Organization (Fabrikdiebstahlschutz durch Betriebsorganisation). H. Sauter. Betrieb, vol. 4, no. 7, Feb. 14, 1922, pp. 218–226, 16 figs. Describes organization of the Ludwig Loewe & Co., Berlin, which is said to greatly aid in detection of burglars and in prevention of theft.

Safety Arrangements in Factories (Sicherheitseinrichtungen in Fabrikbetrieben), R. Bügler. Betrieb, vol. 4, no. 7, Feb. 14, 1922, pp. 205–209, 20 figs. Describes electric installations and devices for protection against fire and burglary.

Vacuum Cleaning. Vacuum Cleaning Applied to Industrial Plants, Charles L. Hubbard. Factory, vol. 28, no. 3, Mar. 1922, pp. 285–288, 6 figs. Discusses applications in factories and selection of proper type of vacuum cleaner for given conditions.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FLIGHT

Soaring. A German View of Soaring Flight. Aeroplane, vol. 22, no. 1, Jan. 4, 1922, pp. 8–10, 4 figs. Discusses development of small sporting-type machines, development of new methods of light construction, and educational value of work done as tending to improve aeronautical construction generally.

Soaring Flight and Soaring Aircraft. Aviation, vol. 12, nos. 7 and 8, Feb. 13 and 20, 1922, pp. 195–198 and 224–225, 3 figs. Review of progress achieved in soaring flight and considerations of its practical possibilities.

Soaring Flight, Its Development and Prospects, Wm. Knight. Aerial Age, vol. 14, no. 24, Feb. 20, 1922, pp. 562–563, 8 figs. Describes Klemperer and Loessl gliders, and gives tables of distances and time of flights made.

FLUIDS

Adiabatic Liquefaction. Adiabatic Liquefaction of Fluids (La liquefaction adiabatique des fluides), Jean Villey. Comptes Rendus des Séances de l'Academie des Sciences, vol. 173, no. 26, Dec. 27,

1921, pp. 1453–1455. Confirms calculations by Brubat, that heat of vaporization of a liquid tends towards a limit L_0, not zero, at absolute zero, and that whatever the initial state, adiabatic expansion must always lead to liquefaction.

FLYING BOATS

Double-Pontoon Airplanes vs. Flying Boats versus Double-Pontoon Airplanes (Zur Frage: Flugboot oder Zweischwimmerflugzeug?), E. Meyer. Motorwagen, vol. 25, no. 2, Jan. 20, 1922, pp. 33–34. Describes Dornier commercial flying boat, type Do.Cs.II 1920, a single-engine, strutless all-metal monoplane with following characteristics: span, 17 m.; surface depth, 3 m.; height, 2.75 m.; length, 10.25 m.; supporting surface, 47 sq. m.; engine, 185-hp. BMW; weight empty, 1350 kg., loaded, 650 kg.; speed, 150 km. per hr., etc.

FOREMEN

Requirements and Training. Can Foremanship Help to Rebuild Profits? B. M. Nussbaum. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 155–159. Notes on cost saving and the foreman; foremen as advisers to directors; training and requirements of good formanship.

FOUNDRIES

Conveying and Mechanical Handling. Conveying and Mechanical Handling in the Foundry. Metal Industry (Lond.), vol. 20, no. 6, Feb. 10, 1922, pp. 123–127, 3 figs. Emphasizes necessity of keeping foundry handling costs at a minimum, and discusses various means to this end.

Dust Removal from Cleaning Room. Removing the Dust from the Casting Cleaning Room, C. C. Hermann. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 171–174, 3 figs. Design of suitable system requires competent consideration of (1) suction at hoods; (2) friction losses in piping; (3) selection of blower unit; (4) discharge resistance; (5) losses due to collector.

Gas Application in. The Application of Gas in the Foundry. Foundry Trade Jl., vol. 25, no. 286, Feb. 9, 1922, pp. 97–100, 7 figs. Describes way in which Mond gas generated at works of Nat. Gas Engine Co., Ltd., is fully utilized. Plant consists of a gas generator, scrubber, gas purifier, exhauster and pressure regulator.

Machine-Tool Industry. Machine Builder Erects Foundry, Pat Dwyer. Iron Trade Rev., vol. 70, no. 10, Mar. 9, 1922, pp. 683–686, 7 figs. Melting and crane equipment was installed sufficient to handle single castings up to 50 tons and daily normal output of 100 tons of castings. Details of new foundry of Toledo Machine & Tool Co., Toledo, Ohio.

Modern Designs. Modern Foundries, M. Fischer. Eng. Progress, vol. 3, no. 2, Feb. 1922, pp. 29–32, 14 figs. Principles governing construction of modern foundries as regards initial costs, enlargement, workmen, and auxiliary arrangements.

White Enameled Interior. Washable White Enameled Foundry Interior. Can. Foundryman, vol. 13, no. 2, Feb. 1922, pp. 17–19, 1 fig. Describes foundry of Waterous Engine Works Co., Brantford, Ont.

FREIGHT HANDLING

Container System. Container System Creates Freight Service. Ry. Age, vol. 72, no. 8, Feb. 25, 1922, pp. 475–476, 5 figs. Describes practice of Cincinnati, Lawrenceburg & Aurora. Inauguration of a demountable body or unit container system in conjunction with motor trucks, and establishment of a small off-track station for handling of these containers.

Containers Carry Freight in Cincinnati. Elec. Ry. Jl., vol. 59, no. 8, Feb. 25, 1922, pp. 315–318, 8 figs. An interurban electric railway without tracks downtown gives through freight service by containers which are carried on motor trucks within city and on electric cars for interurban run.

Electric Tractors and Trailers. Modern Methods of Handling Package Freight, G. Marks. Ry. Age, vol. 72, no. 8, Feb. 25, 1922, pp. 469–470. Use of electric tractors and trailers in freight houses, and savings effected on New Haven line. (Abstract.) Paper read before New Eng. R. R. Club.

Erie Railroad. Erie Adopts Direct Freight Delivery at New York. Ry. Age, vol. 72, no. 3, Jan. 21, 1922, pp. 233–234, 1 fig. Plan involves breaking bulk at Jersey City, N. J., and use of auto trucks, tractors and trailers and ferries.

FUELS

Gas. Burning Fuel Gases Efficiently, H. S. Watts. Iron Trade Rev., vol. 70, no. 9, Mar. 2, 1922, pp. 605–609, 2 figs. Combustion temperature and stack loss are important factors from standpoint of economy. Design and operation of gas burners and principles of continuous heating are discussed.

Fuel Gases and Their Use in Iron and Steel Plants, H. S. Watts. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 2, Feb. 1922, pp. 97–126, 5 figs. Characteristics of gases; design and operation of gas burners; principles of continuous heating.

High-Ash Coal. Low-Ash Coal Not Always Desirable, S. W. Flagg. Power, vol. 55, no. 9, Feb. 28, 1922, pp. 328–330, 4 figs. Discussion of conditions under which it was found that coal with high ash content reduced stoker trouble.

Sawmill Refuse. Generating Power from Waste, H. S. Bastian. Elec. World, vol. 79, no. 8, Feb. 25, 1922, pp. 373–375, 5 figs. "Hogged fuel," or sawmill refuse, proves to be a valuable combustible in lumber-producing regions; care must, however, be exercised in firing if best results are to be obtained.

Vegetable Gas. The Gasification of Vegetable Wastes According to the Process of the German Gas Corporation, Hannover (Germany) (Vegetabilienvergasung nach dem Verfahren der Deutschen Gas-Akt.-Ges., Hannover). Wärme- u. Kälte-Technik, vol. 24, no. 1, Jan. 1922, pp. 5–7, 2 figs. Discusses gasification of tanbark waste, broken hemp stalks, cocoa-bean shells, olive-seed hulls, as well as the hulls of leguminous plants, and gives analyses and thermal values of vegetable gas.

[See also LIGNITE; OIL FUEL; PULVERIZED COAL.]

FURNACES, ANNEALING

Sheet and Tin Mill. Sheet and Tin Mill Furnaces, T. J. Costello and J. H. Knapp. Blast Furnace & Steel Plant, vol. 10, no. 2, Feb. 1922, pp. 141–144, 3 figs. Improvements in furnaces used for heating and annealing sheet and tin.

FURNACES, BOILER

Burners for Blast-Furnace Gas. Tests with Gas Burners on Boilers and Cowpers (Versuche mit Gasbrennern an Kesseln und Cowpern), Eduard Weymann. Stahl u. Eisen, vol. 42, no. 6, Feb. 9, 1922, pp. 215–221, 11 figs. Investigation of different burners for blast-furnace gas for heating of fire-tube boilers and Cowper stoves and description of their arrangement and operation. Comparison of test results. Behavior of burners with fluctuating gas pressures. Describes new American arrangement for regulation of air inlet with fluctuation of gas pressure.

Gas-Fired. The Economic Burning of Excess Gas (Die wirtschaftliche Verfeuerung von Ueberschussgas), M. Schimpf. Glückauf, vol. 58, no. 3, Jan. 21, 1922, pp. 72–76, 8 figs. Account of test carried out at a German mine with a Moll gas-fired furnace and gas-pressure regulator. Demonstrates with aid of numerical example savings which can be effected with use of a regulated gas pressure.

Low-Grade Fuel. The New Mechanical Bamag Furnaces (Die neuen mechanischen Bamag-Feuerungen), H. Pradel. Braunkohle, vol. 20, no. 30, Oct. 29, 1921, pp. 472–476, 5 figs. Describes forced-draft traveling grates and underfeed furnaces of the Berlin-Anhalt Machine Construction Corp., Dessau, for utilization of lignite.

FURNACES, FORGING

Types. Discussion of Forge Furnaces, Charles Longenecker. Forging & Heat Treating, vol. 8, no. 2, Feb. 1922, pp. 122–124. Discusses soaking pits, regenerative-type furnaces, non-regenerative type, and furnaces of small hearth area, pointing out possibilities for saving and increased efficiency with various classes of fuel.

G

GAS

By-Product. Value of By-Product Gas to Industry, H. Dobrin. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 2, Feb. 1922, pp. 79–90 and (discussion) 91–96. Flame temperatures of various gases; use of by-product gas in glass, iron, boiler, and automobile works; furnace design; combustion.

Fuel. See FUELS, Gas.

GAS ENGINES

Manufacture of Parts. How Large Engine Parts Are Made, Pat Dwyer. Foundry, vol. 50, nos. 2 and 3, Jan. 15 and Feb. 1, 1922, pp. 66–73 and 114–119, 18 figs. Jan. 15: Molding practice at plant of Allis Chalmers Co., West Allis, Wis., in production of what are claimed to be largest gas engines in world. Feb. 1: Handling of large engine castings after they are made.

GAS PRODUCERS

Benoid Automatic. Benoid Gas Producer. Eng. Progress, vol. 3, no. 2, Feb. 1922, pp. 37–38, 2 figs. Arrangement, drive and operation of an automatically acting gas producer; properties of gas suitable for illuminating and heating purposes.

Coupled to Gas-Engine Plant. Some Observations on a Producer-Gas Power Plant, H. S. Denny. Engineering, vol. 113, nos. 2926, 2927 and 2928, Jan. 27, Feb. 3 and 10, 1922, pp. 119–122, 152–154, and 184, 10 figs. Account of investigation of large-capacity Mond gas-producer plant coupled up to gas-engine plant of equivalent size. Paper read before Instn. Mech. Engrs. For discussion, see no. 2928, Feb. 10, pp. 160–162.

GAS TURBINES

Economy. Economy and the Gas Turbine, Norman Davey. Engineer, vol. 133, no. 3451, Feb. 17, 1922, p. 177. Gives comparative analyses of gas-turbine cycles (heat absorption at constant pressure) working with common rotary compressor and with kinetic compressor. Writer maintains that gas turbine competes essentially with steam turbine. (Letter to editor.)

Efficiency, Determination of. Thermodynamic Bases for Determining Efficiency to be Expected from Gas Turbines, H. Schmulke. Mech. Eng., vol. 44, no. 3, Mar. 1922, pp. 187–190, 4 figs. Presents, among others, diagrams developed by W. Schüle showing process and efficiency of Holzwarth turbines. Translated from Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 44, Nov. 4, 1921, p. 351.

GASES

Heat Transfer Between Liquids and. Rates of Absorption and Heat Transfer between Gases and Liquids, W. G. Whitman and J. L. Keats. Jl. Indus. & Eng. Chem., vol. 14, no. 3, Mar. 1922, pp. 186–191, 3 figs. Presentation of theory involved in liquid-gas interactions. Summary of Lewis' mathematical treatment with modifications. Verification of theory. Presentation of equations showing effect of operating variables on coefficients for various types of apparatus.

Specific Heat. The Specific Heats of Ammonia, Sulphur dioxide and Carbon dioxide, J. R. Partington and H. J. Cant. Lond., Edinburgh, and Dublin Philosophical Mag. & Jl. of Sci., vol. 43, no. 254, Feb. 1922, pp. 369–380, 2 figs. Experimental results of investigations carried out with object of obtaining reasonably accurate data for use in theoretical discussion.

GEAR CUTTING

Multiple Shaper. Develops Multiple Shaper for Internal Gears. Iron Age, vol. 109, no. 9, Mar. 2, 1922, pp. 592–593, 4 figs. Down-stroke model supplements previous machine of Stevenson Gear Co., Indianapolis; essential features retained.

Planing Spur Gears. Planing Large Spur Gears, Franklin D. Jones. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 529–532, 6 figs. Application of gear planers which cut gear teeth by reproducing shape of templet.

Tooth-Chamfering Machine. Gear Tooth Chamfering Machine. Machy. (Lond.), vol. 19, no. 488, Feb. 2, 1922, p. 558, 4 figs. Describes machine built by Parkinson & Son, Shipley. Effect of chamfer on engagement of gears.

Worm-Gear Generator. A New Worm Gear Generator. British Machine Tool Eng., vol. 2, no. 13, Jan.-Feb. 1922, pp. 439–445, 9 figs. Describes 12-in. worm-gear generator of Smith & Coventry, Ltd., Manchester.

GEARS

Bevel-Gear Testing Machine. The Saurer Bevel Gear Testing Machine. Engineering, vol. 113, no. 2930, Feb. 24, 1922, pp. 228–229, 9 figs. Bed of machine is heavy, circular casting, upon which a pair of sliding heads can be locked in any position, so that angle between axes of heads corresponds to that of bevels to be tested, a range from 52 to 150 deg. being obtainable.

Chain. The Application of Chain Gearing, H. T. Hildage. Can. Manufacturer, vol. 42, no. 2, Feb. 1922, pp. 31 and 51. When adaptable to certain needs; type of chain required; what it will cost; how much space it will occupy; how long it will last.

Friction. Friction Gearing, Chas. S. Pettit. Machy. (Lond.), vol. 19, no. 489, Feb. 9, 1922, pp. 567–569. Discusses frictional contact between driving and driven members; coefficient of friction; pressures of contact; variable-speed disc drives; cup and cone friction clutches; etc.

Herringbone. Standardization of Herringbone Gears, Am. Mach., vol. 56, no. 9, Mar. 2, 1922, pp. 329–330, 2 figs. Recommendations which are result of careful investigation by committee of Am. Gear Mfrs. Assn.

Hot-Rolling. Forming Gears by Hot Rolling, Reginald Trautschold. Iron Trade Rev., vol. 70, no. 6, Feb. 9, 1922, pp. 396–399, 6 figs. Independent application of power to die roll and gear blank and synchronization of their rotation are said to be factors contributing to success of gear-rolling processes.

Spiral Bevel. End Thrusts and Bearing Loads due to Spiral Bevel Gears. Machy. (Lond.), vol. 19, no. 488, Feb. 2, 1922, pp. 545–548, 4 figs. Discusses pinion-cut left-hand spiral, rotating clockwise; pinion-cut left-hand spiral, rotating counter-clockwise; pinion-cut right-hand spiral, rotating clockwise; and pinion-cut right-hand spiral, rotating counter-clock-wise.

GRINDING MACHINES

Plain. A New Precision Grinding Machine. Machy. (Lond.), vol. 19, no. 488, Feb. 2, 1922, pp. 532–534, 5 figs. Plain grinder with positive-acting table traverse and reversing mechanism.

H

HEAT PUMPS

Evaporators and. Experiences with Evaporators in Connection with Heat Pumps (Erfahrungen an Eindampfanlagen mit Wärmepumpe), E. Wirth. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 46, Nov. 12, 1921, pp. 1183–1186, 11 figs. Points out that as economy of evaporation with liquid concentration is based on a minimum consumption of power, it is necessary to carefully investigate all conditions influencing increase in temperature of vapor. Whereas until now investigations have been made only with regard to liquids with low boiling point, data are here given with heavier liquids. Account of author's experiences during several years with heat-pump operation.

HEATING

Central Producer-Gas Plant. Central Heating by Steam, Water or Gas, Samuel R. Lewis. Power, vol. 55, no. 7, Feb. 14, 1922, pp. 267–268. Central producer-gas plant with automatic gas-fired boilers in each building shows an estimated saving in initial investment of $173,000 and a reduction in annual operating expense of $14,700 over steam heating.

Gas. Possibilities of Gaseous Heating, H. H. Clark. Western Soc. Engrs. Jl., vol. 27, no. 2, Feb. 1922, pp. 51–56 and (discussion) 56–58, 5 figs. Relative combustion efficiency of the various gases assuming perfect combustion; comparison of costs of various fuels; comparison of gas and electricity for heating, power and light. Gives a number of charts.

HEATING, HOT-AIR

Reversed Heat Engine. The Reversed Heat Engine as a Means of Heating Buildings, T. B. Morley,

Engineer, vol. 133, no. 3450, Feb. 10, 1922, 145-146, 1 fig. Recapitulates and explains Lord Kelvin's proposal, made in 1852, of an indirect process employing a heat engine and a "warming machine" driven by engine, by means of which heat delivered to building might be much greater than heat of combustion of coal consumed. Discusses its theoretical possibilities and nature of difficulties to be overcome in its application.

HEATING, HOT-WATER

Thermometers for. Thermometers for Tenements with Hot-Water Heating (Wärmemesser für Mietswohnungen mit Warmwasserheizung), H. Wittfeld. Gesundheits-Ingenieur, vol. 45, no. 3, Jan. 21, 1922, pp. 25-28, 1 fig. Describes device for determining amount of total costs of heating which falls to each apartment according to the actual amount of heat consumed in order to do away with present method of determining this cost according to surface area of heated rooms.

HEATING, STEAM

Dry Air with. "Dry Air" with Central Heating (Trockene Luft bei der Zentralheizung), R. Gare. Wärme- u. Kälte-Technik, vol. 24, no. 1, Jan. 1922, pp. 4-5. Points out that not the absolute, but the relative moisture content changes with the heating of air as the absorptivity for steam increases; this change is the same in all heating systems, consequently the idea that central and especially steam heating "dries out" the air more than other heating systems is erroneous.

HEAVY-OIL ENGINES

Naphthalene. Naphthalene Engines (Moteurs à naphthaline), P. Maréchal. Nature, no. 2493, Jan. 14, 1922, pp. 22-23, 1 fig. Describes operation of a recent type in which fuel is vaporized by gasifying at low temperature, which makes engine run smoothly.

HELICOPTERS

Problems. Some Notes on the Helicopter, M. B. Sellers. Aviation, vol. 12, no. 8, Feb. 20, 1922, pp. 228-230, 3 figs. Elements of the problem, some experimental results, difficulties yet awaiting solution. N.A.C.A. Technical Note, No. 47, Apr. 1921.

HYDRAULIC TURBINES

Draft-Tube Designs. A Discussion of Draft-Tube Designs, Webster K. Ramsay. Mech. Eng., vol. 44, no. 3, Mar. 1922, pp. 171-176, 11 figs. With special reference to recent forms known as hydraucone regainer and spreading draft tube.

Flow in Conical Draft Tubes. Flow in Conical Draft Tubes of Varying Angles, George E. Lyon. Mech. Eng., vol. 44, no. 3, Mar. 1922, pp. 177-180, 7 figs. Account of investigation to determine velocity curves at several cross-sections of straight conical draft tubes.

Measuring Efficiency. New Methods for Measuring the Efficiency of Hydraulic Turbines (Note sur un nouveau procédé de mesure du rendement des turbines hydrauliques), L. Barbillion and A. Poirson. Bul. Technique de la Suisse Romande, vol. 48, no. 2, Jan. 21, 1922, pp. 19-21, 1 fig. Describes thermometric method by which losses are measured from temperature difference of water before and after passing turbine.

HYDROELECTRIC DEVELOPMENTS

Canada. A Review of Hydroelectric Progress in Canada. Can. Engr., vol. 42, no. 8, Feb. 21, 1922, pp. 241-244, 3 figs. Progress in development during 1921: 300,000 hp. installed in Dominion, with 177,000 hp. in Ontario and 90,000 hp. in Quebec.

Muscle Shoals, Ala. The Disposal of Muscle Shoals, R. S. McBride. Power, vol. 55, no. 8, Feb. 21, 1922, pp. 288-291, 4 figs. Notes on existing nitrate and power plants, Ford's offer and Secretary Weeks' objections, Alabama Power Co.'s offer. Author has endeavored to avoid expressing opinions, but has merely suggested basis for various arguments pro and con.

Ontario System. Hydroelectric System of Province of Ontario Investigated, W. S. Murray. Elec. World, vol. 79, no. 10, Mar. 11, 1922, pp. 471-474. In report made public by Nat. Elec. Light Assn., writer finds it inefficient, expensive and wasteful and that, in spite of all claims made for it, service from private utilities in United States and Canada is cheaper and better.

Shawinigan Falls, Canada. The New 41,000 Hp. Unit at Shawinigan Falls, Julian C. Smith. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 3, Mar. 1922, pp. 136-139, 7 figs. Describes design features of latest hydroelectric development of Shawinigan Water & Power Co.

St. Lawrence River. St. Lawrence Navigation and Power Investigation. Can. Engr., vol. 42, no. 3, Jan. 17, 1922, pp. 139-143, 1 fig. Details of double development plan as proposed by New York & Ontario Power Co. Suggestions based on 14 years' study of conditions in vicinity of Waddington. Proposed sites at Rapid du Plat and Long Sault.

HYDROELECTRIC PLANTS

High-Head. Highest Head Hydroelectric Power Installations of the World, A. T. Parsons. Jl. Electricity & Western, vol. 48, no. 4, Feb. 15, 1922, p. 155. Discusses limiting factors entering into design and construction of hydroelectric plants for very high heads.

Interconnection of Steam and. Michigan a Leader in Interconnection of Hydro and Steam Plants, Harry J. Burton and William W. Tefft. Elec. World, vol. 79, no. 7, Feb. 18, 1922, pp. 328-331, 2 figs. Twenty water-power and eleven steam stations joined by Consumers' Power Company's 140-Kv. transmission system. Bearing of hydro experience on Middle Western developments. How some problems have been solved.

Spain. Hydroelectric Installations in Spain, Horace F. Parshall. Engineering, vol. 113, no. 2928, Feb. 10, 1922, pp. 167-168. Installations of Barcelona Traction, Light & Power Co. (Abstract.) Paper read before Instn. Civ. Engrs.

I

ICE PLANTS

Electrically Operated. 300-Ton Ice Factory at Grimsby. Engineer, vol. 133, no. 3451, Feb. 17, 1922, pp. 171-173, 5 figs. Describes what is believed to be largest electrically operated direct-expansion ice-making plant in world, recently erected and put to work for Standard Ice & Cold Storage Co., Ltd., by Pluperfect Refrigeration Co., Ltd., Manchester, England.

Central Station Service in the Ice Industry, H. M. Jones. Ice & Refrigeration, vol. 62, no. 2, Feb. 1922, pp. 136-138. Electric drive for ice-making plants, power required; kind and size of motors; comparative cost of operating.

Railway. Establishing Icing Facilities on a Large Scale, W. C. Phillips. Ry. Age, vol. 72, no. 9, Mar. 4, 1922, pp. 533-534, 2 figs. System recently inaugurated on Southern Pacific and Union Pacific gives highly satisfactory results.

IMPACT TESTING

Endurance Tests. Impact Endurance Tests of Rods of Varying Cross-Section. Engineering, vol. 113, no. 2930, Feb. 24, 1922, p. 246. Describes endurance tests to which W. Muller and H. Leber, of the Material Testing Bureau at Darmstadt, Germany, have been submitting rods of varying cross-section. Translated from Zeit. des Vereines deutscher Ingenieure (pp. 1089-1094, 1921).

Notched-Bar Tests. Shock Test on Notched Bars (Zur Gesetzmässigkeit der Kerbschlagprobe), M. Moser. Stahl u. Eisen, vol. 42, no. 3, Jan. 19, 1922, pp. 90-97, 21 figs. Influence of thickness of test pieces on notched-bar impact values, relation of shock effect to unit of volume; characteristic of volume; influence of speed of blows; and of diameter of notch. Conclusions based on tests.

INDUSTRIAL MANAGEMENT

Forms. The Principles of Designing Forms, H. P. Losely. Management Eng., vol. 2, no. 3, Mar. 1922, pp. 158-160, 3 figs. Presents and discusses five principles governing design and use of forms.

Inventory Methods. How to Cut Cost Corners Through Inventory, W. M. Romig. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 86-87, 2 figs. How well-managed inventory methods help to stabilize profits.

Labor-Routine Chart. Labor Routine. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 176-177. Presents chart developed for Todd Dry Dock & Constr. Co. by William C. Bober showing how systems of routine may be charted to bring out each step.

Planning. Planning in Large Contract Plants, George H. Shepard. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 547-551, 13 figs. Cards and records used in planning and dispatching work.

Production Control. The Measurement of Human Work, Walter N. Polakov. Management Eng., vol. 2, no. 2, Feb. 1922, pp. 91-93, 1 fig. The Gantt graphic method of controlling production is claimed to be only one on a correct unit of measurement.

Production Organization. Organization of Production, J. W. Curtis. Eng. & Indus. Management, vol. 7, nos. 5 and 7, Feb. 2 and 16, 1922, pp. 127-130 and 187-191, 19 figs. Discusses use of charts, and organization in erection work. Presents scheme of organization of engineering department of a medium-size works. Drawing office progress chart.

Purchasing Policies. Stabilizing Profits through Proper Purchasing Policies, Park Mathewson. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 136-139. How purchasing executive should apply fundamentals of forecasting.

Reduced Force, Operating with. Operating a Factory with a Reduced Force, John C. Lease. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 533-535, 3 figs. Describes how factory was profitably operated at 30 per cent capacity.

Sales Organization. Sales Organization and Methods, Willard E. Freeland. Taylor Soc. Bul., vol. 6, no. 6, Dec. 1921, pp. 244-251 and (discussion) pp. 251-254. Second report of committee on sales questionnaire, purpose of which was to obtain information about form of organization of sales departments, extent to which engineering phases were recognized and scientific planning and scheduling attempted, and methods of control of important portions of work of distribution organization.

Standard Lot Quantities. Establishing Profitable Standard Lot Quantities, J. A. Bennie. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 167-169, 2 figs. How to determine order points for stock parts.

Time Study. See TIME STUDY.

INDUSTRIAL ORGANIZATION

Administration Problems. Works Organization, T. E. Pattinson. Eng. Production, vol. 4, nos. 70 and 71, Feb. 2 and 9, 1922, pp. 101-104 and 124-127, 18 figs. Deals mainly with problems which have been encountered in administration of a large works organization. Paper presented before Instn. Production Engrs. See also discussion in same journal, no. 72, Feb. 16, 1922, pp. 149-152.

Fundamentals. The Body, Soul and Spirit of Organization, B. A. Franklin. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 143-145. Discusses fundamentals underlying organizing for accomplishment.

Profit Margins, Reestablishing. Reestablishing the Profit Margins in the Edison Industries, Alfred Stuart Myers. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 131-135. Describes executive policies that successfully met problems of depression.

Profits, Stabilizing. Stabilizing the Profits of the Small Factory, Ernest Cordeal. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 146-149. Author points out necessity of constant attention to raw-material market, probable demand for product and stability of wage scales, and shows how useless any cost system may become unless it is intelligently followed up.

INDUSTRIAL RELATIONS

Antagonism of Capital and Labor. The Inevitable Antagonism Between Employers and Employees, C. E. Knoeppel. Management Eng., vol. 2, no. 3, Mar. 1922, pp. 143-148. Writer maintains that interests of capital and labor, instead of being mutual, are absolutely antagonistic; as factors in industrial life they are irreconcilable; they have every reason for staying apart; they have always fought, are fighting now, and will continue to fight. Discusses possibilities of future development of a mutuality of interests.

INTERNAL-COMBUSTION ENGINES

Castings for. Some Castings for Internal Combustion Engines, Ben Shaw and James Edgar. Foundry Trade Jl., vol. 25, no. 285, Feb. 2, 1922, pp. 83-87, 26 figs. Deals with patternmaking for crankcases, drawing board, and core-boxes.

Combustion in. Study of Combustion of Liquid Fuels in Internal-Combustion Engines, with Special Regard to Fuel and Exhaust-Gas Analysis (Beiträge zur Kenntnis der Verbrennung flussiger Brennstoffe in Motoren, unter besonderer Berucksichtigung der Brennstoff und Abgasuntersuchung), E. Terres, Fritz Wehrmann and L. Lueg. Zeit. für Elektrochemie, vol. 27, no. 17-18 and 19-20, 1921, Sept. 1 and Oct. 1, pp. 379-393 and 423-441, 33 figs. Results of tests carried out on a 4-cylinder 40-hp. Benz engine.

Fuels, Effect of. Effect of Different Fuels on the Operation of Internal-Combustion Engines (L'influence de l'emploi de combustibles différents sur le fonctionnement des moteurs à combostion interne), Henri Petit. Technique Automobile et Aerienne, vol. 12, nos. 113, 114 and 115, 1921, pp. 50-62, 72-87 and 97-115, 34 figs. No. 113: Results of experiments to determine power and efficiency of engine; energy contained in given fuel mixed with air; losses, proper conditions of combustion of various fuels, their calorific power; etc. No. 114: Relation between explosion and ignition temperatures; use of inert gases; maximum specific volume; etc. No. 115: Distribution of heat; starting engine; distribution of fuel in cylinders; volumetric efficiency; variable pressure engines, overcharged engines, and others. Gives numerous tables.

Hot-Bulb Marine. Internal Combustion Engine, J. J. Fasola. Inst. Mar. Engrs. Trans., vol. 33, Jan. 1922, pp. 583-628, (includes discussion) 10 figs. Fundamentals and other particulars relating to a modern hot-bulb marine engine.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; CARBURETORS; DIESEL ENGINES; GAS ENGINES; HEAVY-OIL ENGINES; OIL ENGINES.]

IRON, PIG

Desulphurization of. The Desulphurization of Pig Iron and Steel (Zur Frage der Entschwefelung von Roheisen und Stahl), Bruno Simmersbach. Chemiker-Zeitung, vol. 46, no. 8, Jan. 19, 1922, pp. 65-68. Notes on origin of sulphur in pig iron and steel and suggestions for its removal.

L

LABOR TURNOVER

Absenteeism. Absenteeism: a Quanitative Study, J. D. Hackett. Management Eng., vol. 2, no. 2, Feb. 1922, pp. 85-90. Factors from experience on causes, occurence, and duration of absenteeism and condition of absentees.

Unavoidable, Elements of. Elements of Unavoidable Labor Turnover, A. L. DeLeeuw. Management Eng., vol. 2, no. 3, Mar. 1922, pp. 137-142, 5 figs. It is maintained that labor turnover of whatever kind provides measure of management efficiency because its cost is an overhead expense.

LABORATORIES

Foundry. Keighley Laboratories, Limited. Foundry Trade Jl., vol. 25, no. 285, Feb. 2, 1922, pp. 75-80, 14 figs. Traces origin of laboratory and describes its equipment and recent research work carried out in connection with internal chill in gray-iron castings.

Laboratory for Malleable Iron Foundry. Iron Age, vol. 109, no. 10, Mar. 9, 1922, pp. 643-644, 3 figs. Equipment for running carbon, sulphur and manganese determinations facilitates control of product. Getting rid of heavy gases.

Industrial. Research Laboratories in Industrial Establishments of the United States. Nat. Research Council Bul., vol. 3, no. 16, Dec. 1921, 135 pp. List of laboratories arranged by firm names, with a subject classification, giving particulars as to research staff, research work and equipment in each case.

Originally compiled by Alfred D. Flinn, revised and enlarged by Ruth Cobb.

LATHES

Bed Guards. Durability in Machine Tools, P. V. Vernon. Eng. Production, vol. 4, no. 72, Feb. 16, 1922, pp. 153–154, 3 figs. Describes Herbert automatic lathe fitted with bed guards, introduced in 1910, and new model no. 11 hexagon turret lathe, embodying similar protective devices.

Fay, Machining on. Cutting the Production Cost of a Difficult Part, H. A. Loudon. Am. Mach., vol. 56, no. 10, Mar. 9, 1922, pp. 369–370, 6 figs. Describes machining of one of its own parts, the cam drum worm, by the standard Fay lathe.

Turret. A New Hexagon Turret Lathe. Engineer, vol. 133, no. 3450, Feb. 10, 1922, p. 160, 1 fig. Claimed to be an entirely new type. One of chief features is fact that scraped bed slides are completely covered by cast iron guards; another feature is manner in which all possible points of danger are guarded.

Motor-car Engine Production Work on Turret Lathes. Machy. (Lond.), vol. 19, no. 489, Feb. 9, 1922, pp. 570–573, 8 figs. Time-saving and cost-reducing methods for engine department of a motor-car plant.

LIGHTHOUSES

Aerial. Aerial Lighthouses. Aerial Age, vol. 14, no. 24, Feb. 20, 1922, pp. 564–565 and 561, 2 figs. Describes lighthouse being erected at Dijon in order to provide suitable guiding light for aerial routes between Paris and Algiers, Italy and Switzerland. Made by optical firm of Barbier, Bernard and Turenne, Paris.

LIGHTING

Artificial Daylight. Recent Improvements in the Sheringham Daylight, S. H. Groom. Illuminating Engr., vol. 14, no. 9, Nov. 1921, pp. 215–218, 4 figs. Principles upon which Sheringham daylight is based and recent improvements made.

Factory. Better Lighting Increases Production, Ward Harrison, O. F. Haas and F. W. Dopke. Iron Trade Rev., vol. 70, no. 9, Mar. 2, 1922, pp. 610–612, 2 figs. Account of investigation carried out by Dover Mfg. Co., Dover, Ohio, in its plant for purpose of obtaining further practical data showing effect of good lighting on efficiency of production.

Phototechnical Calculations. Phototechnical Calculations According to the Nomographic System (Lichttechnische Berechnungen in nomographischer Behandlungsweise), L. Bloch. Elektrotechnische Zeit., vol. 43, no. 3, Jan. 19, 1922, pp. 73–77, 8 figs. It is shown that practically all of more important calculations in lighting technology can be quickly and easily carried out with aid of nomographic methods.

LIGNITE

Dried, Specific Heat of. Determination of the Specific Heat for Dried Lignite and Lignite Briquettes (Bestimmung der spezifischen Warme fur getrocknete Braunkohle und Braunkohlenbriketts), J. Baudenbacher. Braunkohle, vol. 20, no. 28, Oct. 15, 1921, pp. 433–435, 1 fig. Results of test show that behavior of lignite in the absorption of heat is different from that of anthracite. Specific heat coefficient of German water-free lignite is found to be 0.49.

LOCOMOTIVES

Cylinders. Locomotive Cylinders. Ry. Gaz., vol. 36, no. 4, Jan. 27, 1922, p. 138, 2 figs. Describes method of L. B. Billinton, of Lond., Brighton & South Coast Ry., and results obtained, for renewing port faces of locomotive cylinders which have become prematurely worn to scrapping limits.

Development. What is Your Locomotive Policy? G. M. Basford. Central Ry. Club official Proc., vol. 30, no. 1, Jan. 1922, pp. 1086–1105 and (discussion) 1106–1117, 10 figs. Discusses necessity of formulating a policy for next 20 or 30 years in the development of locomotives for heavy freight, fast freight, way freight, fast passenger, slower passenger, branch-line passenger and freight, yard switching, and transfer.

Diesel-Engined. Direct Drive Diesel-Air Locomotive, W. S. Burn. Eng. Rev., vol. 35, no. 7, Jan. 1922, pp. 221–225, 1 fig. Describes horizontally opposed-piston type of engine, working in conjunction with two separate crankshafts, each being connected by two driving rods at 90 deg. to a jackshaft, and thence to wheels by coupling rods; air system, water-cooling system, and other details of design. Paper read before North-East Coast Instn. of Engrs. & Shipbuilders.

German and Austrian. The Most Modern Types of Former Austrian and German Locomotives Added to the Rolling Stock of the Italian State Railways (I piu moderni tipi di locomotive Ex-Austriache ed Ex-Germaniche, entrate a far parte del parco materiale delle ferrovie dello stato). Industria, vol. 35, nos. 18, 20 and 21, Sept 30, Oct. 31 and Nov. 15, 1921, pp. 402–407, 445–448 and 466–469, 12 figs. Sept. 30: Describes Austrian six-wheel switcher, Prairie and Mogul types, and Prussian ten-wheeler superheater type. Oct. 31: Describes eight-wheel switcher locomotive, a hump engine, and some Mastodon types Nov. 15: List of Austrian and German locomotives added to state railway.

Mikado and 8-Wheel. Mikado Locomotive for the Greenbrier & Eastern Railroad and Eight-Wheel Type Locomotive for the Dayton Goose Creek Railroad. Ry. & Locomotive Eng., vol. 35, no. 2, Feb. 1922, pp. 42–43, 2 figs. Describes Mikado 2–8–2, with tractive effort of 45,750 lb., and eight-wheel 4–4–0 type, with tractive effort of 13,770 lb., Built by Baldwin Locomotive works. See also Ry. Rev., vol. 70, no. 7 Feb. 18, 1922, pp. 213–214, 2 figs.

Northern Pacific Ry. Extensive Order of New Locomotives for the Northern Pacific Railway Company. Ry. & Locomotive Eng., vol. 35, no. 2, Feb. 1922, pp. 35–36, 3 figs. Describes Pacific type 4–6–2, Mikado type 2–8–2, and Mallet type 2–8–8–2, built by Am. Locomotive Co., with tractive efforts of, respectively, 41,900 lb., 57,100 lb., and 105,100 lb.

Ownership and Operation. Factors in the Business of Owning Locomotives, C. B. Peck. Ry. Age, vol. 72, no. 8, Feb. 25, 1922, pp. 471–474, Discusses coöperation between locomotive power and operating departments in designing and operating to secure economy. Paper read before Western Ry. Club.

Rebuilt. Operating Results Show Savings by Rebuilt Power, H. F. Grewe. Ry. Age, vol. 72, no. 7, Feb. 18, 1922, pp. 423–424, 2 figs. Gives locomotive data comparative mileages and expenses; operating costs.

The Passing of the Cross-Compound. Ry. Rev., vol. 70, no. 8, Feb. 25, 1922, p. 265, 2 figs. Describes conversion of a number of ten-wheel type cross-compound locomotives into simple locomotives of same type equipped with superheaters and piston valves.

Shay Geared. Shay Geared Locomotives for Mountain Roads. Ry. Mech. Engr., vol. 96, no. 2, Feb. 1922, pp. 75–76, 3 figs. 150-ton locomotive of Shay geared three-truck type with gear ratio of 1 to 2.45; for Greenbriar, Cheat & Elk Railroad. Comparison with heavy Mikado.

Speed Indicators. The Telco Locomotive Speed-Indicator and Recorder. Engineering, vol. 113, no. 2927, Feb. 3, 1922, pp. 131–133, 27 figs. Describes instrument constructed by Hasler Telegraph Works, London, having an ordinary clock movement which gives actual time and which is combined with gear producing a time record; also a distance counter, and speed-recording gear.

Steam-Turbine. The First Steam Turbine Locomotive. Ry. Mech. Engr., vol. 96, no. 2, Feb. 1922, pp. 69–70, 3 figs. Describes locomotive designed by Belluzzo, in 1908; maximum rotative speed of turbines was 2400 r.p.m. at 28 m.p.h.

Turbine Characteristics and Design of Turbo-Locomotives. Ry. Mech. Engr. vol. 96, no. 2, Feb. 1922, p. 61. Editorial discussing difficulties that must be overcome to apply the turbine to locomotives.

Zoelly Turbine Locomotive for Swiss Federal Railways. Ry. Mech. Engr., vol. 96, no. 2, Feb. 1922, p. 70. Describes new design of Dr. Zoelly, of Escher, Wyss & Co., Zurich, Switzerland. A 4–6–0 type locomotive has been converted from a standard type with usual reciprocating steam engine to turbine-driven engine. Turbine is designed for speed of 8000 r.p.m. or $48\frac{1}{2}$ m.p.h.

LUBRICATING OILS

Airplane Engines. Paraffin viz. Naphthene Base Oils. Sci. Lubrication, July 1921, pp. 5–8 and 13, 4 figs. Describes tests made for purpose of deciding various questions regarding lubrication of aeronautic engines with oils from Texas, Pennsylvania, and oils compounded with graphite.

Cutting Fluids. Cutting Fluids, Eugene C. Bingham. U. S. Bur. of Standards Technologic Papers, no. 204, Dec. 20, 1921, pp. 35–76, 8 figs. Used both to cool and lubricate. When lubrication is more important, it is generally recognized that fatty oils are superior to mineral oils, though reason has never been clearly explained. Evidence appears to be that value of fatty oils is due to their residual valence or acidity which causes their adhesion to metal to be greater than is case with mineral oils. Points out that it may yet be possible to synthesize an oil which has all of virtues of lard oil without its defects.

Dilution. Dilution of Crank Case Oil, C. M. Larson. Sci. Lubrication, Oct. 1921, pp. 13–15, 2 figs. Dilution of motor oils and possible means of preventing or correcting this condition in immediate future. Suggests that new instruments recently developed for detecting dilution be used by motorists, and that motors be drained as soon as instruments show mixture in crankcase has reached dangerous condition

Light Force-Feed. Endurance Tests of Force Feed Oils, J. G. O'Neill. Sci. Lubrication, Aug. 1921, pp. 5–10, 10 figs. Results obtained from endurance test of oils to ascertain service obtained from light force-feed lubricating oils when used in a force-feed lubrication system. Character of changes which take place in these oils under severe service conditions. Reprinted from Jl. Am. Soc. Naval Engrs., May 1921

Tests. Comparative Lubricating Engineering. Sci. Lubrication, Oct. 1921, pp. 20–22. Describes tests made to bring out relative lubricating qualities of various oils and tests made to determine most satisfactory and efficient lubricant for elevator worm gears.

Viscosity. Lubrication and Lubricants, Leonard Archbutt. Soc. Chem. Industry Jl., vol. 40, no. 24, Dec. 31, 1921, pp. 287T–293T. Discusses theory of viscous lubrication; measurement and expression of vicosity; effect of pressure on viscosity and density; solid contact friction; oiliness and its measurement; thickness of lubricating films; solid lubricants.

How Variation of Temperature Affects Viscosity of Lubricating Oils, W. F. Osborne. Power, vol. 55, no. 11, Mar. 14, 1922, pp. 420–421, 1 fig. Includes chart showing how viscosities vary with temperature.

LUBRICATION

Lubrication Engineering. The Status of Lubrication Engineering, W. H. Bailey. Sci. Lubrication, Oct. 1921, pp. 5–7. Discusses conservation of lubricants and liquid fuels, and basis from which these commodities are derived. Outlines purposes of Am. Soc. Lubricating Engrs.

Thickness of Oil Films in Bearings. The Thickness and Resistance of Oil Films in High Speed Bearings, Gerald Stoney. R. O. Boswall and J. Massey. Engineering, vol. 113, no. 2931, Mar. 3, 1922, pp. 249–250, 7 figs. Account of experimental investigation carried out during 1921 at College of Technology, Manchester, England for purpose of determining actual thickness of oil film or of discovering in what way this thickness changes with variations in load, rubbing speed and viscosity.

M

MACHINE GUNS

Patents for Inventions. Ordnance and Machine Guns. Abridgments of Specifications, Period—A.D 1909–15, class 92 (ii), 1921, 355 pp. Patents for inventions.

MACHINE SHOPS

British. A Bradford Engineering Works. Engineer, vol. 133, no. 3452, Feb. 24, 1922, pp. 210–212, 10 figs. partly on p. 214. Describes works of Cole, Marchent and Morley for manufacture of steam engines, Diesel engines, etc.

British Machine Tool Works. British Machine Tool Eng., vol. 2, no. 13, Jan.-Feb. 1922, pp. 428–431, 3 figs. Describes works of Kendall & Gent, Ltd., Gorton, Manchester.

Famous British Works. Eng. Production, vol. 4, no. 71, Feb. 9, 1922, pp. 122–123, 5 figs. Describes works of Greenwood & Batley, Ltd., Leeds for construction of metal-making, hydraulic, electric, turbine and textile machinery.

Famous British Works. Eng. Production, vol. 4, no. 73, Feb. 23, 1922, pp. 170–172, 6 figs. Describes works of Worthington-Simpson, Ltd., Newark-on-Trent, for manufacture of all types of pumping machinery.

Famous British Works. Eng. Production, vol. 4, no. 74, Mar. 2, 1922, pp. 194–196, 6 figs. Describes works of Blackstone & Co., Rutland Engineering Works, Stamford, for manufacture of oil engines and agricultural machinery.

MACHINE TOOLS

Anti-Slip Devices. Anti-Slip Devices Save Time and Money, Fred Horner. Can. Machy., vol. 27, no. 8, Feb. 23, 1922, pp. 19–20, 8 figs. Positive stops to prevent sliding; serration on tool face; anti-slip thrust screws; etc.

Electric Drive for Reversing. Electric Drive for Reversing Machine Tools, A. L. Harvey. Am. Mach., vol. 56, no. 10, Mar. 9, 1922, pp. 371–373. Notes on reversing mechanisms; dynamic braking and "plugging!" power consumed in reversing; effect of reversing on production; variation in power requirements.

MALLEABLE CASTINGS

Reactions in Malleablizing. Studies Reactions in Malleablizing, Arthur Phillips and E. S. Davenport. Foundry, vol. 50, no. 5, Mar. 1, 1922, pp. 185–194, 49 figs. Describes results of experiments showing effect of different temperatures and length of anneal.

MARINE BOILERS

Dyson. The Dyson Boiler, H. G. Cooper. Am. Soc. Naval Engrs. Jl., vol. 34, no. 1, Feb. 1922, pp. 33–55, 16 figs. Describes boiler and tests made at Fuel Oil Testing Plant of Phila. Navy Yard. It is believed that this boiler would prove a particularly satisfactory steam generator for capital ships.

METALLOGRAPHY

Etching. New Etching Method Develops Figures Ascribed to the Influence of Force, Ad. Fry. Forging & Treating, vol. 8, no. 2, Feb. 1922, pp. 99–104, 19 figs. Discusses nature and procedure of etching, and origin and nature of force influence figures. Translated from Stahl und Eisen, Aug. 11, 1921.

METALS

Calorizing. Calorizing, Arthur V. Farr. Engrs., Soc. West. Pa. Proc., vol. 37, no. 6, July 1921, pp. 331–340 and (discussion) pp. 341–343. Description of calorizing based upon standard methods as practiced under General Elec. Co.'s patent rights.

Colloidal State. Colloidal State in Metals and Alloys—III and IV, Jerome Alexander. Chem. & Met. Eng., vol. 26, nos. 4 and 5, Jan. 25 and Feb. 1, 1922, pp. 170–172 and 201–207, 11 figs. Jan. 25: White metal and brass. Feb. 1: Iron and Steel. Paper read before Am. Inst. Min. & Met. Engrs.

Failure Due to Internal Stress. The Failure of Metals Through the Action of Internal Stress Irregularities with Special Reference to Tool Steels, J. Neill Greenwood. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 123–138, 6 figs. Investigation of basic reasons for failures and measures for minimizing their occurences. Bibliography.

Heat Treatment. Heat Treatment of Metals (Les traitements thermiques des métaux), R. Panaud. Outillage, vol. 243, no. 3, Jan. 21, 1922, pp. 73–75, 13 figs. Tempering baths; temperature and methods of tempering and effect on steel and other metals.

Tests for Automotive Industries. Correlation Between Metallurgical and Service Tests, Walter Rosenhain. Automotive Industries, vol. 46, no. 10, Mar. 9, 1922, pp. 566–568. Discusses need for greater coöperation between metallurgical and automotive engineers with a view to developing tests, result of which can be used with greater certainty of success in selecting most suitable metals for various purposes.

Thermal Expansion. Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel, and Aluminum, Wilmer H. Souder and Peter Hidnert. U. S. Bur.

of Standards Sci. Papers, no. 426, Dec. 17, 1921, pp. 497-519, 10 figs. Data on thermal expansion of 29 samples are presented, all of which, except stainless steel, were examined from room temperature to about 600 deg. cent. Samples of stainless steel were heated from room temperature to 900 deg. cent.

METRIC SYSTEM

Russia. The Metric System in Russia (Le système métrique en Russie), Leopold Reverchon. Nature, no. 2491, Dec. 31, 1922, pp. 427-428. Discusses degrees adopting metric system and gives table of equivalents.

MILLING CUTTERS

Top and Side Rake. Formed Milling Cutters and Hobs with Top and Side Rake, Harry E. Harris. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 527-528, 2 figs. Summarizes chief advantages of providing a hook on hob and cutter teeth.

MILLING MACHINES

Locomotive Bar Frames. Profile Milling Locomotive Bar Frames. Machy. (Lond.), vol. 19, no. 490, Feb. 16, 1922, pp. 600-601, 5 figs. Describes machine developed by Ernst Schiess, of Dusseldorf, with object of completely machining locomotive bar frames of about 4 in. in thickness from solid slab as furnished by rolling mills.

MOLDING MACHINES

Automobile Foundries. Modern Molding Machines in Foundries of Automobile Plants (Neuzeitliche Formmaschinen in Giessereien der Automobil-Industrie), Oskar Redeutz. Motorwagen, vol. 25, no. 3, Jan. 31, 1922, pp. 45-53, 26 figs. Describes molding machines constructed by the Richard Kindler Foundry Machine Works, Kirchheim-Teck, Germany, for automobile industry.

Hydraulic Jar-Ramming. French Molding Methods Are Rapid. Foundry, vol. 50, no. 4, Feb. 15, 1922, pp. 153-155, 7 figs. Describes new jar-ramming machine employing hydraulic principle.

Roll-Over. A German Roll-Over Molding Machine (Eine deutsche Umrollformmaschine), U. Lohse. Stahl u. Eisen, vol. 41, no. 52, Dec. 29, 1921, pp. 1889-1892, 7 figs. Notes on development by Pridmore and Tabor, followed by detailed description of design and manipulation of new machine by firm of Alfred Gutmann, Altona-Ottensen, use of which is especially recommended for molds of small and medium size, but of considerable height.

MOLDING METHODS

Pattern and Molding Plates. The Production of Pattern and Molding Plates (Aus der Praxis der Modell- und Formplattenherstellung), Ferd. Brobeck. Zeit. für die gesamte Giessereipraxis, vol. 43, nos. 1 and 2, Jan. 7 and 14, 1922, pp. 1-3 and 19-21, 26 figs. Purpose and use of patterns and molding plates, production of metal patterns. Includes schematic table showing working method of different types of molding machines in separating of pattern and sand.

Roll Methods. Diverse Methods of Roll Molding, R. H. Palmer. Foundry, vol. 50, no. 4, Feb. 15, 1922, pp. 159-163, 16 figs. Rolls cast in solid chills swung on supporting columns, some poured on end and others on side, various methods of gating are described.

MONEL METAL

Uses and Properties. Some Typical Uses and Properties of "Monel" Metal, Edwin S. Wheeler and Robert J. McKay. Engrs.' Soc. West Pa. Proc., vol. 37, no. 6, July 1921, pp. 311-324 and (discussion) pp. 325-330. Deals with occurrence and metallurgy; typical properties, typical and special uses.

MOTION PICTURES

Wasteful Methods, Showing. Films Reduce Losses from Scrap, Winthrop G. Hall. Iron Trade Rev., vol. 70, no. 10, Mar. 9, 1922, pp. 681-682. Moving pictures showing wasteful methods of employees prove effective means of curbing carelessness in handling materials in wire plant. Factors to be considered in filming industrial scenes. (Abstract.) Paper read before Worcester (Mass.) section of Am. Soc. Mech. Engrs.

MOTION STUDY

See POLISHING, Metal; TIME STUDY, Motion Study and.

MOTOR BUSES

Delaware, Maryland and D. C. The Bus in Northern Dixie. Elec. Ry. Jl. (Bus Transportation), vol. 59, no. 6, Feb. 11, 1922, pp. 93-102, 3 figs. Deals with conditions surrounding highway motor-bus operation and regulations prescribed in Delaware, Maryland and District of Columbia.

Eight-Wheel. Eight Wheels Improve Riding Qualities. Elec. Ry. Jl. (Bus Transportation), vol. 59, no. 6, Feb. 11, 1922, pp. 121 and 123, 4 figs. Describes new Californian bus. Has double-axle construction at both front and rear so that virtually it has two trucks. Front four wheels steer in unison; drive to four rear wheels is through two sets of worm and gear axles.

Local Railway Service. A Gasoline Motor Bus for Local Railway Needs (Automotrice à essence et à deux essieux pour chemins de fer d'intérêt local), G. Tartary. Génie Civil, vol. 80, no. 5, Feb. 4, 1922, p. 115, 1 fig. Describes new car seating 16 passengers, put in service by Deux-Sevres Tramway Co.

Snow Removal for. Fighting Snow on Suburban Routes. Elec. Ry. Jl. (Bus Transportation), vol. 59, no. 6, Feb. 11, 1922, pp. 103-104, 4 figs. Use of passenger buses with plows attached, for clearing snow.

Transportation. Putting the Motor Bus and Trolley Together to Build Service, H. W. Grant. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 1-4, 7 figs. Describes linking up of interurban by means of motor buses in Puget Sound district in Washington.

MOTOR SLEDS

Design. The Problem of Motor Sleds (Das Problem des Motorschlittens), H. Schiebler. Motorwagen, vol. 24, nos. 35 and 36, Dec. 20 and 31, 1921, pp. 767-775 and 787-795, 42 figs. Desiderata for structural requirements, technical evaluation of snow, that is, its resistivity and friction coefficients under varying conditions. Description of electric-motor-driven trial sled, and results of tests.

MOTOR TRUCKS

Double-Reduction Axles. New Double Reduction Truck Axle. Automotive Industries, vol. 46, no. 8, Feb. 23, 1922, pp. 458-459, 2 figs. Describes new double-reduction design by John Thomson Press & Mfg. Co.

Steam. 5-Ton Steam Wagon with Uniflow Engine. Engineering, vol. 113, no. 2928, Feb. 10, 1922, pp. 162-163, 23 figs. partly on supp. plate. Describes tipping model embodying the Atkinson uniflow engine and auxiliary tipping engine, which can lift body and bring it back into position in two minutes.

MOTORCYCLES

Olympia Exhibition. The Motor Cycle Show. Automobile Engr., vol. 12, no. 159, Jan. 1922, pp. 13-19, 24 figs. Discusses machines at exhibition held at Olympia, Nov. 28 to Dec. 3.

O

OFFICE MANAGEMENT

Cutting Clerical Cost. Cutting the Clerical Cost, Henry Anson Piper. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 119-124, 7 figs. Planning procedure for plant offices in large organizations.

Scientific. The Application of the Principles of Scientific Management to the Office, William Henry Leffingwell. Bul. of Taylor Soc., vol. 7, no. 1, Feb. 1922, pp. 2-24 and (discussion) 24-26, 13 figs. Discusses planning and control, standardization, investigation and research, inspection and maintenance of quality, scientific office arrangement, etc.

OIL ENGINES

Scott-Still. A New Development in Marine Propulsion. Engineering, vol. 113, no. 2928, Feb. 10, 1922, pp. 177-178. Includes report by H. Riall Sankey on series of trials on Scott-Still engines for a Holt vessel, and gives details of engines.

Still Engine Developments. Engineer, vol. 133, nos. 3451 and 3452, Feb. 17 and 24, 1922, pp. 180-182 and 204-207, 20 figs. Includes full test of report by H. Riall Sankey on tests carried out on Still engine; and review of paper read by Archibald Rennie before Instn. of Engrs. & Shipbuilders in Scotland, giving particulars of the Scott-Still experimental unit.

OIL FUEL

Competition with Coal. Why Fuel Oil Must Continue to Compete with Coal, E. J. Billings. Power, vol. 55, no. 11, Mar. 14, 1922, pp. 417-419. Points out that fair comparison of fuel oil with coal cannot be made on basis of B.t.u. alone. Allowance must be made for higher efficiency and reduced operating expenses.

Gasification System. A System for Complete Fuel Gasification. Automotive Industries, vol. 46, no. 9, Mar. 2, 1922, pp. 509-510, 2 figs. Involves use of device for mechanical agitation of mixture, retort for heating entire charge above vaporization temperature of least volatile elements, and means for admixture of small quantities of exhaust gas to prevent detonation.

Vaporization. A Discussion of Present Methods of Fuel Vaporization, N. Julien Thompson. Automotive Industries, vol. 46, no. 9, Mar. 2, 1922, pp. 515-517, 2 figs. Preparation of fuel-air mixtures for combustion prior to admission to cylinder.

OILS

Linseed, Vanadium Driers for. Vanadium Compounds as Driers for Linseed Oil, F. H. Rhodes and K. S. Chen. Jl. Indus. & Eng. Chem., vol. 14, no. 3, Mar. 1922, pp. 222-224, 2 figs. Describes vanadium driers possessing certain advantages not shown by lead, manganese, or cobalt driers in common use, which should prove very satisfactory in preparation of certain types of paint and varnish.

OPEN-HEARTH FURNACES

Design. Open-Hearth Furnace Design, A. D. Williams. Iron Age, vol. 109, no. 9, Mar. 2, 1922, pp. 577-579, 3 figs. Calculations for hearth area, depth of metal, incline of parts and velocity of gases.

OSCILLOSCOPE

Operation. The Oscilloscope. Motor Transport, vol. 34, no. 883, Jan. 30, 1922, pp. 123-124, 3 figs. Describes invention by means of which it is possible to examine any fast-running machinery either as if it were running at 1/100 of its actual speed, or, at will, as if it were stationary.

OXY-ACETYLENE CUTTING

Under Water. Submarine Cutting Torch Under Water, Robert G. Skerrett. Iron Age, vol. 109, no. 10, Mar. 9, 1922, pp. 637-639, 5 figs. Broken siphon pipe burned off by electric torch under 50 ft of water. Discusses American progress in submerged metal cutting.

OXY-ACETYLENE WELDING

Blowpipe Investigation. An Investigation of Oxy-acetylene Welding and Cutting Blowpipe, with Especial Reference to Their Design, Safety, and Economy in Operation, Robert S. Johnston. U. S. Bur. of Standards Technologic Papers, no. 200, Dec. 28, 1921, pp. 3-108, 71 figs. Apparatus from 14 of most prominent manufacturers were tested under standardized conditions. None of commercial cutting blowpipes procurable appear to be designed according to definite theory and none are efficient in cutting metal of all thicknesses, none were correctly designed, nor free from flash-back phenomena. With properly designed welding blowpipe, it is believed that satisfactory fusion welds may be made.

Explosions, Prevention of. Dangers from the Use of Acetylene Gas and in Oxy-Acetylene Welding. Eng. & Indus. Management, vol. 7, no. 7, Feb. 16, 1922, pp. 192-193. Precautionary methods are given which should be observed by all employed in welding work. Deals with explosions in generator houses; high-pressure systems, and care of cylinders. Based on official memorandum issued by Factory Department of British Home Office.

P

PAPER MANUFACTURE

Load Regulator for Pulp Grinders. Automatic Load Regulator for Motor-Driven Pulp Grinders, W. H. Artz. Chem. & Met. Eng., vol. 26, no. 8, Feb. 22, 1922, pp. 367-369, 4 figs. Describes apparatus, its operation, and advantages.

Process and Machinery. Paper Making and Paper Making Machinery, Ellsworth Sheldon. Am. Mach., vol. 56, no. 9, Mar. 2, 1922, pp. 317-319, 6 figs. Forest is principal source of raw material. Process is continuous from grinding wood to winding finished sheet of paper.

Southern Pine Refuse. The Manufacture of Paper and By-Products from Southern Pine Refuse, Joseph H. Wallace. Worcester Polytechnic Inst. Jl., vol. 25, no. 2, Jan. 1922, pp. 65-79, 3 figs. Discusses manufacture of chemical fiber suitable for Kraft wrapping or book paper and test board by-product manufacture of naval stores; destructive distillation of trash; improvement of lands.

PIPING

Air-Pressure Drop Through. Air Pressure Drop Due to Small Pipe, W. A. Shmidheiser. Power Plant Eng., vol. 26, no. 4, Feb. 15, 1922, pp. 234-235, 1 fig. Describes experiment made to determine air pressure drop through $1^1/_2$-in. pipe.

PISTON RINGS

Design and Uses. The Piston Ring—Lilliputian in Size, Giant Among Parts in Technical and Commercial Importance, Morris A. Hall. Raw Material, vol. 5, no. 1, Feb. 1922, pp. 13-18, 10 figs. Discusses design, forms, and uses.

Locomotive. The "Rowan" Type of Piston Rings For Locomotives. Ry. Gaz., vol. 36, no. 4, Jan. 27, 1922, p. 137, 1 fig. Describes rings patented by William Rowan, of Belfast.

PISTON RODS

Packing for High-Pressure. Packing a Rod For 500,000 Lbs. Pressure, P. W. Bridgman. Power House, vol. 15, no. 3, Feb. 5, 1922, pp. 25-27, 4 figs. Describes principle of packing and some details of its application. Results of high-pressure experiments.

PISTONS

Manufacturing Plant. A Piston Manufacturing Plant, G. M. Ellis. Western Machy. World, vol. 13, no. 2, Feb. 1922, pp. 53-55, 7 figs. Describes plant of W. H. Jahns at Los Angeles; methods and equipment used.

PLATES

Rectangular, Bending of. The Bending of a Rectangular Plate Supported on All Sides and Subjected to a Single Load (Ueber die Biegung der allseitig unterstützten rechteckigen Platte unter Wirkung einer Einzellast), S. Timoschenko. Bauingenieur, vol. 3, no. 2, Jan. 31, 1922, pp. 51-54, 3 figs. Explains how to solve problem of deflection of rectangular plate braced on two opposite sides and supported on the two other sides.

POLISHING

Metal, Motion Study in. Motion Study in Metal Polishing, E. Farmer and R. S. Brooke. Eng. & Indus. Management, vol. 6, no. 26, Dec. 29, 1921, pp. 738-742, 3 figs. Experiment with a wattmeter on process of roughing.

POWER PLANTS

Design. Developments in Power Station Design. Engineer, vol. 133, nos. 3450 and 3552, Feb. 10 and 24, 1922, pp. 148-150, 6 figs. and 201-204, 5 figs. Feb. 10: Describes Usco air heater of Underfeed Stoker Co., and the Howden air heaters for marine work. Feb. 24: Notes on high-pressure steam turbines.

European Practice. European Practices Tend Toward Greater Economy, A. Dyckerhoff. Elec. World, vol. 79, no. 9, Mar. 4, 1922, pp. 421-424, 6 figs. Standardization of equipment and grouping of related activities. Waste-heat boilers, gas turbines, large mercury rectifiers and novel frequency changer. Shunt motors for shears. Power-factor correction.

nstructing Operators. Instructing Power-Plant Operators, J. A. MacMurchy. Power, vol. 55, no. 7, Feb. 14, 1922, pp. 260-262. Problems of making

operator familiar with equipment for which he is responsible. Methods of providing proper instructions.

PRESSES

Notching. Notching Press for Armature Plates and Segments Engineer, vol. 133, no. 3451, Feb. 17, 1922, p. 188, 2 figs. Constructed with object of providing machine wherehy armature plates or segments thereof may be notched, internally or externally, in accurate and continuous manner.

Safety Devices. Safety Devices for Power Presses. Machy. (Lond.), vol. 19, nos. 474 and 487, Oct. 27, 1921 and Jan. 26, 1922, pp. 96–99 and 523–525, 16 figs. Oct. 27: Various types of gate guards. Jan. 26: Deals with gate, stationary and sliding guards, provided for power press equipment of Cleveland Metal Products Co.'s plant, Cleveland, Ohio.

PRODUCER GAS

Analysis. Graphical Treatment of Stack Gas Analysis and of Producer Gas Analysis—II, W. Trinks. Blast Furnace & Steel Plant, vol. 10, no. 2, Feb. 1922, pp. 131–135, 8 figs. Graphical representation of producer-gas analysis. Review of graphic charts as introduced by W. Ostwald.

PULVERIZED COAL

Combustion. Combustion of Pulverized Fuel, F. P. Coffin. Combustion, vol. 6, no. 3, Mar. 1922, pp. 129–132, 1 fig. Chemistry of combustion; ash; flames; velocities of fuels; preheating air for combustion; control of furnace temperature. (Excerpt.)

Evaporative Tests. Pulverized Coal (Le combustible pulvérisé), Charles Baron. Mémoires et Compte Rendue des Travaux de la Société des Ingénieurs Civils de France, vol. 74, no. 7–8 9, July-Sept. 1921, pp. 403–411, 1 fig. Details of evaporation tests carried out at various plants to show efficiency of powdered coal burning.

PUMPING ENGINES

Vertical Triple-Expansion. The Vertical Triple-Expansion Pumping Engine, L. A. Quayle and F. H. Brown. Mech. Eng., vol. 44, no. 3, Mar. 1922, pp. 155–161 and (discussion) pp. 161 and 176, 5 figs. Study of pumping-engine installations at Cleveland, Ohio, during past 65 years. New record performance at Division Ave. pumping station.

PUMPS, CENTRIFUGAL

Sugar Industry. Centrifugal Pumps in Sugar Processes, Irwin McNiece. Sugar, vol. 24, no. 2, Feb. 1922, pp. 92–93. Discusses some salient pumping problems, and what requirements of the units must be to obtain maximum service. From Sugar Central and Planters' News.

Water Leakage. On the Leakage of Water through the Clearance Rings in a Centrifugal Pump, Otogorô Miyagi. Technology Reports of Tôhoku Imperial University, vol. 2, no. 3, 1921, pp. 1–16, 3 figs. Notes on pressure difference at clearance rings; quantity of leakage; volumetric efficiency; loss of head due to leakage. Numerical example is given.

PYROMETERS

Maintenance. Some of the Difficulties Experienced in Maintaining a Pyrometer Installation in a Works, Robert S. Whipple. Ceramic Soc. Trans., vol. 21, Part 1, Session 1921–22, pp. 1–23, 7 figs. Chief difficulties experienced with pyrometers and methods by which they can be overcome or avoided. Same article in French, pp. 24–43.

R

RADIODYNAMICS

Control of Automotive Devices. Radio Control, H. H. Germond and W. P. Flynn. Wisconsin Engr., vol. 26, no. 5, Feb. 1922, p. 87, 1 fig. Discusses development of radiodynamics and describes a radio-controlled cart.

RAILLESS TRACTION

Rail vs. Trackless Transportation Versus Rail Transportation, Karl A. Simmon. Elec. Ry. Jl., vol. 59, no. 6, Feb. 11, 1922, pp. 233–236, 2 figs. Advantages and disadvantages of trolley, auto bus, and trackless trolley. Draws definite conclusions as to field for which each type of vehicle is most suitable.

RAILS

Corrugation. Formulas for Wave Lengths of Corrugations and Axis Diameters (Formeln fur Riffellängen und Achsendurchmesser), Emil Madsen. Verkehrstechnik, vol. 38, no. 35, Dec. 15, 1921, pp. 543–546, 2 figs. Results of investigation show that a proper axle diameter is of greatest importance in overcoming corrugation, causes for which are enumerated.

Failures. French Investigation of Rail Failures Charles Fremont. Iron Age, vol. 109, no. 8, Feb. 23, 1922, pp. 523–524, 8 figs. Causes of increasing number. Effect of exfoliation. Rapid corrosion of rails. Segregation and poor-quality metal. Translated from Génie Civil, Nov. 19, 1921.

Heads, Conditions Affecting. Conditions Which Affect the Head of the Rail, James E. Howard. New York R. R. Club Official Proc., vol. 32, no. 3, Jan. 20, 1922, pp. 6611–6619 and (discussion) 6619–6625. Discusses strains in rails due to cooling; formation of cracks; rail tests; rail failures; etc.

Internal Fracture. The Presence of Internal Fractures in Steel Rails and Their Relation to the Behavior of the Material under Service Stresses, Henry S. Rawdon. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 110–116, 7 figs. Discusses discontinuities or internal fractures in some types of steel rails and in other wrought-steel products, evidently serving as "nucleus" or starting point from which larger defects, termed transverse fissures, grow, under stress conditions to which rails are subjected in pratice.

Loads, Action of. Action of Rolling Loads on Rails (Étude de l'action des charges roulantes sur les rails), S. Timochenko. Le Génie Civil, vol. 79, no. 26, Dec. 24, 1921, pp. 555–556. Assumes the rail as a bar of infinite length on a continuous elastic base, and develops formulas.

RAILWAY CONSTRUCTION

Reinforced Concrete, Use of. On the Question of Reinforced Concrete (Holland), C. Leemans. Int. Ry. Assn. Bul., vol. 4, no. 2, Feb. 1922, pp. 347–358, 16 figs. Use of ordinary concrete and reinforced concrete on state railways of Java and Sumatra.

RAILWAY ELECTRIFICATION

Chile. Electrification of the Chilean State Railways. Ry. Rev., vol. 70, no. 6, Feb. 11, 1922, pp. 185–188, 5 figs. Application of hydroelectric power; details of electrification; direct current system considered best suited to conditions.

Direct Current. Railway Electrification with Direct Current (Jernbanernes elektrificering med likeströ m), C. Mohr. Elektroteknisk Tidsskrift, vol. 35, nos. 4, 5 and 6, Feb. 5, 15 and 25, 1922, pp. 23–26, 32–36 and 43–45, 9 figs. Notes on adoption of direct current for electrification of railway section between Kristiana and Trondhjems.

England. London, Brighton & South Coast Railway Electrification, Philip Dawson. Ry. Gaz., vol. 36, no. 6, Feb. 10, 1922, pp. 209–211, 1 fig. Report on proposed substitution of electric for steam operation of suburban, local and main-line passenger and freight services. (Abstract.)

France. The Foremost French Railway Electrification Project, G. de La Rochette. Ry. Rev., vol. 70, no. 5, Feb. 4, 1922, pp. 148–152, 6 figs. Midi Railway is developing water power for local industries and operation of 1850 miles of line. Will generate 396,000 hp. in six big hydroelectric centers.

Improvements Due to. Electrification and Its Relation to Steam Railroads, N. W. Storer. St. Louis Ry. Club Official Proc., vol. 26, no. 9, Jan. 13, 1922, pp. 188–197 and (discussion) 197–208. Discusses improvements due to electrification, and electric locomotives.

Switzerland. The Electrification of the Gotthard Line Between Lucerne and Chiasso (Die Elektrisierung der Gotthardstrecke Luzern-Chiasso der Schweizerischen Bundesbahnen), K. Sachs. Elektrotechnische Zeit., vol. 43, nos. 1, 2, 3, 4, 5 and 6, Jan. 5, 12, 19, 26, Feb. 2 and 9, 1922, pp. 1–7, 47–52, 78–85, 114–120, 143–148 and 180–186, 75 figs. Deals with power supply and distribution, power stations, feeder systems, overhead lines, and locomotives.

RAILWAY MAINTENANCE

Ditching Machines. Railway Ditching Machines and Performance Records. Eng. News-Rec., vol. 88, no. 10, Mar. 9, 1922, pp. 390–393, 5 figs. Wing-type ditchers clear track ditches and dress slopes rapidly and cheaply. Comparative costs of hand, team and machine work.

RAILWAY MANAGEMENT

Freight Loss and Damage. Prevention of Freight Loss and Damage, Joe Marshall. Can. Ry. Club Proc., vol. 21, no. 1, Jan. 1922, pp. 19–36 and (discussion) 36–40. Discusses claim prevention, the various kinds of damages for which claims are made, etc.

RAILWAY MOTOR CARS

Converted Auto Trucks. Making Motor Rail Cars from Auto Trucks, Donald A. Hampson. Ry. Rev., vol. 70, no. 6, Feb. 11, 1922, pp. 191–192, 2 figs. Describes a two-car Reo train, built by J. B. Worchester Co., Middletown, N. Y., for Alabama road, with seating capacity of 24 in each car, and operating crew of two.

Developments. Recent Development in the Railcar Field. Automotive Industries, vol. 46, no. 10, Mar. 9, 1922, pp. 556–557, 5 figs. Describes car of Indiana Truck Corp. and that of Service Motor Truck Co. Both fitted with regular and special reverse gear-sets which make possible high-speed operation in either direction, and both employ four-wheel leading trucks with live axles running in plain bearings.

Gasoline. Operating Results with Gasoline Motor Cars. Ry. Age, vol. 72, no. 9, Mar. 4, 1922, p. 516. Describes operation of Bowen motor cars by Pittsburgh and Shawmut Company to reduce cost of maintaining passenger service.

RAILWAY OPERATION

Automatic Train Control. Automatic Train Control on the Chesapeake & Ohio Ry. During the Big Snow Storm. Ry. Rev., vol. 70, no. 8, Feb. 25, 1922, pp. 257–258. Report from Calvin W. Hendrich, of Am. Train Control Co., Baltimore, of behavior of his system of automatic train control during recent heavy snow fall.

G. R. S. Company's Auto-Manual Train Control. Ry. Age, vol. 72, no. 9, Mar. 4, 1922, pp. 521–523, 6 figs. Improvements of automatic train-control system of Gen. Ry. Signal Co., Rochester, N. Y.

Train Control Test on Raritan River. Ry. Signal Engr., vol. 15, no. 2, Feb. 1922, pp. 58–60, 2 figs. Describes automatic train control of "M-V All Weather" Train Controller Co. of Newark, N. J., and tests carried out on Central of New Jersey.

Webb Automatic Train Control Tested on the Erie Ry. Signal Engr., vol. 15, no. 2, Feb. 1922, pp. 65–66, 2 figs. Describes nine tests made on Erie R. R., all of which were satisfactory.

Avoidable Waste. Avoidable Waste in Car and Locomotive Operation, William Elmer. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 93–97, 2 figs. Outlines procedure for determining whether engines are properly loaded and used. Includes several appendices, one of which gives method of working out most economical tonnage for loading freight engines of any division, based on actual practicable performance in everyday operation. Discusses avoidable waste in operation of cars under three heads: (1) Their utilization in hands of agents, shippers and consignees; (2) handling and dispatchment in yards and on road; and (3) repair and inspection.

RAILWAY SHOPS

Can. Pac., Montreal. A Railroad Shop Organized for Efficiency. Machy. (Lond.), vol. 19, nos. 487 and 488, Jan. 26 and Feb. 2, 1922, pp. 502–504 and 535–537, 8 figs. Describes Angus shops of Can. Pacific Ry. Co., Montreal, Canada. Jan. 26: General arrangement. Feb. 2: Designs of jigs and fixtures used; outlines some methods that have made it possible to reduce costs.

Machining Operations, Cost of. What is Wrong with the Railroad Shops? Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 557–560. Investigation into relative costs of performing machining operations in seven representative railroad shops.

RAILWAY SIGNALING

Automatic-Block. Automatic Block Signaling, J. E. Saunders. Armour Engr., vol. 13, no. 2, Jan. 1922, pp. 71–85, 8 figs. Economy of automatic signals; manual versus automatic block; train operation by signal indication; elements of automatic block signaling.

Color-Light. Color Light Signals. Ry. Engr., vol. 43, no. 505, Feb. 1922, pp. 65–66 and 74. Report of committee on Light Signals appointed by Minister of Transport. Advocates this type of signal, a color-light type with separate lenses for each color indication.

Federal Audible Signal. The Federal Signal Company's Audible Signal. Ry. Age, vol. 72, no. 9, Mar. 4, 1922, pp. 517–518, 4 figs. Describes experiments on Boston & Albany in Mass. and New York. An audible warning sounded in conjunction with visual indication given by three-position automatic semaphore.

Locking Arrangement. Locking Arrangement for Movable Point Crossing Frogs, F. Parsons. Ry. Signal Engr., vol. 15, no. 2, Feb. 1922, pp. 63–64, 4 figs. Describes system installed on Central of Argentine which insures safety with minimum apparatus. Read before Inst. Ry. Signal Engrs.

Phase Shifter for A. C. Circuits. A Phase Shifter for Adjusting A. C. Track Circuits, W. F. Price. Ry. Signal Engr., vol. 15, no. 2, Feb. 1922, pp. 61–62, 8 figs. Discusses lag of current in wet and dry weather and describes a phase shifter which works equally well on double element vane or galvanometer relays.

Three-Position, Belgium. Weissenbruch Thee-Position Signal System as Used in Belgium, T. S. Lascelles. Ry. Signal Engr., vol. 15, no. 2, Feb. 1922, pp. 55–58, 6 figs. Four indications given, clear, caution, attention or stop. Illustrations of the various positions.

RAILWAY STATIONS

Train Indicator Time-Tables. Train Indicator Time-Tables at Railway Stations. Ry. Gaz., vol. 36, no. 5, Feb. 3, 1922, pp. 177–179, 3 figs. Describes Benn & Cronin train indicator time-table.

RAILWAY TIES

Creosoting Timber Bridges and. Creosoting Timber on the Santa Fe Railway System, A. F. Robinson. West. Soc. Engrs. Jl., vol. 27, no. 3, Mar. 1922, pp. 84–90 and (discussion) pp. 90–96. Deals with creosoting timber bridges and track ties. See also Ry. Maintenance Engr., vol. 18, no. 2, Feb. 1922, pp. 44–46, 1 fig. (Abstract.)

RAILWAY TRACK

Ballast. Report of Committee 11—On Ballast. Am. Ry. Eng. Assn. Bul., vol. 23, no. 239, Sept. 1921, pp. 131–158, 6 figs. Application of ballast; ballast tools; specifications for ballast shovels.

Frogs, Reclaiming. Philadelphia & Reading Reclaims Frogs by Unique Methods. Ry. Mainetnance Engr., vol. 18, no. 1, Jan. 1922, pp. 13–14, 8 figs. Describes system which, it is claimed, is attended with very satisfactory results. Both plain and hard center equipment is repaired.

Maintenance. Track Maintenance by Contract on the Canadian Pacific Ry., H. G. Harton. Eng. News-Rec., vol. 88, no. 10, Mar. 9, 1922, pp. 399–401. Successful results of three years on 400 miles.

Plant Sidings. Trackage for Industrial Plants, Fred F. Hartford. Indus. Management, vol. 63, no. 3, Mar. 1922, pp. 151–154, 5 figs. Factors underlying their profitable installation.

Snow Fences. Snow Fence Design and Location. Elec. Traction, vol. 18, no. 2, Feb. 1922, pp. 144–146, 4 figs. Describes types successfully used by Chicago, North Shore and Milwaukee R. R., Rochester & Syracuse R. R., and Quebec Railway, Light, Heat & Power Co.

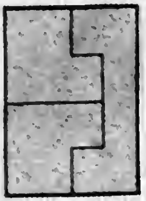
RAILWAYS

Cost of Transportation. On the Question of Net Cost; Rates (All Countries except America), Henry Gréard. Int. Ry. Assn. Bul., vol. 4, no. 2, Feb. 1922, pp. 331–345. Determination of net cost of carriage (passengers and goods), taking capital charges into consideration. Its relation to rates charged.

Reconstruction, France. Rebuilding Railway

Made in all sizes-1½" to 120" Diameter

(Larger if necessary)



The right-angled **INTERLOCK** is your safeguard

A Challenge to Your Vision

When new ideas are born, they face many tests and encounter a wall of indifference and opposition.

We are loath to abandon old ideas—right or wrong. If they are right they survive and replace worn out notions.

For nine years—

Zelnicker Ever-Tyte The Piston Ring for All Engines

has claimed attention from those who could see in today's achievements the dawn of a still greater tomorrow. EVER-TYTES' results have surpassed the expectations of critical users in all units. On their performance, they have stood unchallenged with maximum savings and greater capacity.

Now coated on the face with .003" Zinc, they seat and deliver full capacity in an incredibly short time.

Will You Investigate EVER-TYTES NOW?

Gillette Safety Razor Co.

The Ever Tight Piston Ring Co.,

St. Louis, Mo.

Gentlemen:

Replying to your letter of October 30th, we are using your Ever-Tyte Piston Rings on gas engines, and are receiving very good service.

Yours very truly,

GILLETTE SAFETY RAZOR COMPANY,

Material Division.

EVER-TYTE PISTON RING DIVISION
WALTER A. ZELNICKER SUPPLY CO.
1600 KINGSLAND AVE (WELLSTON) ST LOUIS

Structures in Northern France, M. Pellarin. Eng. News-Rec., vol. 88, no. 10, Mar. 9, 1922, pp. 397–398, 3 figs. Unique operations employed to save as much of damaged structures as possible. Work on Nord and Est railways cited. Translated from Revue Générale des Chemins de Fer.

Russia. The Railroad Transportation Situation in Soviet Russia, E. A. MacMillan. Ry. Rev., vol. 70, no. 7, Feb. 18, 1922, pp. 218–222, 1 fig. Describes deplorable condition of present rail equipment. (Abstract.) Read before Can. Ry. Club.

South America. South American Transportation Problems (Südamerikanische Verkehrsprobleme), Colin Ross. Verkehrstechnik, vol. 39, no. 4, Jan. 27, 1922, pp. 42–47, 2 figs. Review of development of South American railways; the Argentinian railways; transportation over the Andes; the railway systems of Chile and Brazil; the central trans-continental lines; the Pacific railways.

Tests Department, New Haven, R. R. The Department of Tests of the New Haven Railroad, H. P. Hass. New England R. R. Club, Jan. 10, 1922, pp. 235–248 and (discussion) 248–272. Discusses objects of the department, which are, principally, safety and economy of operation, methods used to obtain proper product being, through use of specifications and through use of tested product sheets. Details of the five divisions of department.

REFRACTORIES

American Practice. Notes on American Practice in Refractories, W. J. Rees. Ceramic Soc. Trans., vol. 21, Part 1, Session 1921–22, pp. 69–84 and (discussion) 84–88, 19 figs. Outstanding feature of American practice is well-developed organization of plant for maximum production with minimum costs.

New. The Development of a New Refractory, A. F. Greaves-Walker. Soc. of Chem. Industry Jl., vol. 41, no. 2, Jan. 31, 1922, pp. 13T–14T. Describes work undertaken by Am. Refractories Co. in conjunction with Mellon Inst. on the production of a new refractory, and laboratory tests made.

Resistance Tests. Resistance Tests on Refractory Products under Load at Different Temperatures, V. Bodin. Ceramic Soc. Trans., vol. 21, Part 1, Session 1921–22, pp. 56–65, 8 figs. Discusses investigations to find method of determining directly crushing strength at different temperatures, and their results. In French, pp. 44–55.

Thermal Conductivity. On the Determination of the Thermal Conductivity, Specific Heat, Density and Thermal Expansion of Different Rocks and Refractory Materials, Yoshiaki Tadokoro. Tohoku Imperial University Sci. Reports, vol. 10, no. 5, Dec. 1921, pp. 339–410, 42 figs. partly on supp. plates. Account of investigation begun four years ago in research laboratory of Imperial Steel Works, Yawata.

REFRIGERATING PLANTS

Condenser Cooling-Water Diagram. Cooling Water for Ammonia Condenser, Alex H. Luedicke. Power, vol. 55, no. 8, Feb. 21, 1922, p. 302, 1 fig. Explains easy way to find amount of water required.

Corrosion in Systems. Control of Corrosion in Refrigerating Systems, F. N. Speller. A.S.R.E. Jl., vol. 8, no. 3, Nov. 1921, pp. 216–221 and (discussion) 221–224. Reviews what has been done and discusses possible application of these principles. Methods of protection are divided into two classes, viz.: by rendering water slightly alkaline, usually done by use of lime; and by eliminating free oxygen from solution.

REFRIGERATION

Brine Freezing of Fish. Brine Freezing of Fish, Harden F. Taylor. Refrig. World, vol. 57, no. 1, Jan. 1922, pp. 21–24. Refrigeration promises only solution of problem of distributing fish from sea to distant consumers in first-class condition. Describes brine freezing process. Brine-frozen versus air-frozen fish.

RESEARCH

Mechanical Engineering Advisory Committee. Mechanical Engineering Advisory Committee for Division of Engineering, Alfred D. Flinn. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 115–116. Describes contemplated program of committee formed within organization of Am.Soc. of Mech.Engrs.

Problems. Research Problems Discussed. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 117–118. Discussion of papers by F. A. Wardenburg and A. D. Flinn. Report of A.S.M.E. work in lubrication, by Albert Kingsbury. Progress in steam-table research described.

ROLLING MILLS

Engines, Combination Gas and Steam. Development of Rolling Mill Engines, F. J. Denk. Blast Furnace & Steel Plant, vol. 10, no. 2, Feb. 1922, pp. 153–154. Advantages of combination of gas engine with steam engine.

Sheet Mills. Apollo Steel Company Enlarge Plant by the Addition of a New Sheet Mill Unit. Blast Furnace & Steel Plant, vol. 10, no. 2, Feb. 1922, pp. 126–130, 9 figs. Describes general layout, buildings, and equipment, including modern improvements in sheet-mill construction.

Extends Facilities for Sheetmaking. Iron Trade Rev., vol. 70, no. 8, Feb. 23, 1922, pp. 532–537, 10 figs. Otis Steel Co. completes eight-mill plant at its Riverside works, Cleveland. Substantial construction of buildings, liberal floor areas for all operations and flexible crane system are outstanding features.

Otis Steel Company Completes the Erection of a Modern Sheet Mill Department, Donald N. Watkins. Blast Furnace & Steel Plant, vol. 10, no. 2, Feb. 1922, pp. 118–122, 7 figs. Located at Riverside plant in Cleveland. Most important installations include extra heavy mills, electric drives, powdered coal fuel, continuous pair furnaces, electric furnace chargers, Baird water-cooled floors, etc.

Tables. Roller Bearings Mill Tables, J. M. Kelly. Blast Furnace & Steel Plant, vol. 10, no. 2, Feb. 1922, pp. 139–141, 2 figs. Describes new rolling mill tables in which were installed flexible roller bearings.

RUBBER

Thermal Insulation. Thermal Insulation of Rubber. Rubber Age, vol. 2, no. 12, Feb. 1922, p. 590. Discusses report by Food Investigation Board of experiments made with onazote.

Vulcanized. Determination of True Free Sulfur and True Coefficient of Vulcanization in Vulcanized Rubber, W. J. Kelly. Jl. Indus. & Eng. Chem., vol. 14, no. 3, Mar. 1922, pp. 196–197. Describes methods of analysis by means of which a more complete study of distribution of sulphur between the various ingredients of rubber compound can be made.

S

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SHAFTS

Torsional Vibrations. Torsional Vibrations of Shafts (Verdrehungsschwingungen von Wellen), O. Föppl. Schweizerische Bauzeitung, vol. 79, no. 5, Feb. 4, 1922, pp. 56–59, 11 figs. Demonstrates practical applicability of theoretical determination of coefficients of natural vibration of shafts with rotating masses.

SHEARS

Pressure Required for Shearing. Formulas for Pressure Required for Shearing Metal, D. C. Oviatt. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, p. 528, 1 fig. Presents formulas for shear calculation and explains application.

SHERARDIZING

Experiments. Experiments with Sherardizing, Leon McCulloch. Min. & Metallurgy, no. 182, Feb. 1922, p. 63. Study of effect of iron in zinc dust on sherardizing process and on resulting coatings, giving evidence that no part of a sherardized coating can contain less than 6 per cent iron. (Abstract.) See also Am. Inst. Min. & Met. Engrs. Trans., no. 1131–N, Feb. 1922, 4 pp. (complete paper).

SINE BARS

Uses. The Use of the Sine Bar. Machy. (Lond.), vol. 19, no. 488, Feb. 2, 1922, pp. 529–531, 6 figs. Gives some examples of wide range of angle work covered by it. Is more adaptable than the protractor.

SPRINGS

Handling and Heat-Treating. Methods of Handling and Heat-Treating Springs. Can. Machy., vol. 27, no. 8, Feb. 23, 1922, pp. 21–25, 23 figs. Principles governing uniform heating and cooling; type and arrangement of equipment; stationary and continuous furnaces; utilizing heat in waste gases.

Impact Absorption. Graphic Representation of Absorption of Impact by Springs, Leslie H. Mann. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 554–555, 2 figs. Determination of energy absorbed by spring under load based upon assumption that body producing deflection of spring is moving with its center of gravity in line with axis of spring, or in line with point that will cause spring to act most efficiently.

STANDARDIZATION

Advantages. Significance of Standardization to American Industry and the Federal Government, A. A. Stevenson. Mech. Eng., vol. 44, no. 3, Mar. 1922, pp. 185–186 and 203. Advantages of standardization to all, including Government as largest consumer. How Government should coöperate with industry. What is being done by Am. Eng. Standards Committee.

Waste Elimination through. Waste Elimination Through Standardization, H. Campbell and Alex Tauh. Am. Mach., vol. 56, no. 10, Mar. 9, 1922, pp. 363–364. Reducing manufacturing costs. How standardization benefits both manufacturer and consumer. Introduction of universal numbering system. Multiplying service by six.

STEAM

Ruths Storage System. The Ruths Steam Accumulators (L'accumulatore di vapore Ruths), E. C. Constam-Gull. Industria, vol. 35, no. 24, Dec. 31, 1921, pp. 521–527, 17 figs. Various examples of application of this system of equalizing pressure loads; savings effected in fuel.

The Ruths Steam Storage System (Der Ruthssche Dampfspeicher), G. Schulz. Stahl u. Eisen, vol. 42, no. 5, Feb. 2, 1922, pp. 165–171. Writer points out favorable influence on boiler fire effected by a constantly uniform steam consumption in boiler house, which has been verified by tests conducted by Prof. Jossé, Berlin. It is claimed that this uniform steam consumption can, in many cases, be obtained by use of a new steam accumulator which is described.

STEAM ENGINES

Steam Consumption of Reciprocating. The Coefficients of Steam Consumption of Reciprocating Steam Engines (Die Verbrauchzahlen der Kolbendampfmaschinen und ihre Beurteilung), R. Doerfel. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 4 and 6, Jan. 28 and Feb. 11, 1922, pp. 84–87 and 133–136, 10 figs. Revisal of rules for efficiency tests. Determination of tolerances. Results of tests on state of resistance. Thermal equivalent according to the law of 1899 and method subsequently in use of determining steam consumption reckoned from zero deg. cent. feedwater temperature or with arbitrary deductions. The Clausius-Rankine comparative method and difficulty of evaluation of waste heat in feedwater and water of condensation of cylinder walls, cover and receiver.

Torsiograph, Measurements with. The Torsiograph and Its Use in Steam-Engine Operation (Ueber den Torsiographen und seine Anwendung im Dampfmaschinenbetriebe), Jos. Geiger. Elektrotechnik u. Maschinenbau, vol. 40, no. 4, Jan. 22, 1922, pp. 40–42, 4 figs. Describes instrument for measurement of deviation of angle, coefficient of cyclic variation and the varying torsional stresses in transmission gears and crankshafts.

STEAM GENERATORS

Electrically Operated. Generation of Steam by Electricity, E. T. Kaelin. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 3, Mar. 1922, pp. 127–133, 7 figs. Field of use for electric-steam generator, its advantages to consumer from load-factor point of view and to electric supply company as outlet for surplus power. Discusses types of electric-steam generators with particular reference to water-resistance type.

STEAM PIPE

Diameter. The Most Economical Pipe Diameter for Steam-Power Piping (Der billigste Rohrdurchmesser für Kraftdampfleitungen), O. Denecke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 49, 50, 51 and 52, Dec. 9, 16, 23 and 30, 1922, pp. 394–396, 405–408, 418–421 and 427–431, 4 figs. Calculation of diameter taking only pipe friction into consideration, and taking separate resistances into consideration. Numerical examples of high-pressure saturated-steam turbines.

STEAM POWER PLANTS

Oil-Burning. Operation of Oil-Burning Steam Plants, C. H. Delany. Iron Age, vol. 109, no. 8, Feb. 23, 1922, pp. 525–527, 4 figs. Discussion of plant characteristic diagram, with particulars regarding its use in establishment of a standard of performance and in increasing plant efficiency. (Abstract.) Paper presented at joint meeting of Am.Soc.Mech.Engrs. and Am.Inst.Elec.Engrs.

STEAM TURBINES

Efficiency Tests of 60,000-Kw. Efficiency Tests of a 60,000-Kw. Turbine, Herbert B. Reynolds and Walter F. Hovey. Power, vol. 55, no. 11, Mar. 14, 1922, pp. 411–413, 4 figs. Results of tests on turbine installed in power station of Interborough Rapid Transit Co. (Abstract.) Paper to be read before Am.Soc.Mech.Engrs.

STEEL

Alloy. See ALLOY STEELS.

Basset Direct-Production Process. Direct Production of Steel (La production directe de l'acier), E.-H. Weiss. Nature, no. 2491, Dec. 31, 1921, pp. 423–427, 5 figs. Describes Basset process as applied at Dennemont works, of producing steel direct from ore.

Cracking. Intercrystalline Cracking of Mild Steel in Salt Solutions, J. A. Jones. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 102–109, 9 figs. Describes action of various solutions in producing cracking of steel in state of stress.

Failure on Hardening. The Mechanism of the Failure of Steel upon and after Hardening. G. W. Green. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 139–145, 7 figs. Outlines causes of stressing and subsequent failure.

Fatigue Tests. Endurance of Steel Under Repeated Stresses, D. J. McAdam, Jr. Chem. & Met. Eng., vol. 25, no. 24, Dec. 14, 1921, pp. 1081–1087, 22 figs. Fatigue tests on many commercial and alloy steels develop no evidence of "endurance limit;" ultimate tensile strength closely related to endurance stress at 1,000,000,000 cycles; special White-Souther machine and semi-logarithmic graphs used.

Identification and Storage. A New Idea in Steel Identification and Storage. Ry. & Locomotive Eng., vol. 35, no. 2, Feb. 1922, pp. 44–45, 2 figs. Describes method of marking steel bars for identification, and also designing and constructing suitable steel storage racks, employed by Gould & Eberhardt, Newark, N. J.

Literature, 1921. Review of Iron and Steel Literature for 1921, E. H. McClelland. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 4–8. Classified list of the more important books, serials and trade publications during year, with a few of earlier date, not previously announced. Also in Forging and Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 4–8.

Phosphorus, Influence of. Influence of Phosphorus upon the Microstructure and Hardness of Low-Carbon, Open-Hearth Steels, Edward C. Groesbeck. U. S. Bur. of Standards Technologic Papers, no. 203, Nov. 21, 1921, pp. 1–33, 15 figs. Two series of specimens, one of basic and the other of acid open-hearth steel, with phosphorus content in each series varied in four or five steps within limits 0.008 to 0.115 per cent, which mark the ordinary limits of phosphorus content in plain carbon steel, were employed in study of relationship between phosphorus content and microstructure and hardness resulting from series of different heat treatments tried.

Properties in Hardening Range. Properties of Some Steels in the Hardening Range, W. R. Chapin. Am. Soc. for Steel Treating Trans., vol. 2, no. 6, Mar. 1922, pp. 507–514 and (discussion by Zay Jeffries) pp. 514–515, 4 figs. Report applies only to steels which, when properly quenched, harden throughout mass, and are martensitic when so hardened.

ACORN
BRAND

A babbitt that will not break

Recent analyses of bearing failures by one of the principal railroads and by one of the leading manufacturers of automobiles showed that more than eighty per cent of these failures were due to breakage of the babbitt lining.

Cadman's ACORN Babbitt is the only metal which is guaranteed to eliminate this trouble. The photographs reproduced above illustrate its remarkable ductility. A load of 67400 pounds applied to a cylinder 1 inch in area and 1½ inches high, equivalent to a pressure of more than 33 tons per square inch, failed to fracture the sample. A cast rod bent double shows no sign of breakage.

This unique ductility is combined with superior bearing properties in every other respect.

A sample of ACORN Babbitt, proving our ability to guarantee that it will not fracture under any conditions, will gladly be mailed upon request.

(Clip the coupon or simply enclose your card in an envelope)

A·W·
Cadman
Manufacturing Co.
Pittsburgh
Pa.

Master Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletin M-1, samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:...**Position:**............................

Company Name:..

Address:...

Wire, Low-Carbon Steel. Ghost Lines and Grain Elongations in Hot Rolled and Cold Drawn Low Carbon Steel Wire, N. B. Hoffman. Am. Soc. for Steel Treating Trans., vol. 2, no. 6, Mar. 1922, pp. 516–523 and (discussion) pp. 523–525, 26 figs. Shows relation existing between ghost lines, bands, and elongated grain structures as found in low-carbon steel wire.

STEEL CASTINGS

Heat Treatment. The Heat Treatment of Steel Castings, Walter H. White. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 437–440. Suggestions for obtaining good results.

STEEL, HEAT TREATMENT OF

Alloy Carbonizing Boxes. Do Alloy Carbonizing Boxes Pay? C. M. Campbell. Am. Soc. for Steel Treating Trans., vol. 2, no. 6, Mar. 1922, pp. 495–499. Considers factors governing life and performance of carbonizing boxes, and reasons why they should not be placed on supply account instead of becoming part of equipment.

Brinell Hardness, Calculating. New Development on the Influence of Mass in Heat Treatment, E. J. Janitzky. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 377–383, 2 figs. Also Iron Age, vol. 109, no. 10, Mar. 9, 1922, pp. 658–659, 2 figs. Suggested formula for calculating Brinell hardness from given data. Applicable to alloy and carbon steels. Paper presented at N. Y. Section of Am. Soc. for Steel Treating.

Carbon Steel. Effect of Heat Treatment on the Mechanical Properties of 1 Per Cent Carbon Steel, H. J. French and W. George Johnson. U. S. Bur. of Standards Technologic Papers, no. 206, Dec. 27, 1921, pp. 93–121, 16 figs. Study of effects of varying time-temperature relations in heat treatment on tensile and impact properties, hardness, and structure of 1 per cent carbon steel, including (a) effect of temperature variations in hardening (b) time at hardening temperatures both above A_{cm} and between the Ac_1 and A_{cm} transformations, (c) effects of tempering steel hardened in different ways and effects of "soaking" just under lower critical range, (d) comparison of oil and water hardening for production of definite strengths.

Effect of Heat Treatment on the Mechanical Properties of One Per Cent Carbon Steel, H. J. French and W. George Johnson. Am. Soc. for Steel Treating Trans., vol. 2, no. 6, Mar. 1922, pp. 467–494, 16 figs. Results of tests show that most suitable oil or water quenching temperature for steel which is subsequently to be tempered at relatively high temperatures is slightly above end of Ac_1 transformation.

Cold-Headed Bolts. Cold-Headed Bolts—Their Metallography and Heat Treatment, W. E. Hillman. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 369–376, 20 figs.; also Iron Trade Rev., vol. 70, no. 8, Feb. 23, 1922, pp. 538–541, 18 figs. Various degrees of distortion may be found in same bolt; however, annealing at 1150 deg. Fahr. will remove weakening effect of cold work. Annealing above critical range is preferable.

Fixtures for. Special Fixtures for Heat Treating, E. H. Tingley. Forging & Heat Treating, vol. 8, no. 2, Feb. 1922, pp. 96–99, 7 figs. Describes a number of appliances for heating and quenching small parts as developed from suggestions made by workmen of Delco-Light Co. heat-treating department.

Structural Changes due to Heating Medium. Influence of the Heating Medium on the Structural Changes in Steel, A. E. Bellis. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 398–401 and (discussion) pp. 401–402. Analysis of structural changes as they are influenced by heating and cooling medium.

STEEL PLANTS

Pressed Steel. Description of a Pressed Steel Plant. Blast Furnace & Steel Plant, vol. 10, no. 2, Feb. 1922, pp. 144–147, 4 figs. Brief history of reorganization of Sharon Pressed Steel Co., Sharon, Pa., equipped to manufacture and assemble heavy pressed-steel products. Routing and handling.

STOKERS

Motion Pictures of Operation. Motion Pictures of a Stoker Furnace in Operation, R. Sanford Riley. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 103–104, 4 figs. Describes invention of F. H. Daniels and pictures taken at plant of Bird & Son, Inc., East Walpole, Mass., showing operation of a 9-retort extra long Riley underfeed stoker.

STREET RAILWAYS

Cars, One-Man. One-Man Car Operation with Double-Truck Cars, H. S. Sweet. Elec. Ry. Jl., vol. 59, no. 4, Jan. 28, 1922, pp. 156–158, 9 figs. Describes new one-man car in Utica equipped with turnstiles to admit passengers who pay as they leave. (Abstract.) Paper read before N. Y. Elec. Ry. Assn.

Two New Types of Safety Cars for Chicago, Charles Gordon. Elec. Ry. Jl., vol. 59, no. 2, Jan. 14, 1922, pp. 65–71, 14 figs. Describes single-truck and double-truck one-man safety cars, both arranged for double-end operation with separate entrance and exit passageways.

STRESSES

Flat Cylinder Heads. Stresses and Deformation in Flat Circular Cylinder Heads, Gilbert Dudley Fish. Mech. Eng., vol. 44, no. 3, Mar. 1922, pp. 165–169 and (discussion) p. 170, 12 figs. Analysis covering homogeneous elastic disks, where form and loading are symmetrical with respect to all diameters, where loading is combination of fluid pressures and of forces acting normally on concentric circles, where thickness is uniform, and where all strains are within limits of true elasticity. Formulas applicable to all cases considered are developed, and equations are given for constants of integration involved in mathematical analysis.

Thermal. The Thermal Stresses in Spherical Shells Concentrically Heated, Charles H. Lees. Roy. Soc. Proc., vol. 100, no. A 705, Jan. 2, 1922, pp. 379–394, 7 figs. Discusses stresses set up in materials by difference in temperature and its application to blast furnaces and others.

STRUCTURAL STEEL

Tensile Properties. Tensile Properties of Some Structural Alloy Steels at High Temperatures, H. J. French. Am. Soc. for Steel Treating Trans., vol. 2, no. 5, Feb. 1922, pp. 409–422, 8 figs. Account of tests conducted by Bur. of Standards to determine tensile properties of a number of structural alloy steels throughout temperature range of 20 to 550 deg. cent.

SWAGING

Hot. Hot Swaging, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 7, Mar. 1922, pp. 521–526, 10 figs. Describes swaging operations, based on practice and recommendations of the Langelier Mfg. Co., Providence, R. I.

T

TEMPERATURE CONTROL

Automatic Valve. Temperature Regulation by Automatic Valve, G. A. Wegner. A.S.R.E. Jl., vol. 8, no. 3, Nov. 1921, pp. 203–210, 6 figs. Discusses control of a valve through which vapor pressure is made controlling factor, the object being to assist man in charge in his task and to make desired results more certain.

TERMINALS, LOCOMOTIVES

Georgia. An Engine Terminal for Economical Operation, G. W. Tutan. Ry. Age, vol. 72, no. 8, Feb. 25, 1922, pp. 463–467, 7 figs. Describes combined roundhouse and shops of Central of Georgia railroad, including design of enginehouse structure and shop equipment.

TERMINALS, RAILWAY

Freight. Katy Builds Freighthouse of Fireproof Construction. Ry. Age, vol. 72, no. 10, Mar. 11, 1922, pp. 559–561, 7 figs. Describes new inbound terminal of Missouri, Kansas & Texas, at Dallas, Texas.

TEXTILE INDUSTRY

Science in. Science in the Textile Industry. Mech. Eng., vol. 44, no. 3, Mar. 1922, pp. 181–184, 1 fig. Two papers presented before Textile Division of A.S.M.E.: Hidden Wastes in Textile Plants, Thayer P. Gates; and Economy in Textile Drying, B. R. Andrews. Discussion.

TIDAL POWER

Utilization. Using Sea Power (Utilisons la "Houille Bleue"), H. Lémonon. La Nature, nos. 2482 and 2484, Oct. 29 and Nov. 12, 1921, pp. 278–283 and 310–316, 19 figs. Oct. 29: Describes systems of tidal power production by Reynolds, Tommasi, Legrand, Praceiq, etc. Nov. 12: Describes systems depending on use of turbines and hydraulic accumulators.

TIME STUDY

Bedaux Human Power Measurement. The Bedaux Principle of Human Power Measurement, L. C. Morrow. Am. Mach., vol. 56, no. 7, Feb. 16, 1922, pp. 241–245, 2 figs. Describes system practiced by Chas. E. Bedaux Co., Cleveland, Ohio. Application to compensation of labor. Isolation from methods, equipment and piece rates. Simplicity of records.

Motion Study and. Time and Motion Study, Eric Farmer. Eng. & Indus. Management, vol. 7, nos. 3, 4, 5, 8, Jan. 19, 26, Feb. 2, 23, 1922, pp. 70–75, 95–98, 136–139, 221–223. Jan. 19: Review of past works by Taylor and Gilbreth. Jan. 26: New point of view in undertaking time and motion study; reducing unproductive labor. Feb. 2: Correct definition of motion study. Feb. 23: Time study.

TRACTORS

Caterpillar. A New Caterpillar Development, F. Rowlinson. Sci. Am., vol. 126, no. 3, Mar. 1922, pp. 194–195, 8 figs. British efforts to save power and increase speed by means of a track that will yield to local obstacles. Describes new type of caterpillar suspension and its application.

Four-Wheel Drive. A Four-Wheel Drive Tractor from the Pacific Coast. Automotive Industries, vol. 46, no. 10, Mar. 9, 1922, pp. 554–555, 4 figs. Describes the Wizard 4-Pull tractor which transmits power to all four wheels by roller chains and steers by disconnecting power from wheels on one side.

Road-Rail Trucks and. The Stronach Dutton System of Road Rail Traction. Roy. Engrs. Jl., vol. 35, no. 2, Feb. 1922, pp. 93–96, 2 figs. on supp. plates. Principle adopted is to support front axle of a short-wheel base tractor by a four-wheeled bogie running on a Decauville line A drawbar is carried from bogie pivot to back of tractor for attachment of such trucks as can be hauled. Most recent pattern of tractor hauling train and converting from road to rail or rail to road traction.

Samson. Cooling Capacity Increased in Samson Tractor, P. M. Heldt. Automotive Industries, vol. 46, no. 9, Mar. 2, 1922, pp. 502–505, 4 figs. Technical description. Improvements in lubricating and cooling systems; enlarging of radiator and fan; etc.

Types. Tractor Show Marked by New Designs, P. M. Heldt. Automotive Industries, vol. 46, no. 8, Feb. 23, 1922, pp. 451–457, 8 figs. Creeper tractor construction; road building and maintenance tractors; corn-belt and grain-belt tractor requirements contrasted; new machines and parts described.

TRANSPORTATION

Highway. Highway Transportation. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 2, Feb. 1922, pp. 318–358. Symposium containing following papers: Highway Transportation, Thomas H. MacDonald. Inspection of Highway Construction, William G. B. Thompson. Financing and Bonding Highways, John N. Cole. Highway Bonding from the Viewpoint of the Surety Company, E. A. St. John. Financing and Bonding Highway Work, Edward C. Lunt. The Motor Vehicle in Highway Financing, Harry Meixell. The Motor Truck as an Asset to Railroad Operation, R. S. Parsons. Motor Vehicle Control, G. Wythe Munford. Discussion, W. K. Hatt.

Railway. Railroad Transportation. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 2, Feb. 1922, pp. 288–316 Symposium containing following papers: Railroad Transportation, Howard Elliott. Railroads and Their Employees, W. N. Doak. Railroad Transportation and Owners of Railroad Securities, F. A. Molitor. Discussion, George W. Simmons.

Water. Water Transportation. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 2, Feb. 1922, pp. 266–286. Symposium containing following papers: Water Transportation, R. H. M. Robinson. The American Merchant Marine, Winthrop L. Marvin. The Merchant Marine Problem, Emory R. Johnson. Water Transportation in Its Relation to the Railways, Samuel O. Dunn.

U

UNEMPLOYMENT

Improving Statistics. Suggestions for Improving Employment and Unemployment Statistics, Thomas Warner Mitchell. Management Eng., vol. 2, no. 3 Mar. 1922, pp. 161–166. Present data are shown to be incomplete. Presents unemployment score data sheet devised by author on which to account for potential working time of a given working force for any period of time.

V

VALVES

Gate, Electrically Operated. Tests on Motor-Operated Gate Valves for High-Pressure Steam, T. W. Stinson. Power, vol. 55, no. 7, Feb. 14, 1922, pp. 263–265, 5 figs. Emergency-closing tests made on five motor-operated 6-in. to 10-in. gate valves, against steam at 225 lb. pressure and 150 deg. Fahr. superheat blowing to atmosphere.

VENTILATION

Effect of CO in Air. The Physiological Principles Governing Ventilation When the Air is Contaminated with Carbon Monoxide, Yandell Henderson and Howard W. Haggard. Jl. Indus. & Eng. Chem., vol. 14, no. 3, Mar. 1922, pp. 229–236, 5 figs. (Abstract.) Report to Chief Engineer of New York & New Jersey Tunnel Commissions.

VENTURI METERS

Air and Gas Measurement. The Metering of Large Volumes of Air and Gas By Means of the Venturi Tube, John L. Hodgson. Instn. Min. Engrs. Trans., vol. 62, Part 3, Jan. 1922, pp. 208–218 and (discussion) 218–220, 9 figs. Account of application of Venturi meter.

VIBRATION

Fixed Members. The Natural Vibrations of Fixed Members of Variable Cross-Section (Die Eigenschwingungen eingespannter Stäbe von veränderlichem Querschnitt), N. Mononobe. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 444–451, 3 figs. Describes method for calculating transverse oscillations of elastic members with variable cross-section. Formula is derived which permits calculation of oscillating frequencies of members of relatively complicated form by making use of the oscillating frequency of similar truncated cones. Useful in calculating effect of vibrations in slender structures, such as chimneys, towers, etc., caused by earthquakes.

VISCOSIMETERS

Conversion Chart. Viscosimeter Conversion Chart. Power, vol. 55, no. 10, Mar. 7, 1922, p. 377, 1 fig. Presents chart for finding viscosity reading of a particular oil on any of standard viscosimeters when its reading on one of viscosimeters has been determined by experiment at same temperature.

VOCATIONAL TRAINING

Seasonal Industries. A Management Problem in Seasonal Industries, D. W. Ruckey. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 77–79, 1 fig. Problem of seasonal industries is to efficiently teach large increases of working forces in minimum of time. Solution of problem is training of largest possible corps of instructors, both as to instructional methods and as to operating procedure and organization.

W

WASTE

Causes and Reduction. A Campaign Which Cut Wastes in Half, Peter F. O'Shea. Factory, vol. 28, no. 3, Mar. 1922, p. 281. Tells how nearly 50 per cent of entire yearly waste bill was reduced by Dennison Mfg. Co. by a systematic following up of twelve causes of waste.

MECHANICAL ENGINEERING

Volume 44 June, 1922 Number 6

The Muscle Shoals Plant and the Nitrogen Supply[1]

A Résumé of the Development of the Nitrate Industry in the United States and a Discussion of Its Present Requirements

By J. K. CLEMENT,[2] WASHINGTON, D. C.

This paper opens with an outline of the essential uses of nitrogen in this country and goes on to cover briefly the four forms in which nitrogen was obtainable before the processes for taking it from the atmosphere were developed.

The fixation of atmosphere nitrogen is taken up, the chief features of the three best-known methods being touched on.

Development of the industry in the United States leads to a discussion of the Government Nitrate Plant No. 2 usually spoken of as Muscle Shoals. The general conditions of this plant are outlined, including its power and raw-material requirements and the convenience with which these requirements can be supplied.

The various chemical processes are explained in some detail and finally some charts and a table give interesting side lights on the nitrogen situation in this country and abroad.

THE enormous consumption of nitrogen in the production of ammunition during the war emphasized its importance in the manufacture of military explosives. Nitrogen is an essential constituent of practically all explosives, both military and those used in blasting, mining and other industrial purposes.

Quite recently the publicity concerning the Government's projects at Muscle Shoals has recalled attention to the importance of nitrogen in agriculture and industry.

Nitrogen is essential to all vegetable and animal life and is required in a number of important industries; for example, the dye and drug industry, the refrigeration industry, the manufacture of artificial leather, photographic films, acids and chemicals. Of the three important elements of commercial fertilizers, nitrogen, potash and phosphorus, nitrogen is probably the most important.

SOURCES OF NITROGEN

Nitrogen is usually obtained in one of the following forms: proteins, ammonia, nitrates and cyanides.

The nitrogen contained in plants and animals is usually in the form of proteins and is known as organic nitrogen. A very considerable part of the nitrogen used in agriculture is organic nitrogen and is obtained from manure, cottonseed meal, dried blood, and tankage and fish scrap. Ammonia, nitrate and cyanide nitrogen are referred to as inorganic nitrogen. Until a few years ago the inorganic nitrogen supply of the world was obtained from the beds of sodium nitrate of Chile and from coal. With the exception of a small quantity of potassium nitrate produced in India, all of the "nitrate" nitrogen of the world came from Chile and the world was dependent on this source for its nitrogen for the production of explosives, nitric acid, and for use in certain important industries.

Ammonia and cyanides are obtained as by-products in the destructive distillation of coal in gas works and by-product coke ovens and in the distillation of shales.

FIXATION OF ATMOSPHERIC NITROGEN

Four-fifths of the air is nitrogen. The nitrogen of the air is, however, extremely inert, and this tremendous source of supply was therefore until within the past twenty years not available for use by man.

There are now three processes for the fixation of atmospheric nitrogen that are commercially successful:

a Arc process,
b Cyanamide process,
c Synthetic or Haber process.

Arc Process. The arc process was the first process successfully developed on a commercial scale. At the high temperature of the electric arc the oxygen and the nitrogen of the air combine to form nitric oxide. On cooling, the nitric oxide is further oxidized to nitrogen dioxide and absorbed in water to form nitric acid or acted upon by lime to form calcium nitrate. The arc process is the only fixation process that produces nitric acid directly. Its heavy power requirements, 8.41 kw-years per metric ton of nitrogen fixed, limit its use to localities where power is abundant and cheap. It has been developed chiefly in Norway.

Cyanamide Process. The cyanamide process is based on the fact that calcium carbide heated to about 1000 deg. cent. combines with nitrogen gas to form calcium cyanamide. Commercial cyanamide or lime nitrogen contains about 20 per cent nitrogen. It may be used directly as a fertilizer or treated with steam under pressure to form ammonia. The cyanamide process requires a large amount of power, 1.97 to 2.30 kw-years per metric ton of nitrogen. It was established in Italy in 1906 and later in Germany, Norway, Sweden, Canada, Austria-Hungary, France, Japan and Switzerland.

Haber Process. The Haber process for the synthesis of ammonia was established in Germany in 1913. Prior to the end of the world war it had not been successfully operated in any other country. A mixture of nitrogen and hydrogen gas, under a pressure of from 100 to 200 atmospheres, is passed over a suitable catalyzer heated to 550 deg. cent. A small percentage of the gases is converted into ammonia which is removed from the system, the remaining nitrogen and hydrogen being returned to the catalyzer. The power requirements are small, 0.42 kw-year per metric ton of nitrogen fixed.

NITROGEN-FIXATION PLANTS IN THE UNITED STATES

The desirability of the United States becoming self-sustaining as regards fixed nitrogen was recognized prior to our entry into the war, Congress having appropriated $20,000,000 for the investigation of nitrogen fixation and for the construction of nitrate plants in 1916. Shortly after the declaration of war the decision was made to erect a plant of small capacity, 10,000 tons of ammonia per year, using a modified form of the Haber process. Construction of this plant, United States Nitrate Plant No. 1, began in October, 1917.

The heavy losses to shipping caused by the German submarines in 1917 and 1918 threatened to reduce the tonnage available for the transportation of nitrate from Chile, and made it unsafe for the United States to depend on imported nitrates. To meet this condition a contract for the erection of United States Nitrate Plant No. 2 was made in November, 1917. This plant was to have a capacity of 110,000 tons of ammonium nitrate per year, and was to use the cyanamide process. The important consideration in the selection of the cyanamide process was its dependability. A plant using this process had been in operation for

---

[1] Published by permission of the Chief of Ordnance, U. S. Army.

[2] Major, Ordnance Department, U. S. A.

Paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly abridged. All papers are subject to revision.

several years at Niagara Falls, Canada, and the services of the members of its operating organization were available for the design and operation of the Muscle Shoals plant. Later the program was increased to include United States Nitrate Plants Nos. 3 and 4 at Toledo and Cincinnati, Ohio, these plants to have a capacity of 55,000 tons of ammonium nitrate each.

The last two plants were not completed. Plant No. 1 was operated experimentally for several months, but not successfully. Plant No. 2 began operations about two weeks before the armistice was signed and was continued in operation long enough to demonstrate its ability to operate satisfactorily.

United States Nitrate Plant No. 2

United States Nitrate Plant No. 2 is located in northwestern Alabama, on the south side of the Tennessee River, about one mile below the Muscle Shoals. It is the largest cyanamide plant in the world, having a capacity of 220,000 tons of cyanamide or 110,000 tons of ammonium nitrate per year.

Construction of the plant began in January, 1918, and operation in October, 1918. The total cost including the 60,000-kw. steam power plant at Muscle Shoals, but not including the 30,000-kw. steam power plant on the Warrior River, the Warrior-Muscle Shoals transmission line and the Waco limestone quarry, was approximately $70,000,000.

The principal raw materials required, other than the nitrogen of the air, are limestone and coke. The daily consumption of these materials when operating at full capacity is 1200 tons of limestone and 300 tons of coke. An ample supply of limestone of pure quality is located about 30 miles south of Muscle Shoals. Coke can be procured at Birmingham.

Fig. 1 General View of Carbide Furnaces Charging Floor

When operating at full capacity the plant requires approximately 85,000 kw. This power will eventually be available at Wilson Dam which is located within a mile of the nitrate plant. To furnish the power during the war and prior to the completion of the hydroelectric development on the Tennessee River, two steam power plants were erected: one at Muscle Shoals, and one at Gorgas on the Warrior River. The plant at Gorgas, known as the Warrior extension power plant, was built as an extension to the existing plant of the Alabama Power Company. The generating unit is a 30,000-kw. General Electric turbo-generator. The Muscle Shoals plant contains a 60,000-kw. Westinghouse turbo-generator consisting of one high-pressure and two low-pressure turbines each connected to a 20,000-kw. generator.

The limestone is burned in seven rotary kilns—one of which is a spare unit—each having a capacity of 200 tons of stone a day. The coke is crushed and dried and the lime and coke are mixed in suitable proportions for charging into the carbide furnaces.

The carbide furnaces are twelve in number—ten being required for full-capacity operation. Each furnace has a rated capacity of 50 tons of 80 per cent calcium carbide per day. The power consumption of one furnace is 6000 kw. The current is 3-phase, 60 cycles, and enters the furnace from the top, through carbon electrodes.

At the temperature of the electric arc, the lime and coke react to form carbide in accordance with the equation:

$$3C + CaO = CaC_2 + CO$$

The process is continuous, the molten carbide being tapped from the surface at intervals of about forty minutes. The carbon monoxide gas burns on contact with the air to carbon dioxide which escapes into the atmosphere. Fig. 1 gives a view of the furnaces.

The carbide is allowed to cool and is then ground to a fine powder. From the mill it is conveyed to the lime-nitrogen or cyanamide building where the fixation of nitrogen takes place. At a temperature of about 1000 deg. cent. calcium carbide and nitrogen react in accordance with the equation:

$$CaC_2 + N_2 = CaCN_2 + C$$

For this reaction a pure quality of nitrogen is desired. The nitrogen is separated from the oxygen of the air by the Claude process. The nitrogen or liquid-air building contains 30 Claude columns, each having a capacity of 500 cu. m. of nitrogen an hour.

The electric ovens in which the fixation of nitrogen takes place consist of vertical cylinders about 30 in. inside diameter and 5 ft. high. The heating unit is a carbon pencil located in the center of the oven. There are 1536 of these ovens. The weight of a charge of carbide is about 1600 lb. Nitrogen gas enters at the bottom of the oven. After about four hours the electric current is turned off and the reaction, being exothermic, proceeds without further external heating. The process requires about forty hours for completion. The product is removed from the furnace in the form of a cylindrical pig of cyanamide or lime nitrogen. After cooling, the pigs are crushed and ground to a fine powder. In this condition the lime nitrogen contains about one per cent of calcium carbide which is removed by spraying with water, the water reacting with the carbide to form acetylene gas which escapes. Fig. 2 illustrates these ovens.

Fig. 2 Lime-Nitrogen Ovens

Calcium cyanamide reacts with steam under high pressure to form ammonia. The reaction is as follows:

$$CaCN_2 + 3H_2O = 2NH_3 + CaCO_3$$

This reaction takes place in large heavily walled steel autoclaves. The process is intermittent and requires from six to eight hours. The ammonia gas passes out at the top of the autoclave and carries with it a large amount of steam. Most of the steam is removed from the gas by condensation. The calcium carbonate is discharged in the form of a sludge and is a waste product. The plant has a capacity of 150 tons of ammonia per day.

The production of nitric acid from ammonia had never been carried out on a commercial scale prior to the world war, although the Ostwald process for the oxidation of ammonia to nitric oxide had been tried out on a small scale. If a mixture of ammonia and air is heated to a temperature of, say, 1000 deg. cent. under ordinary conditions, the reaction products obtained are nitrogen and water vapor. Ostwald found that by passing the gas over a suitable catalyzer, such as a fine platinum gauze, heated to a bright red heat, most of the nitrogen in the ammonia may be oxidized to nitric oxide:

$$2NH_3 + 2^1/_2O_2 = 2NO + 3H_2O$$

On cooling, the nitric oxide combines with more oxygen to form

nitrogen dioxide, which is then absorbed in water to form nitric acid.

In the Muscle Shoals plant the oxidation takes place in aluminum boxes or converters in the bottom of which the electrically heated platinum gauze is held in a horizontal position (See Fig. 3). The mixture of ammonia and air is passed downward over the gauze and the products of the reaction are carried to coolers and then to the nitric acid absorption towers. The capacity of the plant is about 450 tons of 50 per cent acid per day.

Ammonia and nitric acid react readily to form ammonium nitrate in accordance with the equation:

$$NH_3 + HNO_3 = NH_4NO_3$$

This reaction takes place in tanks lined with acid-proof brick, the ammonia gas being piped into the tanks from above. The product is a liquor containing about 45 per cent ammonium nitrate. This liquor after being freed from sediment is piped to the nitrate houses where the water is evaporated and the ammonium nitrate is finally obtained in granular form. It is then ready to be loaded in cars and shipped to powder plants.

During the time the plant was in operation about 1700 tons of high-grade ammonium nitrate were produced.

The Products and Their Utilization

During the war ammonium nitrate was used chiefly in the manufacture of amatol, a mixture of ammonium nitrate and trinitrotoluene in the proportion of 80 parts ammonium nitrate to 20 parts TNT.

Of the several products which the plant is capable of producing without any additional facilities, two are available for use as fertilizer material: cyanamide and ammonium nitrate. Although certain of its chemical properties have limited the amount that may be safely used in a ton of mixed fertilizer, large quantities of cyanamide have been used in fertilizer material. It can be produced at a lower cost than any other form of fixed nitrogen. Ammonium nitrate has not been used heretofore in commercial fertilizers to any appreciable extent. While it is entirely suitable as a plant food, its marked hygroscopic property is an obstacle to its use in fertilizers. If a way is found to overcome this property it will undoubtedly be in demand as a fertilizer material. The one product for which a market is at hand and which could be produced at Nitrate Plant No. 2 is ammonium sulphate. To manufacture this material it would be necessary to provide additional facilities at a cost of perhaps two million dollars. In case the plant is operated for the production of fertilizer material, ammonium sulphate will probably be the principal product until such time as a market is developed for other products.

The future of nitrogen fixation in the United States will depend in large measure on the relation between the demand and supply of inorganic nitrogen.

The world's production of inorganic nitrogen in 1910 was 654,000 tons. By 1913 it had increased to 823,000 tons and in 1918 it amounted to 1,300,000 tons. The increase in production was most rapid in the case of fixed atmospheric nitrogen and least rapid in the case of Chilean nitrate The war demand increased the Chilean production only ten per cent—from 450,000 to 500,000 tons. The production of by-product ammonia increased from 220,000 tons of nitrogen in 1910 to 390,000 tons in 1920. During the same period the production of fixed atmospheric nitrogen increased from 10,000 tons to 467,000 tons.

Table 1 shows the national production capacities for inorganic nitrogen other than Chilean nitrate in 1921. It will be noted that Germany leads with more than half of the world's total capacity. The United States, Great Britain, and France follow in the order named.

Approximately one-half of the inorganic nitrogen consumed in the United States at the present time is used in the production of fertilizers. The balance is about equally divided between explosives and the chemical and other industries. The consumption in fertilizers is increasing more rapidly than the consumption for other purposes.

The enormous increase in the use of inorganic nitrogen for fertilizers is due principally to the increased use of commercial fertilizers. To some extent, however, it is due to the replacement of organic nitrogen by inorganic nitrogen. Animal tankage, dried blood, and cottonseed meal, which in the past have furnished a considerable part of the nitrogen contained in commercial fertilizers, are being used more and more for cattle feed.

The total nitrogen returned to the soil each year by fertilizers is a fraction only of that annually lost from land under cultivation. As the natural fertility of the soil decreases and the value of farm lands and farm products increases, there should be a corresponding increase in the demand for fertilizers. It is not unreasonable to expect that the use of fertilizer will grow more rapidly in the future than it has in the past, providing only that it is available in sufficient quantities and at a reasonable price.

Assuming an increase of 10 per cent per year, it has been estimated[2] that the total consumption of inorganic nitrogen in the United States will be 291,500 tons in 1924 and 438,000 tons in 1930. The estimated domestic supply of by-product nitrogen from coal for the same years is 122,500 and 159,500 tons, respectively. The difference will have to be supplied by nitrogen-fixation plants and by imports. A considerable part of the deficiency—45,000 tons—could be obtained by the operation of United States Nitrate Plant No. 2.

Fig. 3 Catalyzers for Oxidation of Ammonia to Nitric Oxide

In the event of a future war, the requirements would be much greater. National preparedness, moreover, requires that the fixation of nitrogen be well established in the United States, so that in the event of a serious national emergency the country will be self-sustaining as regards the supply of nitratesa nd explosives.

The operation of the Muscle Shoals plant should contribute materially toward the building up of the nitrogen-fixation industry in this country.

---

[2] Consumption & Supply of Inorganic Nitrogen in the United States, by Major D. P. Gaillard, *Chem. & Met. Eng.*, vol. 22, nos. 17 and 18, 1920.

TABLE 1 NATIONAL SOURCES OF INORGANIC FIXED NITROGEN (MAXIMUM) IN 1921[1]

(Net tons of Nitrogen)

Countries	By-Product from Coal	Atmospheric Nitrogen			Total
		Arc	Cyanamid	Haber	
Germany	165,000	.....	132,000	330,000	627,000
United States	127,000	300	44,000	12,800	181,100
Great Britain	110,000	.....	.....	......	110,000
France	16,000	1,400	64,000	......	81,400
Norway and Sweden	......	33,000	31,000	......	64,000
Austria	11,000	.....	24,000	......	35,000
Italy	3,000	1,300	20,000	......	24,300
Canada	3,000	900	13,000	......	16,900
Switzerland	......	....	8,000	......	8,000
Other countries	30,000	2,800	22,000	......	51,800
	465,000	39,700	358,000	342,800	1,205,500

[1] Calculated from data compiled in the office of the Nitrate Division, Ordnance Department, U. S. A.

Some Principles of the Construction of Unfired Pressure Vessels

By S. W. Miller,[1] Rochester, N. Y.

This paper discusses in general terms forge and fusion welding and riveting, and comments on the factors affecting welding efficiency. The composition of the best base weld metal and welding wire is touched upon and proper welding conditions mentioned. The weakness of the single "V" weld is pointed out and the use of lower-tensile-strength material advocated. The question of relieving welding strains by annealing is also treated and these and the foregoing observations are all based upon the practical experience of the writer. In considering the relative merits of welded and riveted tanks a specific instance is cited to show the superiority of the former. The results of testing welds in a Strohmenger alternating bending impact machine are also given.

There are two appendices to this paper. In Appendix No. 1 the details of the testing of ten specimens of welded plates and the results are presented along with the author's comments and conclusions. Appendix No. 2 deals with the testing of four half-inch plate-steel and two Armco iron welded tanks. The details and many photographs in both appendices capably illustrate the results and conditions under which the tests were conducted.

THE use of containers or vessels made of various materials for holding gases and liquids under pressure has been a common practice for many years. These vessels have been made of all kinds of material and with or without joints as conditions and the fancy of the designer controlled. The vessels carrying heavy pressure have been usually, in the past, of riveted construction, although forge welding of such vessels, or parts thereof, has been practiced for a long time.

Forge welding is expensive and therefore not suitable for many types of vessels. Riveted joints have also been used because of their ease of construction and of the certainty with which their efficiency may be calculated. Much of this certainty is due to our long acquaintance with them; to the many tests that have been made on them, and to the fact that they may be readily inspected both during and after their manufacture. From a construction standpoint, however, riveted joints are objectionable for many reasons, among which is their decided tendency to leak.

It must be always kept in mind also that many failures have occurred with riveted construction and that such construction is not as simple a matter as it would appear, if one were to be guided entirely by what is sometimes said. The fact of the matter is that in the case of a great many people, familiarity with riveted construction has developed a sort of contempt for the dangers accompanying it. It is only necessary to recall the protests that were made against the restrictions on double-riveted lap joints in the A.S.M.E. Boiler Code to see that this is true.

Of recent years fusion welding of such vessels, usually in steel plate or sheet, has been used to a very great extent, the welding generally being done by the oxy-acetylene or metallic-electrode arc processes. These processes, when properly applied under proper conditions, produce a safe structure that has great advantages in regard to cost, lightness, strength and freedom from possible leakage.

Single Objection to Fusion Welding

The only objection that can be raised against vessels made by fusion-welding processes is that the integrity of the weld depends very largely on the honesty and ability of the welder, because it is very difficult, if not impossible, to inspect the weld satisfactorily. This fact, coupled with accidents that have occurred have created in the minds of many a suspicion that fusion-welding processes are not safe and that pressure vessels made by their use should be condemned.

Unfortunately, it is true that there have been accidents of a more or less serious nature from defective welds, or from those improperly made. It is equally true and equally unfortunate that vessels whose parts have been joined by other means than fusion welding have been equally productive of accidents, if not more so; and while it is also true that failures of seamless vessels have occurred, yet the advocates of fusion welding cannot rely on any such statements to help their case.

The real difficulty in the case of fusion-welded pressure vessels is that the art is so new that it has not been reduced to standard practice. The first welding torch was patented in 1903 and the progress of the art was very slow at first. Really the welding of pressure vessels has not been in use to any great extent for more than 10 or 12 years, and it is hardly to be wondered at that the knowledge of the art is limited compared with the knowledge of riveted joints and of the best methods of making them. Undoubtedly, when fusion welding will have been in use for as many years as riveting, those living at that time will wonder why there was any question of the value and safety of fusion-welding processes.

But on those of us who are living now and who are interested in fusion-welding processes, lies the burden of devising means and ways of producing safe vessels, to which we can point with satisfaction and pride as being not only the equal of other constructions but far superior to them.

The two main points of superiority in such vessels are their freedom from leakage and their much greater efficiency of the joint. As in other developments of mechanical and industrial processes, much has been done in the way of fusion welding by cut-and-try methods, and those of us who have been in the business for years can testify to the difficulties encountered. These troubles only stimulated the enthusiastic worker, and methods were developed which overcame many of them, but at great expense and loss of time.

Welding Efficiency

When welding began to be studied in a more careful manner, much was said about the efficiency of a weld, i.e., the ratio of the strength of a weld to the strength of the material of which it was made.

In what follows I feel that it will be well to limit discussion to vessels made of steel plate or sheet, because it is this material and vessels made of it with which we are principally concerned. I believe, however, that the principles which I shall attempt to develop are equally applicable to other materials.

It was found by trial that the efficiency varied greatly, ranging from as low as 20 per cent to as high as 95 per cent, and sometimes higher. There was much discussion as to what percentage should be used for the design of welded pressure vessels, and it was not to be wondered at that with the wide variation in efficiency no agreement could be arrived at as to what value should be assigned to the weld.

After considerable study and experiment I arrived at the conclusion that it would be necessary to eliminate the consideration of this variable and unknowable efficiency, by either making the weld so strong that rupture could not occur there, or by making the plate so weak that rupture would occur there always. It may seem that these two statements are the same, but they are not, as will be explained later, and it has finally become very clear to me that the second statement is the basic principle for the construction of safe welded pressure vessels.

Factors Affecting Weld Efficiency

It is easy to see that the efficiency of a weld may vary for different reasons—the welder may be inefficient, the welding material may be poor, the torch or electrode may not be capable of proper operation; but beyond all these things is the fact that the mate-

---

[1] Proprietor, Rochester Welding Works. Mem. Am.Soc.M.E.

Abridgment of a paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

rials, or base metals, which have been used for making tests vary very widely in strength. One test may have been made with 50,000-lb. material, another, with material of 65,000 lb. tensile strength. With the same welding material and the same operator the weld metal in the two cases should have the same strength. If we assume this at 50,000 lb. tensile strength, the weld in the low-tensile-strength plate will have efficiency of 100 per cent, while in the high-strength plate the efficiency would be about 77 per cent. Evidently, these two results cannot be compared unless the strength of the base material be considered. Therefore one of the first things to do is to decide what kind of material to use for the base metal.

It has been known for years that forge welding gives best results in low-carbon material, and on the other hand, tool steel is difficult, if not impossible, to forge-weld if full strength is desired. This is natural, because the high-carbon steel is easily burned at a temperature that will injure the low-carbon material but little.

In the course of my investigations I found several years ago that in two very large shops where fusion welding was one of the most important processes, they were using material of this character and had had splendid success with it. I have made numerous tests on various kinds of steel plate and found in these tests that the best welds were made in material of the same general character, that is, low-tensile-strength plate.

Composition of Best Base-Weld Metal

I have therefore come to the conclusion that the base metal most successful for welding is of about the following chemical composition:

Carbon, per cent	0.15 max.
Manganese, per cent	0.60 max.
Sulphur, per cent	0.05 max.
Phosphorus, per cent	0.04 max.

It should have about the following physical characteristics:

Tensile strength	50,000 lb. max.
Yield point	at least half tensile strength
Elongation, per cent in 8 in.	$\frac{1{,}500{,}000}{\text{tensile strength}}$.

Further investigation showed, much to my surprise, that material of this composition and strength would not always weld well, and I believe I have demonstrated that there is something more necessary than the above specifications if the most satisfactory material is to be obtained.

The microscope shows that steel which welds badly contains large numbers of small non-metallic impurities, which are probably oxides or silicates, because the percentage of sulphur is too small to form so much manganese sulphide. This indicates poorly made steel and evidently the coöperation of the steel maker is needed if we are to have satisfactory material with which to work.

I have occasionally found that improperly annealed steel also gives trouble in welding even in the absence of non-metallic impurities, but not to such an extent.

I have no hesitation in saying that steel of the above chemical composition, if free from non-metallic impurities, is the best metal, in my opinion, for the making of pressure vessels.

There is another reason for this statement and it lies in the fact that such material is very ductile, and will stand punishment in the nature of overheating or mechanical work that higher carbon steel will not stand, and inasmuch as there are always strains in welding due to the contraction of the heated metal, any material that will stand these strains and absorb them is much superior to one that will not.

Much trouble has been experienced in welding long seams in such high-carbon material as ship plate, and much credit is due to those who have exercised ingenuity enough to overcome this trouble; but it is much easier, cheaper, and safer to avoid it than to overcome it, and all my experience shows that the use of the material suggested will avoid the trouble.

Welding-Wire Composition

The welding wire ordinarily used for gas welding is a low-carbon material of about the following composition:

Carbon, per cent	0.06 max.
Manganese, per cent	0.15 max.
Phosphorus, per cent	0.03 max.
Sulphur, per cent	0.03 max.

It is a very carefully made product and of superior quality, and gives very good results. In half-inch plate of sufficient strength to break the weld, it gives a tensile strength of about 52,000 lb. per in. in a double "V" weld when the weld is of equal section with the plate. I do not believe that it is strong enough, however, to allow for welds that are somewhat imperfect, if it is desired to always break the plate and never the weld.

I have therefore advocated low-carbon nickel-steel wire of the following composition:

Carbon, per cent	0.15 to 0.25
Manganese, per cent	0.50 to 0.80
Sulphur, per cent	0.045
Phosphorus, per cent	0.04
Nickel, per cent	3.25 to 3.75

This corresponds to the Society of Automotive Engineers' specification No. 2320. This material tested under the same conditions as the ordinary welding wire above mentioned, gives a tensile strength of from 57,000 lb. to 63,000 lb. in the weld.

Another Good Welding Wire

I have no doubt that other equally good or better welding materials can be devised. I know of one that is better in some respects, but it is not quite ready for the market. Tests made with it have shown an average in 12 tests of 62,400 lb. with a maximum of 64,500, and a minimum of 58,600, so that the results are quite uniform.

It should be clearly understood that I am not presenting the claims of any particular materials, but am only giving the results of my personal experience. I am advocating very strongly the use of a welding material of such character as will most easily make a sound, clean weld, of a base metal that is weak enough to absorb the welding strains and to break always outside of the weld, and of methods that will always insure these results.

Under the head of methods, the type of weld is of importance. I have demonstrated to my own satisfaction that a single "V" weld is never as strong as a double "V" weld. The latter requires twice as much welding material and is therefore more expensive. A single "V" weld cannot usually be bent backward, i.e., with the top of the "V" concave to the bend. Under such a test the chances are very great that the break will take place through the center of the weld. The reason for this is that it is impossible to get freedom from defects at the bottom of the "V." This is shown clearly by the photographs.

Weakness of Single "V" Weld

Iron oxide melts at a lower temperature than the steel, and it flows down the side of the "V," accumulating underneath the edges due to its surface tension, and when the welding rod is applied there is a film of oxide at the bottom of the "V" or under it, over which the melted metal flows, leaving a line of weakness. It also works up more or less into the bottom of the "V," leaving cracks which are frequently microscopic but none the less dangerous.

According to my observation, the ruptures of welds, not only in pressure vessels, or steel plate or sheet, but in cast iron and other metals, have been with single "V" welds. I do not recall a case of a double "V" welded piece giving way in the weld. We never use a single "V" weld if it is possible to use a double "V," even if it is necessary to weld overhead to make the bottom of the "V" sound.

Of course, where there can be no bending, as in the case of a convex head welded to a shell, there is no particular danger, especially as the fiber stress is low. Also, if the double "V" weld cannot be used for any reason, there can be no argument, but the stress must be kept at such a point as will be safe, or the design changed to permit the use of the double "V."

A double "V," on the other hand, permits of the burning out of these defects, and if any do remain, they are in the center of the weld, where their only effect is to slightly reduce the tensile strength, which can be compensated for by increasing the thickness of the

weld. This cannot be done with the single "V," because increasing the thickness of the weld on one side increases the fiber stress due to a given pressure, on account of the eccentricity of the load. This can be readily seen in the testing machine, because the test piece bends toward the bottom of the "V."

Proper Welding Conditions Essential

The use of a double "V" may not be necessary in all cases, but for all important work I am satisfied that it should be used. With double "V" welding it is necessary to clean the scale carefully from the second side welded before welding. This scale comes from the action of the air on the red-hot metal during welding of the first side, and if it is not removed it will get into the weld and make it weak and brittle. There are two reasons for this: First, melted steel will dissolve quite an amount of oxide just as water dissolves salt, but on cooling, when the metal crystallizes, it rejects to the boundaries of the grains much of this foreign material, and as it has no strength, the metal is injured; second, if the oxide is present in large enough amounts, it is included in the weld, unless great care be taken to float it to the surface of the metal during the welding, with the same result as before.

I might speak here of the necessity of forcing to the surface all foreign material during welding, as in my opinion this is an important source of defective welds. Another difficulty, which is really the same thing, is allowing melted metal to run over on to metal that has not been fused. As the latter is always covered with a coat of oxide, the result is a weak spot in the weld. It should also be noticed that the thicker the material being welded, the more liability there is of any or all of these defects occurring, and this is one reason for my belief that we should not, at the present time, attempt to use material of a greater thickness than $^5/_8$ in. for making fusion-welded pressure vessels.

Regarding the thickness of material, it should be noted that a single "V" weld in material $^5/_8$ in. thick, using a 90-deg. "V," is $1^1/_4$ in. wide. It is not possible to protect all this surface at once with the welding flame, or with the gases from the arc, and the very hot metal comes in contact with the air and is coated with oxide. The weld metal has to be remelted more or less, the amount of remelting and oxidation increasing as the thickness increases.

Again, a single "V" weld is seldom welded through, even in the best welding shops, because objection is made to any drops projecting from the inside, for reasons which are sometimes good and sometimes bad. And as it is difficult, if not impossible, to avoid these projections, the welder stays away from the sharp edges of the "V," which melt away readily, and ball up due to the surface tension of the melted metal. This balling up results in a wide opening at the bottom of the "V," which is hard to fill up. The result of not going through is an unsound weld at the bottom of the "V."

Oxides Cause Rupture

It may not be out of place to say a few words about the bearing of oxides on the weld strength. I have shown[1] that the path of rupture in steel fusion welds is first initiated at visible inclusions. If there are none of these, the next place they begin is at the grain boundaries, even when no foreign matter can be seen there at the highest power of the microscope. This is true in both gas and electric welds. It is known that such welds are overoxidized, and the inference is fair, I think, considering this and other evidence, that oxides are the cause of the intergranular rupture. It is evident that every effort should be made to keep welds as free from oxides as possible. Tests indicate that the tensile strength of an oxidized weld in $^1/_2$-in. plate is about 43,000 lb. per sq. in. The yield point of the specified base metal would be something over 25,000 lb. per sq. in., so that there is quite a margin of safety in a poor weld, as far as tensile strength is concerned, even when the weld is no thicker than the plate. It is commercially possible to reinforce a weld 15 per cent on each side, so that its section will be 30 per cent greater than that of the plate. Therefore the tensile strength of a poor weld reinforced would be, referred to the plate section, say, 55,000 lb. per sq. in., or more than that of the plate. I therefore conclude that a reasonable reinforcement of the weld is necessary for safety. The above figures are based on the use of straight low-carbon-steel welding wire. If higher-strength material be used, the margin of safety is still greater. For example, the average tensile strength of the special wire welds referred to is 62,400 and the minimum 58,600 referred to the weld section. A 30 per cent increase would mean an adjusted plate strength of about 76,000 lb. per sq. in., which is much higher than the upper limit for ship plate, 68,000 lb. From a design standpoint it is of course desirable to use as strong a plate as possible to make the vessel as light as may be. But we must be sure that the plate is always sufficiently weaker than the weld, and allowance must be made for the defects that cannot be avoided in practice.

I would again speak of the danger of assuming a weld value in design that is based on a plate stronger than the weld. Such a value is pure assumption, in spite of tests, because no account can be taken of the unknown strains in the sheet. If, on the other hand, the plate is purposely made enough weaker than the weld, there can be no danger of the weld giving way under any circumstances. If it can be shown that this can be done under usual shop conditions, it would be fair, I believe, to assign a high weld value to such construction. It should be kept clearly in mind that weld values have been in the past taken from welds made on different principles than those here advocated, and that they cannot be applied fairly under the proposed conditions. It is as if a riveted joint could be designed that had 150 per cent of the plate strength. Surely it would not be fair to assign to such a joint an arbitrary efficiency of 70 per cent.

There must be a limit to the tensile strength of a weld, and in my judgment the margin by which the plate strength should be less than the weld strength is not known with sufficient exactness to permit of any general statement being made as to its amount.

Lower-Tensile-Strength Material Advocated

Assuming that a weld 30 per cent stronger than the plate is enough to allow for usual defects in the weld, and that such a defective weld will always break the plate, we might assume that we could safely use 65,000-lb. plate, and would be safe if the weld tensile strength were 65,000 lb. per sq. in. and if it were reinforced 30 per cent. This would be true theoretically, but I am afraid of practical difficulties. The welding strains would not be absorbed by the plate as readily as with softer base metal, and there is doubt in my mind as to the welding qualities of such plate. I am strongly of the opinion that these difficulties are absent in the case of the suggested base metal. Therefore, it seems to me that till such tests have been made as will show beyond question that the use of high-tensile-strength plate is safe, we should use lower-tensile-strength material which is known to be satisfactory. It is important, however, to determine in the near future the possibilities of higher-tensile-strength material than that specified.

One precaution that should always be taken for important work is the rerolling of the shell after it is welded. The reasons for doing this are that it is impossible, particularly with heavy sheets, to roll them truly round at the ends, and the flat spots that are left there are liable to cause trouble when the vessel is put in service, due to its tendency to assume a circular section under pressure. This puts a bending stress on the weld which it is not well suited to resist, while if the shell is rerolled, the strain becomes tensile. Further, it tends to relieve the welding strain, if not to entirely remove it, and to locate defective welds.

Relieving Welding Strains

The question of annealing pressure vessels after welding, in order to relieve the welding strains, is one about which not much is really known. It would seem to depend partly on the thickness of the sheet. The thin sheet will readily distort during the welding and relieve the welding strains, while a thicker one will not do this so easily. This is another reason for limiting the thickness of the material. Another thing that influences the strain is the diameter of the shell, as a large shell will accommodate itself to the strain more readily than a small one of the same thickness.

The annealing of a pressure vessel may mean several things: First, heating of the weld and its vicinity to a sufficient temperature to relieve the welding strain; second, the annealing of the

---

[1] Path of Rupture in Steel Fusion Welds. Paper read before the A.I.M.E., Feb., 1919.

weld metal to reduce the grain size to make it more ductile; third, the annealing of the metal next to the weld to remove the coarseness of the grain produced by the welding heat. There may be also combinations of any two or all three of these treatments. It should be clearly understood, however, that the temperatures for the three treatments mentioned are entirely different. The temperature for relieving the welding strain does not need to be more than a very dull red, say, not over 900 deg. fahr., and even this may not be necessary, as is shown by the fact that many cast-iron pieces are welded successfully without being heated to a dull red.

The refining of the grain in the base metal requires a higher temperature, which must be above the upper critical or Ac$_3$ point. This temperature varies with the chemical composition of the steel, particularly as regards its carbon content. This temperature for the steel specified in this paper is about 1525 deg. fahr.

The chemical composition of a weld varies not only with the composition of the welding wire, but also with the method of its making. However, a gas weld made with ordinary straight carbon-steel wire has a very low carbon content, not much over 0.04 per cent, and for forged material, steel of this composition would have an Ac$_3$ point of about 1625 deg. fahr.

It is well known, however, that a casting requires a higher refining temperature than a forging of the same chemical composition, and by test I have found[1] that a gas weld made as described has a refining temperature of about 1750 deg. fahr.

In an electric weld made with bare wire there is a large percentage of nitrogen, in some cases as high as 0.14 per cent, while the other elements are usually present approximately in the same proportions as in a gas weld.

The presence of nitrogen entirely changes the critical points, and in the case of such a weld they appear to be absent. This does not mean that the structure of an electric weld cannot be altered, but it does mean that the temperature would have to be determined by experiment.

In the case of nickel-steel welding wire, the weld contains over $2^1/_2$ per cent of nickel. Nickel lowers the upper critical point, depending on the amount of nickel present—in this case, about 50 deg. fahr.

It will therefore be seen clearly that annealing for any purpose except relieving the strains is impossible from a commercial point of view, as it would involve a double heat treatment.

It is evident that it is not necessary to heat the whole vessel for the purpose of relieving the welding strains, and probably a dull red heat for a distance of 2 in. or 3 in. on each side of the center line of the weld in $^1/_2$-in. material would be sufficient.

It is doubtless true that either annealing and rerolling can be omitted in some cases, and that neither of them would be required for safety in other cases. But it seems clear that the higher the tensile strength of the plate, the greater the necessity of taking these precautions. A further reason for using low-carbon sheet is that it is not liable to be injured by the welding heat as much as higher-carbon material.

It may be objected that the carrying out of these principles will be so expensive as to make it commercially impossible to use fusion welding for pressure vessels. There are two answers to this. First, the burden of proof of the correctness of the statement rests on those who make it, and until proof is given of its correctness, the mere assertion is not evidence. Second, if it be true in any case that safe practice (and this does not of necessity include all the precautions mentioned for every case), makes welding too expensive, then it is obvious that welding cannot be used.

Further, there is involved the matter of salesmanship. If we believe that a properly welded vessel is better and safer than a riveted one, we should be able to sell it in all cases where it is worth the price, and if it were not worth the price, we could not honestly urge its installation.

It is quite possible that poorly welded pressure vessels are much cheaper than well-riveted ones, and that this has been used as a means of reducing prices in some cases. But if this be true, those responsible for the poor welding cannot come into court with clean hands, and their arguments would be invalid. Fortunately, such arguments are rarely heard, but unfortunately, we must make specifications which guard against such possibilities.

Welded vs. Riveted Tanks

It may be of interest to consider the relative merits of welded and riveted tanks as far as strength is concerned. Only one instance will be given. Assume the riveted tank to be double lap-riveted of $^1/_2$-in. plate of 60,000 lb. tensile strength, and 5 ft. in diameter. With a factor of safety of 5, it would be good for 140 lb. working pressure by the usual formula. If the welded tank were of the same dimensions of 50,000-lb. plate, with a weld strength of 125 per cent of the plate, which is easily obtained, it would be good for 141 lb., if a weld efficiency of only 85 per cent were assumed, using the same factor of safety and formula. I really believe that the welded vessel is far superior to the riveted one in this case, in every way.

Objection has been raised to the use of welding because of the small resistance of welds to alternating stresses and shocks, to which any pressure vessel is subject in service. It is true that if the base metal is stronger than the weld, the weld readily gives under such stresses, but it does not seem to be so if the base metal is weaker.

In order to determine whether the ideas which I held were correct, a number of welded plates were tested and then later further tests of actual pressure vessels were conducted. The complete results of both sets of tests are presented in the appendices to this paper, selections from which appear in the present abridged publication.

Also through the courtesy of the Quasi Arc Weldtrode Co. a number of tests were made in their Strohmenger alternating bending-impact machine, especially designed for testing welds. The test piece, $^3/_8$ in. by $2^1/_2$ in. in section, with the weld machined flush with the base metal, is clamped in the jaws, with its edge level with the center of the weld. The vibrating head is loose on the test piece, the opening being $^1/_2$ in. wide. The head travel is so adjusted that the test piece bends $^5/_{32}$ in. on each side of its central position, so that the travel before impact is $^1/_8$ in. and the total bend $^5/_{16}$ in. The number of alternations is about 600 per minute. Of course, no quantitative results can be obtained, but the results were quite consistent in the forty-two tests which were made.

One set of tests was made with two welding wires, an ordinary low-carbon steel, and 3.5 per cent nickel steel. Two base metals were employed, and 3 test pieces were made with each combination, a total of 12. The results of this series were as follows:

Base metal	Welding rod	Average no. of alterations before rupture	Broke
57,000 lb. tensile strength, bar steel	Carbon steel	3300	all in weld
57,000 lb. tensile strength, bar steel,	Nickel steel	5600	all in weld
47,000 lb. tensile strength, plate,	Carbon steel	4550	all in weld
47,000 lb. tensile strength, plate,	Nickel steel	8550	all out of weld

These results show clearly the superiority of the low-strength-plate—high-strength-weld combination. It might be said that the unwelded plate gave about the same results as did the nickel-steel welds.

It seems clear that the stiff nickel-steel weld threw the strain into the soft plate, which broke just next the weld in the zone coarsened by the heat, and if this zone has about the same resistance as the solid plate, as the tests indicate, there can be little fear of danger from alternating stresses in service in a vessel made in the same way. It should be remembered, however, that the higher the tensile strength of the plate, the higher the carbon content, and therefore the greater danger from the welding heat, especially if the heat be applied rapidly and the cooling occur quickly. This has resulted in ruptures in heavy boiler plates, say $1^3/_{16}$ in. thick, due to the formation of a sorbitic zone next the weld, and to the strains set up in the sheets by the weld shrinkage. This trouble can be avoided by preheating sufficiently to avoid forming sorbite, which requires a rather rapid rate of cooling for its formation. This sorbitic condition would doubtless have an effect on alternating-stress tests, and such tests should be considered a necessary part of any program for studying the value of plate for welding purposes.

---

[1] Journal of the American Society of Refrigerating Engineers, Nov., 1918, p. 202.

APPENDIX NO. 1

TESTS OF WELDED PLATES

In order to determine whether the ideas which I held regarding fusion welding of unfired pressure vessels, were correct, I took up the matter with H. S. Smith, then president of the International Acetylene Association and Prof. C. A. Adams, director of the American Bureau of Welding, and with their coöperation a number of tests were conducted.

Altogether there were ten plates tested and a summarization of the general results is given in Table 1.

Specimen B, from the York Mfg. Co., was purchased with the understanding that it was same general type of material as the others, but on analysis it was found to contain 0.24 per cent carbon and to be of about 64,000 lb. per sq. in. tensile strength. The ground test piece broke in the weld at 58,000 lb. Another cold-bend test piece of another exactly similar weld in another plate of the same material broke outside of the weld and the hot-bend test piece bent flat on itself, without cracking.

Fig. 1 Cracks in Weld of Specimen B; Magnification 2.3

Probably the most interesting case of the ten specimens tested is that of specimen B, in which cracks were found in the plate at a distance up to $^3/_4$ in. from the edge of the weld, which could frequently be seen with the naked eye and which were readily visible with a magnifying glass (Figs. 1 and 2). It should be noted that the plate had not been fused where the cracks occurred. Examination was made of these cracks by taking a section through them and examining under the microscope.

The pieces so examined were taken from another test plate made of the same steel and in the same way, the test pieces having been strained in a 50,000-lb. testing machine, which was not sufficiently strong to break them, but which did open up the cracks referred to so that they could be seen. These cracks (Fig. 3) apparently only occurred on the second side welded, and are probably caused by the resistance to shrinkage due to the stiffness and strength of the plate, although the poor general quality probably had also a considerable effect. I had never noticed such cracks before, although I have since found them in sheet material of poor quality.

Microscopic examination of the section taken through one of these cracks is very interesting. The plate, as received, was quite heavily coated with mill scale, which had been rolled into the surface. This is brought out by the pickling. An examination of the weld with a hand glass shows quite clearly that this mill scale has been fused in the vicinity of the weld. Of course the temperature of the plate near the weld was high, probably 2300 deg. fahr. or 2400 deg. fahr., which would be sufficient to melt the scale. Also the plate at that temperature was in the γ range.

At this high temperature the crystallization of the metal is different from that at room temperature in that the grains are of different shape and larger, and that the carbon is all in solution in the iron. The weld having been made on one side, the plate is rigid and the expansion due to the heat compresses the metal where it is weakest, that is, hottest, and when it cools the contraction occurs at the same place. If the strain is great enough, the plate cracks if it is not sufficiently ductile. If the metal were of poor quality, and brittle at high temperature, the condition would be worse. In either case, capillary attraction might draw the melted scale into the cracks.

At this high temperature the solvent power of the iron for impurities is considerable, and it is quite reasonable to suppose that some of the mill scale was dissolved. As the metal cools, some of the oxide would fall out of solution, and be rejected to the grain boundaries then existing, that is the austenite or γ ones. Even if this did not occur, the strain might cause minute cracks, the surfaces of which would oxidize easily. Whatever occurred, the recrystallization that took place later in the cooling, when the metal passed from the γ to the α condition, could not pass these impurities, which outlined the γ grains, and which, when the metal was cold, showed their location.

It is well known that tool steel, when burnt, shows such markings around the grains, these being sharply angular instead of being rounded as the alpha grains are. I sectioned one of the pieces through one of these cracks in the plate, and in examining it at low power I noticed a network which did not coincide with the α grain boundaries. Higher power showed it to be apparently a film of oxide. Still higher power seems to confirm this.

Microphotographs are given showing the structure. Fig. 4 shows that the network is quite extensive, being to the right of the large crack which is the result of the tensile test of the material. I have no doubt that originally this crack was not much larger than the network. Fig. 5 shows part of the network at a higher magnification, and Fig. 6 at still higher power. Figs. 5 and 6 show quite clearly that the pearlite and cementite do not lie at the films and in some case the α grain boundaries can be readily seen. They are clearly different and distinct from the films.

A section from sample No. 1 of specimen B showed no cracks in the plate, but some few in the weld, which were about 1/200 in. deep. In some cases it appears that these cracks pass through the center of particles of cementite as shown in the photograph (Fig. 7). Whether the cementite was actually ruptured or not is a question, although I am inclined to think that it was. This would require the rupture to have occurred, at least partly, below the Ar_1 point. It is of course, possible that the main part of the crack occurred at high temperature and that it extended at a lower temperature. These cracks are very small and have no apparent effect on the strength of the welded piece, because even when the welds were ground down level with the plate, the plate broke in the middle third between the weld and the shoulder in a natural, normal manner.

These cracks are also very shallow, and most of them are filled with oxide, showing that they occurred at high temperature. The weld scale is very adherent, requiring for its removal much longer pickling in dilute hydrochloric acid than ordinary weld scale. It appears to run down into the cracks as a continuous part of the surface scale in some cases, and there are in the surface scale particles of metal.

Sample No. 2 of specimen B appeared from general observation not to be of good steel. The fractures in the tensile test pieces were not silky as they should be, but were more or less harsh to the eye. It is worth noticing that welds made with nickel steel wire, in 64,000-lb. plate, the welds being reinforced the usual amount, broke the plate outside the weld with the same necking down as would be expected in an ordinary tensile test.

Leaving aside for the moment the question of welding, it would seem that we must pay much more attention to the quality of the steel used for welding than we have in the past, and this brings up the question of some of the mysterious failures of boiler shells, ship plates, etc., and I am inclined to believe that much of the trouble has come from defective steel; the defects have not been detected, and they probably could not be detected, by any ordinary examination or the regular tests.

There was, for instance, the quite noted case[1] of the plate failures on a ship being built in England, which gave trouble from brittleness after having passed all Lloyd's tests successfully. This case was investigated by some of the ablest metallurgists in England, and the consensus of opinion appeared to be that the plate was from a basic open-hearth heat that had not been properly treated with manganese and was otherwise badly made.

Attention was called to the remarkable angularity of the grains. It was found by analysis that the steel was very high in oxygen and nitrogen.

TABLE 1 RESULTS OF TESTS OF WELDED PLATES

Specimen	Sample	Lb. Per Sq. In.		Per Cent		Weld Ground	Location of Break
		Tensile Strength	Yield Point	Elongation in 8 in.	Reduction of Area		
A	1	50,900	32,400	25.7	.....	no	3 in. from weld
	2	50,500	31,400	27.1	.....	yes	2½ in. from weld
	4	51,000	32,000	29.0	.....	yes	3 in. from weld
B	1	58,500	43,100	4.25	.....	yes	In weld
	2	64,000	41,300	19.6	53.6	no	1½ in. from weld
	4	63,700	41,500	23.5	53.1	yes	3 in. from weld
C	1	29,750	27,300	2.3	4.2	yes	In weld
	3	31,700	27,100	3.4	4.7	yes	In weld
	5	41,100	27,100	6.6	10.6	yes	In weld
D	1	48,100	30,500	26.0	4.5	yes	2 in. from weld
	3	47,250	30,300	27.0	3.2	yes	2 in. from weld
	5	49,100	29,100	29.7	2.9	yes	2 in. from weld
E	1	51,100	32,930	31.0	59.0	no	1½ in. from weld
	2	51,680	32,700	26.6	58.4	yes	1½ in. from weld
	4	51,320	32,000	25.0	61.2	yes	Outside of weld
F	1	42,570	.....	21.9	61.15	yes	Outside of weld
	3	43,210	.....	25.9	63.1	yes	Outside of weld
	5	43,010	.....	21.0	61.5	yes	Outside of weld
G	1	50,000	31,400	.....	60.7	no	2½ in. from weld
	2	52,560	32,700	21.3	57.6	yes	2½ in. from weld
	[illegible]	52,200	31,380	21.6	53.6	yes	2½ in. from weld
H	1	39,300	.....	6.7	2.46	yes	In weld
	3	45,830	.....	21.9	67.95	yes	Outside of weld
	5	44,740	.....	11.8	3.63	yes	In weld
I	1	43,050	.....	24.4	64.35	yes	Outside of weld
	3	42,430	.....	22.9	67.6	yes	Outside of weld
	5	42,490	.....	15.1	.....	yes	In weld
J	1	40,850	.....	12.1	2.53	yes	In weld
	3	44,150	.....	22.5	73.7	yes	Outside of weld
	5	43,670	.....	22.2	70.9	yes	Outside of weld

---

[1] The Remarkable Failure of a Consignment of Ship Plate, by J. B. Wilson. Proceedings of Engineers & Shipbuilders in Scotland, 1914, p. 227.

Analyses were made by a number of chemists and the results not only showed the above, but that the steel was badly segregated. While the standard tests did not show anything wrong with this material, alternating-stress tests did show clearly that the metal was inferior, and the matter is referred to, not with the idea of trying to include such tests in specifications, but to show that at times more searching tests than the usual ones may be needed.

In many other cases in the literature this same angularity of grain is noticed in photographs, even if no reference is made to their shape in the text, so that angular grains would be indicative of poor material. It would seem that they represent the γ grain boundaries, and not the α ones.

I do not doubt that invisible intergranular films may exist along the γ grain boundaries in many cases, which would open paths for oxidation when heated or which under severe strain might result in rupture, particularly if the strain were accompanied by shock. I am convinced that such is the case in welds, because I have broken many pieces under the microscope, and even where there was no evidence of intergranular films at 1200 diameters, the rupture was generally along what are apparently the γ grain boundaries.

TABLE 2 A.S.T.M. SPECIFICATIONS FOR FLANGE AND FIREBOX STEEL

Kind of Steel	Flange Steel	Firebox Steel	Remarks
Carbon, per cent	.	0.12 to 0.25	Plates $\frac{3}{4}$ in. thick or less
Manganese, per cent	0.30 to 0.60	0.30 to 0.50	Plates $\frac{3}{4}$ in. thick or less
	0.30 to 0.60	0.30 to 0.60	Plates over $\frac{3}{4}$ in. thick
Phosphorus, per cent	0.05 max.	0.04 max.	Acid
	0.04 max.	0.035 max.	Basic
Sulphur, per cent	0.05	0.04	
Tensile strength	55,000 to 65,000	52,000 to 62,000	lb. per sq. in.
Yield point	0.5 ten. strength	0.5 ten. strength	
Elongation in 8 in.	$\frac{1,500,000}{\text{ten. strength}}$	$\frac{1,500,000}{\text{ten. strength}}$	Minimum per cent

There are three classes or qualities of steel plate, called flange, firebox and tank. The specifications[1] of the American Society for Testing Materials for the first two are given in Table 2.

Steel of tank quality has no specification. It may have as high as 7500 lb. tensile strength and be full of impurities, and is entirely unfit for important work. It is made from heats that for some reason are off.

Firebox steel is evidently of better quality from its composition, having less phosphorus and sulphur. But there are further differences that are hard to describe, and which are usually known only to the mill. For much work, flange quality is plenty good enough, while for the better work, firebox quality is needed; but in my judgment the tensile strength and carbon are too high in the A.S.T.M. specification for really important work, and the specification proposed earlier in the paper I believe to be much more suitable. In any case, high quality is essential to the best work, and for such work firebox steel should be specified.

This matter of quality, as distinguished from chemical composition, has been referred to at some length, because my experience has been that it affects the quality of the weld. This is especially true where the metal contains notable amounts of what Brearley calls "mechanical dirt." It is coming to be believed more and more that oxides of various kinds are largely responsible for the poor quality of steel, and I have found that steel containing this dirt foams and spits during the welding, and that the welds made in it are weak. Of course all steel plate contains some impurities, and it is very hard to say how much to allow, or how to draw a specification limiting the amount. But steel of firebox quality never gives any trouble, as far as I know, and I believe that we will be safe if we specify it for important work.

Fig. 2 Crack in Both Plate and Weld of Specimen B; Magnification 3.2

The superficial cracks in the nickel-steel welds referred to are not found in all cases, and they are rare in welds made with ordinary materials and their presence is not fully understood.

The important thing is to provide a weld that will be sufficiently strong even when somewhat defective, and the base metal so weak that it will take the strain in preference to throwing it in the weld. I do not believe that these minute cracks in nickel-steel welds are any different from those occurring with ordinary welding material. This is not saying that welds free from them are not desirable because they are, but nickel steel should not be condemned on this ground alone, any more than should ordinary welding material, because the cracks have occurred in both.

The cracks in the plate of specimen B are of particular interest, because they show necessity of having the base metal of such a quality as will not be injured during the welding, and it is significant that none of the other plates had them, though they were looked for very carefully. We must not forget that special materials have had to be developed for specific processes, for instance, the use of bessemer steel is general for screw-machine stock, because the chips from it break up readily and do not clog the tools. In the same way, we must have for welding purposes a steel that meets the requirements. Fortunately, such steel is not difficult to obtain, and the steel maker will be glad to furnish it if he knows what the requirements are, and it is our business to advise him of them.

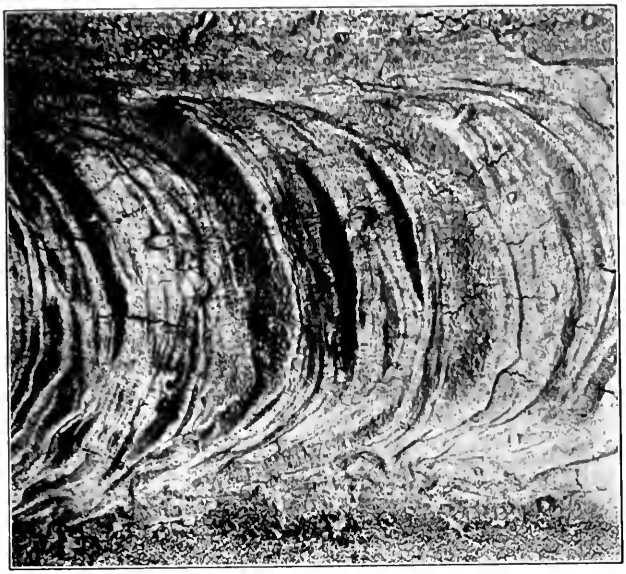


Fig. 3 Cracks in Weld and Plate After 50,000-lb. Tensile Load Failed to Break Test Piece. Scale Pickled off Before Taking Photo; Magnification 3.6

Any welding wire used must be of good and uniform quality if good results are always desired. I have found very bad results from some nickel-steel rod. I cannot say yet where the trouble lies, but it does not appear to be entirely dependent on the chemical analysis, and I have no doubt that the general quality of it and other wires will be found just as important in all cases as I know it is in some.

It should be clearly understood that I do not believe nickel steel to be the best welding material that can be made. I have had great success with it, and it is to my mind the best material now readily available for high-strength welds. But I would be glad to see other wire giving similar high strength, because it is very probable that still better qualities can be obtained by other alloys than nickel. It is just as important to have suitable wire for welding pressure vessels as it is to have suitable plate, and if our needs are realized they will be met.

I feel very strongly that some method of protecting the weld from the action of the oxygen in the air or in the welding flame must be used, if we want the highest efficiency. I do not mean that we cannot make safe pressure vessels now, because we can and it is being done every day, but we want to do better.

The following general conclusions may be drawn from these tests:

a If the weld is ground to the same thickness as the plate, the break will probably occur outside of the weld.

b Since all welds not ground flush broke outside of the weld, it is highly improbable that any double "V" welded piece of low-strength plate and properly reinforced will break in the weld.

c Bare-wire arc electric welding is not practical with a nickel-steel rod.

d Arc welds made in low-strength plate with proper electrodes and reinforced will always break the plate under tensile test.

APPENDIX NO. 2

TESTS OF WELDED PRESSURE VESSELS

Further tests of actual pressure vessels were later conducted to determine whether theories were borne out in practice. Six tanks were tested, of which four were made of firebox steel showing on chemical analyses of ladle tests to have the following composition: Carbon 0.12 per cent;

---

[1] A.S.T.M. Specifications 1921, p. 230.

manganese 0.38 per cent; phosphorus 0.012-0.015 per cent, and sulphur 0.028-0.035 per cent.

Tensile tests at the mill gave the following results:

	Longitudinal	Transverse
Tensile strength, lb. per sq. in	48,100–49,260	52,700
Yield point, lb. per sq. in	36,900–36,200	37,000
Elongation in 8 in., per cent	31–30	30

These four tanks were welded with $^1/_8$-in. diam. nickel-steel wire of the following composition: Carbon 0.21 per cent; manganese 0.60 per cent; phosphorus 0.025 per cent; sulphur 0.023 per cent and nickel 3.20 per cent. A No. 8 D-B tip, having a mixing chamber 0.098 in. diam., and the flame adjusted to suit the idea of the welder was used. A 90-deg. double "V" was used for the longitudinal seam, which was made with a cutting torch, and the scale carefully removed as much as possible with a chisel and wire brush. While the thin scale could not be taken off, all the large particles were removed. The head seams were 90-deg. single "V," made and cleaned in the same way.

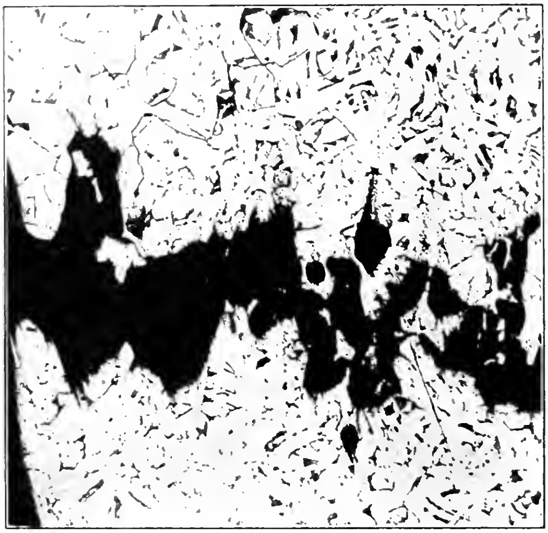


Fig. 4 Crack of Specimen B Opened by Strain. Originally of Same Character as Network at Right Which Outlines the γ Grains. Etched With Picric Acid; Magnification 100

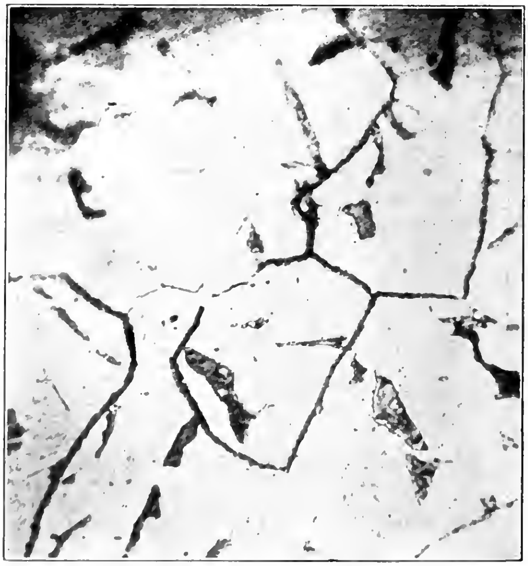


Fig. 5 Specimen Shown in Fig. 4 at Higher Magnification. Films of Oxide at γ Grain Boundaries are Very Clear and α Grains Can be Seen With Pearlite Lying at Outer Edges; Magnification 430

It was thought desirable to get some information about the shrinkage of the welds, so tram marks were made at different places along the seams on the outside of the shell, after the first side of the longitudinal seam was welded, with a tram 5 per cent long, so that the marks were about equidistant from the center of the weld. The same tram was used on the head seams after the heads were tacked in place, and before welding. The circumference of the tank was measured with a steel tape just inside each head seam, and at 3 other places, equally spaced, between the first two.

There were five welders used at different times on the work, which was done at the Rochester Welding Works. Their records bearing on their ability for the work, are as follows:

Fig. 6 Magnification of Portion of Fig. 5, Showing Details More Clearly; Magnification 1200

Fig. 7 Bottom End of Crack in Weld, Extending Through Cementite Which the Crack Appears to Have Split. Etched With Picric Acid; Magnification 1200

A Six years' experience. All-around job welder. Had welded heavier steel plate but very few pressure vessels.

B and *D* Four years' experience. All-around job welder. Had never welded plate as heavy, and never welded pressure vessels.

C Six years' experience. Good job welder, and had welded many pressure vessels up to $^3/_8$-in. plate thickness, but never thicker.

E Four years' experience in pressure-vessel welding but never in over $^3/_8$-in. plate.

These records show that none of these men could be called experienced on the job at hand.

In all the tanks, records of time and welding rod used were taken, but are not given because of the great variation in the fitting up, so that comparisons of the welders based on these figures would be unfair.

Only three of the tanks were tested because the pump was not of sufficient capacity to burst them in any reasonable time, although it was good for 2500 lb. pressure. It is hoped that a larger-capacity pump will be obtained soon and the test finished.

Tank No. 1 longitudinal seam was welded by A and *B*. The seam fitted so badly that it had to be wedged against a 70-lb. rail, after clamping the ends together and to the rail, to straighten it, and even then *B*'s end did not line up well. No tacking was done, and the welding was begun inside at the center of the length, both welders working toward their ends, using the backward method. The seam was allowed to cool over night and the tram marks (Fig. 8) and measurements made as mentioned above. The same men welded the outside of the seam, again working backward, beginning again at the center at the same time, and working toward the ends. The measurements were taken again after the shell was cold.

Fig. 8 No. 1 Tank (Same as Nos. 2, 3 and 4) Set up for Test. Figures 1 to 5 Locate Tramming Points at Seam

The heads (Fig. 9) were then tacked in place, with tacks from 9 in. to 12 in. apart, leaving the bottom of the "V" $^1/_4$ in. open before tacking. The tacks were somewhat over 1 in. long. The tacking and welding were done by *C*, who used forward welding. After tacking, the tank was allowed to become cold, the tram marks applied, and the welding finished. When cold, the measurements were again taken.

The pipe connections for testing were of $^1/_2$-in. extra heavy pipe, and were threaded in place, and gas-welded inside. The one in the center of the head was badly located for the test, as will be seen later, but would have been perfectly safe in service. An additional set of tram marks was put on this tank at the points where the circumference was measured. They are shown in Fig. 14 and were for the purpose of getting the elongation at and near the weld, if possible. The marks were on 2-in. centers, and the total length between the outside ones at each point was 10 in. All the tram marks on the shell were really chordal distances, but the errors of reading them were doubtless more than those due to their being chords instead of arcs.

All marks were laid out with a tram or dividers, and a jeweler's glass used to read them with a scale graduated to hundredths of an inch. The steel-tape measurements were read to the closest thirty-second of an inch. The shell not being round, it was only possible to divide up the inequalities between it and the heads as well as could be done. After the welding was done, the shell at the longitudinal seam was 0.21 in. higher than the head at one end, and 0.25 in. at the other. Similar variations occurred in the other tanks.

Fig. 9 Head of Tanks Nos. 1 to 4, Showing Radius Before Testing

Fig. 11 Head of No. 1 Tank After Testing to 2150 lb.; Radius About 19 in. Note That Diameter of the Head Flange Decreased from the Weld Out

Fig. 10 Luders' Lines on Knuckle of Tank No. 1 at 1150 lb. Light Diagonal Lines Indicate a Stretching of the Metal Due to Stress Perpendicular to Them

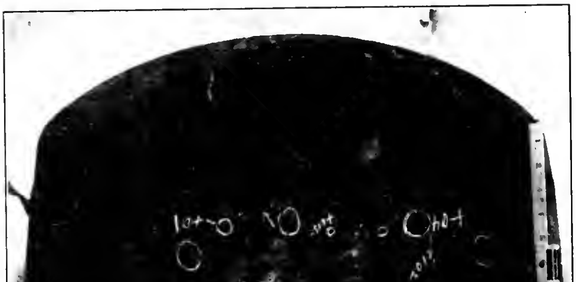


Fig. 12 Head of Tank No. 5 Bulged After Test. Original Radius 35 in., Final Radius 19 in.

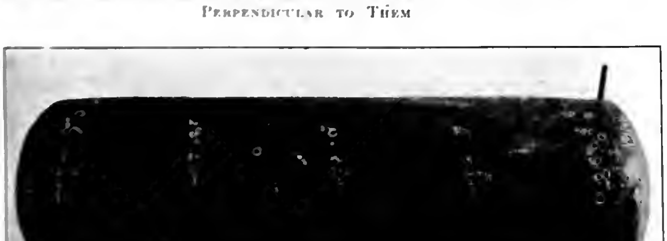


Fig. 13 One Seam of Tank No. 5 After Testing to 1900 lb. Nipple at Left Tapped in and Arc-Welded, and One at Right Tapped in and Gas-Welded Inside. Note Distortion of Ends

The testing was done with a motor-driven pump, which was found too small on the first test. A second one was built, and while it had sufficient strength, it did not have enough capacity to burst the shell, which, with the heads, simply stretched, with very little effect on the welds. This was true throughout the tests.

In no case could the welds be injured beyond the formation of minute pinholes or cracks, which, while they helped to keep the pressure down, at no time gave any evidence of any general rupture. These small cracks did not appear in any case until a very high pressure had been reached, the lowest being 1350 lb. This pinhole was stopped with one blow of a center punch, and did not appear again until the pressure reached 2100 lb. This means a fiber stress of about 31,000 lb. when the pinhole appeared, and of about 48,000 lb. when it showed up the second time. The fiber stress of 435 lb. working pressure is 10,000 lb.

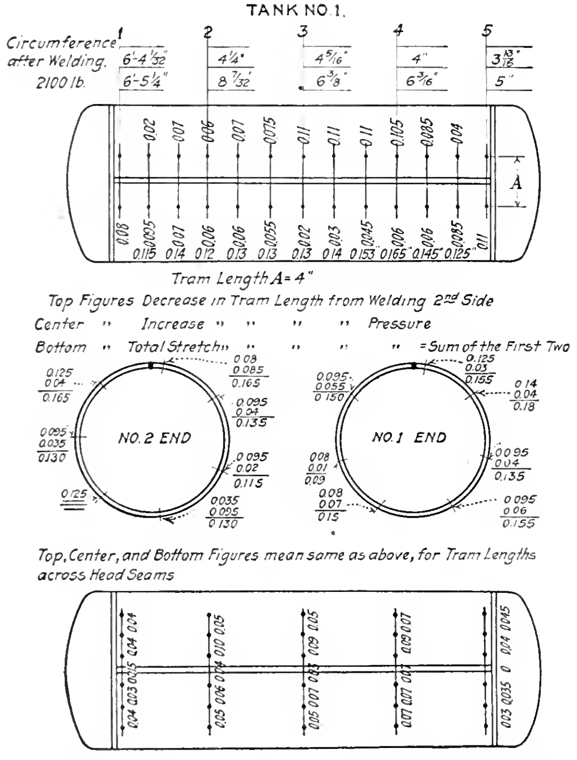


Fig. 14 Tram Measurements of Tank No. 1

The details of the test are as follows: The pressure was raised to 800 lb. and the seams then struck good swinging blows with an 8-lb. sledge. The pressure fell to 750. The pressure was increased, and at 1150 lb. Luders' lines appeared in the scale on the knuckle of the head, as shown in Fig. 10. At 1450 lb. a few drops of water appeared at the pipe nipple in the center of the head, but this leak stopped at 1500 lb. The yield point of the tank was very clear at 1500 lb., at which point the pressure was steady for a long time, while the heads could be seen stretching. The shell also took a slight permanent set, as will be seen from the following tabulation.

Circum. in.	Before test	At 400 lb.	At 800 lb.	At 1200 lb.	At 1500 lb.	At 1500 lb.[1]	After test	After 2150 lb.	Total stretch
1	76 1/32	76 1/16	76 1/8	76 1/8	76 1/4	76 5/16	76 1/4	77 1/4	1 7/32
2	76 1/4	76 1/4	76 1/4	76 5/16	76 1/2	76 5/8	76 9/16	80 7/32	3 31/32
3	76 5/16	76 11/32	76 11/32	76 11/32	76 11/32	[2]77	76 13/16	78 3/8	2 1/8
4	76	75 31/32	75 31/32	76 1/32	76 3/16	[2]76 31/32	76 3/8	78 9/16	2 9/16
5	75 13/16	75 27/32	75 27/32	75 13/16	76 1/8	76 5/32	76 1/16	77	1 3/16

---

[1] After prolonged application of this pressure.
[2] Flat spot in this vicinity had straightened out.

1500 lb. corresponds to a fiber stress of about 33,000 lb., as close as could be expected to the tests of the plate.

The pressure was raised very slowly to 1750 lb., at which the pump broke down and the test was stopped for the time being. The pipe nipple in the center of the head was removed and placed in the shell about 4 in. from the head seam, because the bulging of the head had opened the thread in the sheet away from that on the nipple. It was tapped into the shell, and a heavy boss electrically welded around it. There was no further trouble with it. Nor was there any leak at the other nipple, which was threaded in flange of the head and gas-welded inside before the head was welded to the shell.

A further test was made with a new pump, the pressure being raised to 2150 lb., without any leaks. The tank was continually stretching (Fig. 11) and at this pressure a small crack appeared in the longitudinal seam 18 in. from one end, and a very small pinhole in the head seam 12 in. from longitudinal seam. On account of these leaks the pressure dropped to 2100 lb., and the test was stopped. 2150 lb. corresponds to a fiber stress of about 49,500 lb. very close to the ultimate strength. The tram measurements are all given in Fig. 14. The remaining two tanks, numbered 5 and 6, were made of two pieces of Armco iron requiring two longitudinal seams.

The pressure was carried up to 800 lb. and the sledge test applied with no sign of failure. At 500 lb. Luders' lines appeared on the heads, and on account of their long radius, they bulged rapidly, and it was difficult to detect the yield point of the shell. It was probably at about 1100 lb. There was an increase of 1/2 in. in circumference at the center at 1250 lb.

At 1750 lb. a small crack, due to a lap on the inside of the seam, appeared, and the pressure was released, the defective part cut out and welded up.

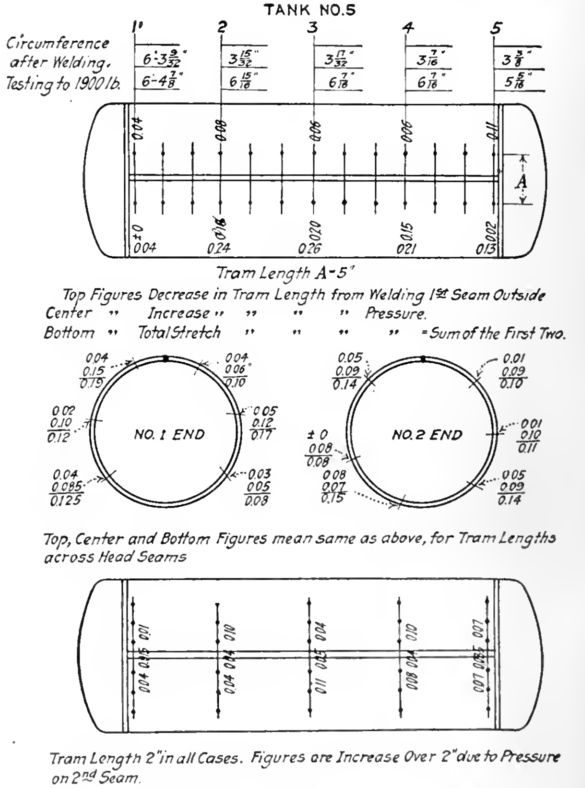


Fig. 15 Tram Measurements of Armco Tank No. 5

The pressure was increased to 1900 lb., when the weld in the center of the head, where the pipe-nipple hole had been welded up, gave way in a small crack. This, and the fact that the tank was stretching, made it impossible to continue the test. The fiber stress at 1900 lb. is about 43,800 lb., and as the tensile strength of Armco iron is about 44,000 lb., it is probable that the tank would eventually have given way at about this pressure. Figs. 12 and 13 show the results of the test.

It should be noticed that during the welding of these tanks almost everything was done that should not have been. The plates were badly rolled, they were out of line and flat, and fitted up badly. The "V's" were made with a cutting torch, and the welding was done with little regard to method and system. There was no preheating of the seams when the second side was welded, nor were the seams annealed or the shells rerolled to bring them more nearly to a truly circular shape. Also the heads did not fit the shells, as the latter were not circular. All of these were bad practices for a vessel designed for high-pressure work.

There were, however, four precautions taken. The plate was of low tensile strength, the wire of high tensile strength, the weld double "V," and the welding well done. So that in spite of the bad practices, the results are, in my judgment, very satisfactory, and resulted in safe pressure vessels. You may fairly ask if I would allow such bad practices in regular work, and I would reply without hesitation that I would not subscribe to any such conditions at all, because it is cheaper in a properly equipped shop to do the work right than to do it as these tanks were done. This is aside from any question of safety, or of good work, which are always paramount. How many of the precautions noted above should be taken in any case, depends on the conditions under which the tanks would be used, and so cannot be generally specified. It seems clear that the proposed method of using low-tensile-strength plate, high-strength welding wire, both of proper quality, with other precautions as may be needed, will result in uniformly safe work.

Using Exhaust Energy in Reciprocating Engines

BY J. STUMPF,[1] CHARLOTTENBURG, GERMANY, AND C. C. TRUMP,[2] SYRACUSE, N. Y.

There are a surprising number of cases where oil, gas or steam engines will show better economy than purchased power and electric motors, and this may be emphasized where the exhaust from steam engines is valuable for heating or process work. Up to now, reciprocating engines have suffered from losses due to incomplete expansion. There has been a compromise between such losses and mechanical ones connected with the use of very large cylinders. Oil engines, multiple-expansion and uniflow steam engines are coming to use high ratios of expansion, and these are doing much to reduce exhaust losses. Many advantages may be gained, however, if the energy remaining in the exhaust at release can be converted into kinetic energy, and from that into partial vacuum in the cylinder.

The theoretical problems are presented in this paper for discussion, and practical applications to either single-cylinder or multi-cylinder engines are suggested and illustrated.

WITH the rising prices for fuels in this country, anything which may result in fuel economy through turning more heat into useful work should be of interest.

The use of kinetic energy in long exhaust pipes has often been attempted in a practical way to the writers' knowledge in gas, gasoline and oil engines, especially of the two-stroke-cycle type, to improve the scavenging effect and increase the power output. Successful results were usually obtained more from a method of trial and error than from any attempt at design, or the use of nozzles, diffusers, etc., which might avoid losses and improve the effect.

Similar long pipes have been used on the suction side of air compressors, and on the discharge of pumps, to improve the volumetric efficiency. Whether conscious attempts have been made to produce such effects in ordinary steam engines, which usually have exhaust-valve passages too tortuous to avoid serious losses, will no doubt be brought out in discussion. It is probable that the studied application of suitable exhaust pipes with properly designed nozzles for gas and steam engines, especially those with piston-controlled exhaust ports, is new, for a United States patent has just been allowed on it.

In Fig. 1 is shown a conventional indicator card from a steam engine, with the loss due to incomplete expansion represented by the shaded area *D*. It will be noted that this area is large as compared with the small part of it due to opening the exhaust ports, or valves, considerably in advance of the end of the stroke. If the energy represented by *D*, plus that due to expansion to a lower final pressure such as the area *E*, can be converted into partial vacuum, it will obviously be transferred, or at least all of it but the losses, to the compression side of the card as useful work, represented by the area *F*. This would have the effect, evidently, of reducing the back pressure in the cylinder of the engine, and therefore the final compression pressure by a greater amount the more energy there is available at release.

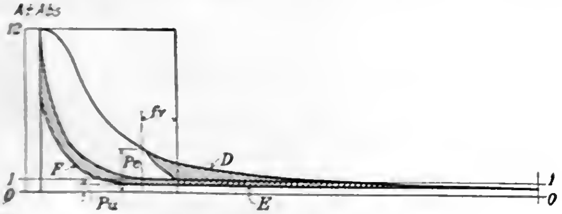


FIG. 1 CONVENTIONAL STEAM-ENGINE INDICATOR CARD SHOWING EXHAUST ENERGY

The several diagrams in Fig. 2 show how the loss due to incomplete expansion would increase with longer cut-off and higher release pressures. They also indicate how these losses may be turned into gains in useful work by reduction of back pressure and compression. The cards are all drawn for exhaust to atmospheric pressure and the pressure scale is in atmospheres. They indicate that any method of transferring energy into partial vacuum must be able to take care of variable loads. They do not indicate any relations between the time of exhaust opening and the velocities used in the exhaust pipes. These would have to be shown in a different kind of diagram, based on energy rather than pressures. The problem is somewhat similar to those met in ballistics, or in the design of Humphrey gas-pumping engines, in which kinetic energies of solid and elastic bodies have to be figured with respect to time and distance. The number of variables is so many, that graphic rather than numerical methods of computation are to be recommended.

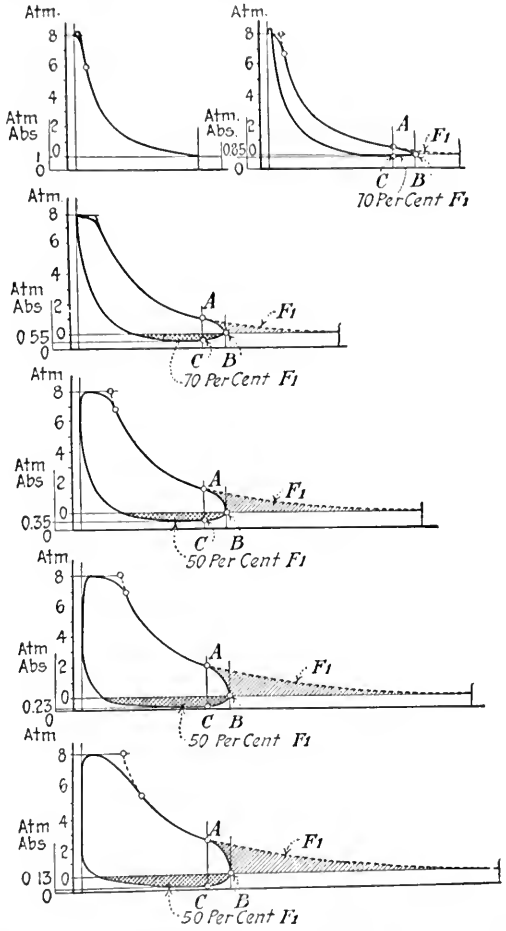


FIG. 2 CUT-OFF AND RELEASE PRESSURE EFFECTS ON INCOMPLETE EXPANSION LOSS

LONG EXHAUST PIPE IN PRACTICE

In order to give an idea of the practical application of a long exhaust pipe, for the above purpose, a uniflow steam cylinder with a number of exhaust nozzles and a long pipe is shown in Fig. 3. The nozzle in the cylinder is difficult to design for best efficiency because it is opened relatively slowly by the piston near the end of its stroke. The other end of the pipe should have some kind

---

[1] Privy Councilor and Professor Technische Hochschule.

[2] Vice-Pres., Humphrey Gas Pump Co. and Stumpf Una-flow Engine Co.

Presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

of diffuser for reducing velocity energy to pressure energy, and this is also not easy to design. The action of the pipe itself would seem to depend upon the following several variable factors:

a The speed of the engine and number of exhaust puffs per minute.
b The variation of pressure at and after release at the cylinder.
c The variation of pressure at the other end of the pipe.
d The area of the nozzles and exhaust pipe.
e The length of the pipe.

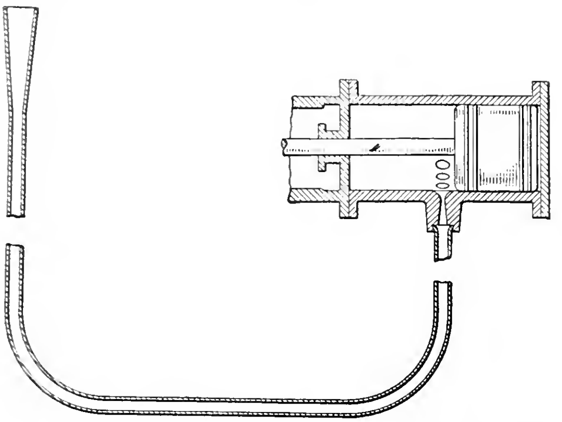


Fig. 3 Exhaust Nozzle and Long Pipe of Uniflow Steam Cylinder

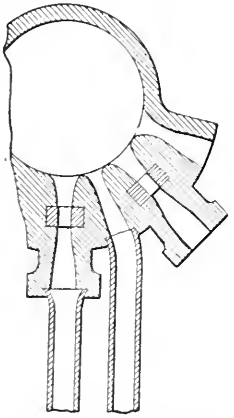


Fig. 4 Extra Nozzles and Exhaust Pipes for Regulation under Load Variation

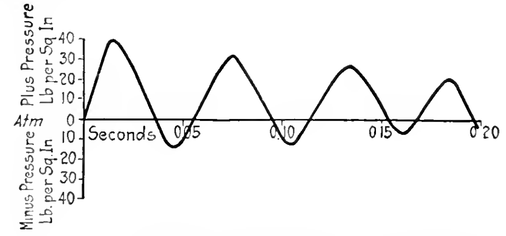


Fig. 5 Probable Vibration of Medium in Exhaust Pipe of Single-Cylinder Engine

f The duration of the exhaust period till closing of ports.
g The compression and expansion of the steam or gas itself.
h Heating due to friction.
i Cooling due to outside temperature conditions.

It may have been the experience of many, as it has been of the writers, that a pipe of this kind, subject to sudden puffs, will cause the steam or gas in it to pulsate. It is sometimes evident in cards taken with sensitive indicator springs. Its length and volume relations may be likened to those of an organ pipe. The difference may be pointed out that the pressure changes and velocities may be higher in this case, and vibrations much slower and longer are desirable than would be the case in the production of sound waves, which are to be avoided with exhaust pipes. It is evident, however, that the slower the speed of the engine the longer must be the pipe.

Provisions for Load Variation

For engines running at moderate and nearly constant speed, the pipe length may be fixed and the area designed to give the best suction effect at the most desirable load. Variation of load can be provided for, as shown in Fig. 4, with extra nozzles and exhaust pipes which may be thrown in or out of action by the engine-governing system. Another method would be to provide an exhaust pipe in the form of a coil, with valves which would change connection between cylinder nozzles and diffuser so as to vary the length of the pipe. This might be necessary with variable speed engines.

With single-cylinder engines the length of exhaust pipe necessary to produce the maximum suction effect may be too great for practical uses. As with a musical instrument, however, each vibration of the medium in the pipe may have its harmonic; or at least will be followed by other pulsations of reduced amplitude. If the second or third pulsation is caught at its lowest pressure as the exhaust ports close instead of the first, the pipe will have to be only one half or one third as long, respectively. The effect of friction losses and cooling may change the exact length, but the result may be in favor of the shorter pipe. Fig. 5 illustrates the kind of a vibration which may be expected.

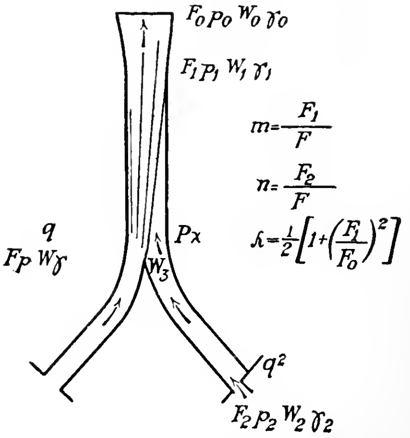


Fig. 6 Twin-Nozzle Design for High-Speed Multiple-Cylinder Engine

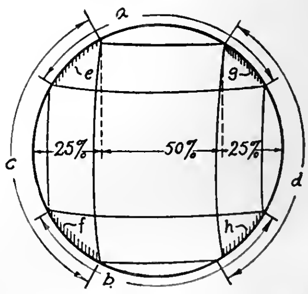


Fig. 7 Overlapping of Exhausts for Two-Cylinder Double-Acting Engine

Calculations for the proper length of exhaust pipes involve so many variables that it is probably easier to choose a reasonable size of pipe and arrange the cylinder with approximately the proper nozzles, then cut and try with different lengths of pipe and with a sensitive spring indicator on the engine until the best length is found. It may be interesting to suggest the use of graphical curves of pressure-volume, energy-volume, and energy-time as a means of arriving at the approximate design with which to start experiments.

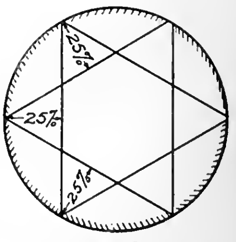


Fig. 8 Gain in Overlapping With Three-Cylinder Double-Acting Engine

Overlapping Exhausts

For multiple-cylinder engines, especially those which run at high speed, the periods of exhaust will overlap, and by proper design of nozzles one exhaust may be made to draw on the other. Such a twin-nozzle design is indicated in Fig. 6, which is that on which the work with a two-cylinder locomotive has been based. The overlapping of the exhausts for such a two-cylinder double-acting engine is shown in Fig. 7. The gain in overlapping with a three-cylinder, double-acting engine is shown in Fig. 8.

It is evident from these two diagrams that with four exhaust puffs per revolution, or less, it is necessary to take account of the

vibratory action of the exhaust pipe. Its length and volume and the cooling and friction loss must be fixed either by calculation or by experiment, or in combination. With six or more exhaust puffs per revolution the suction effect may be almost entirely produced by ejector nozzles, so paired as to coöperate and induce partial vacuum in each cylinder at the instant when the exhaust port is closed, at the beginning of compression. Even in this case it may be necessary to proportion the exhaust pipes, in length and volume, so that adverse vibrations may not be set up to spoil the vacuum.

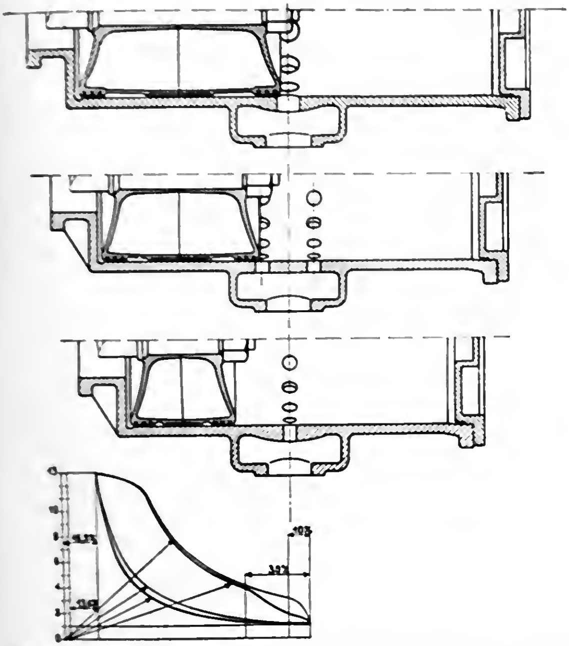


Fig. 9 Area Modification and Location Rearrangement to Shorten Piston and Cylinder of Double-Acting Engine

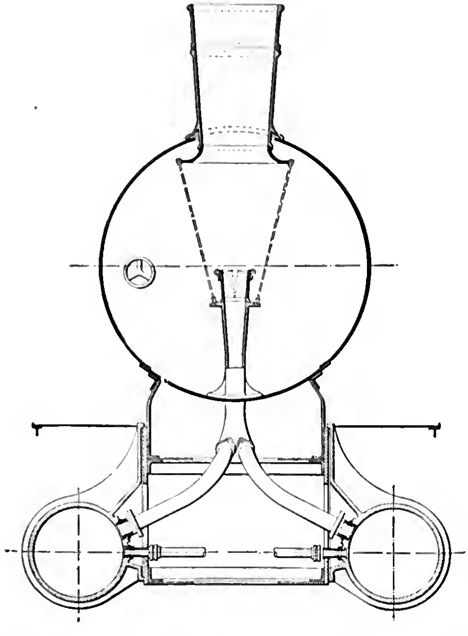


Fig. 10 Number of Exhaust Ports Reduced and Large-Diameter Exhaust Belt Dispensed With in Non-Condensing Engine

Single-acting engines of four cylinders and less will evidently require longer exhaust pipes than those of six cylinders and more. The higher speeds at which these engines are usually run will tend to reduce the necessary pipe length. All the benefits of the exhaust-ejector action accrue to single-acting engines, except that when the pistons control the exhaust ports they cannot be made shorter, as will be explained later, with respect to this advantage, in double-acting uniflow engines.

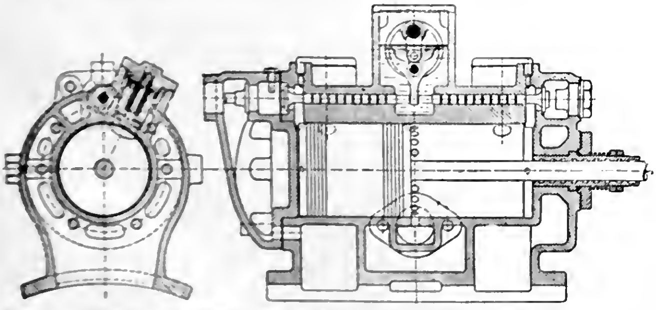


Fig. 11 Original Cylinder Design With Long Piston, Numerous Exhaust Ports, Large Exhaust Belt and Necessary Compression-Relief Valves

Ordinary counterflow steam engines with exhaust valves, or with a single valve for admission and exhaust, not only would be difficult to arrange with suitable nozzles to avoid eddy losses, but the exhaust period is usually made too long to be covered by the larger pulsations of the long pipe, or the ejector effect of other nozzles. A cylinder with exhaust ports, like a two-stroke-cycle gas engine or a uniflow steam engine, can be provided with almost unlimited exhaust port area and the exhaust period can be controlled—to be long for high speeds, or short for low speeds. The four diagrams in Fig. 9 show how the exhaust ports may be modified as to area, and rearranged as to location, so that, with a double-acting engine, both the piston and cylinder become shorter. For non-condensing work, such as in locomotives, automotive vehicles, and a large proportion of our stationary engines, the number of ports may be reduced to one, two or three, and the exhaust belt of large diameter dispensed with as shown in Fig. 10. The smaller nozzles in this illustration are provided for bleeding steam, after it has done useful work, for heating cars, or feedwater. Such nozzles may also be used for supplying steam for process work, or for heating, with a small part of the exhaust from stationary engines. The long exhaust pipe and ejector action may also be used to reduce the clearance volume required to control compression, or to dispense with exhaust valves, when it is desired to operate the engine with exhaust against back pressure higher than atmospheric, and use all the steam for heating or process work.

Comparison of Cylinder Designs

The practical advantages of reducing the exhaust orifices to two long slots are well illustrated by comparison between Figs. 11 and 12. Fig. 11 shows the original design of cylinder for a portable engine and boiler for farm or well-driller use. The long piston, large number of exhaust ports, large exhaust belt, and the necessity for compression-relief valves, are evident. In Fig. 12, however, the piston and cylinder have been shortened considerably, the piston over 25 per cent, and the cylinder nearly 20 per cent. The exhaust ports and belt have been reduced to two nozzles, and the cylinder support has been simplified and moved to one end only. Compression-relief valves have been dispensed with, except for small drain cocks for starting a cold engine. The long exhaust pipes are shown leading to the smokepipe, in Fig. 13. Experience with the locomotive has shown a more uniform draft is induced than was the case with the sudden puffs of the ordinary exhaust-pipe arrangement. The pipe which is shown leading out of the diffuser in the smokestack is evidently provided to take off steam for heating feedwater.

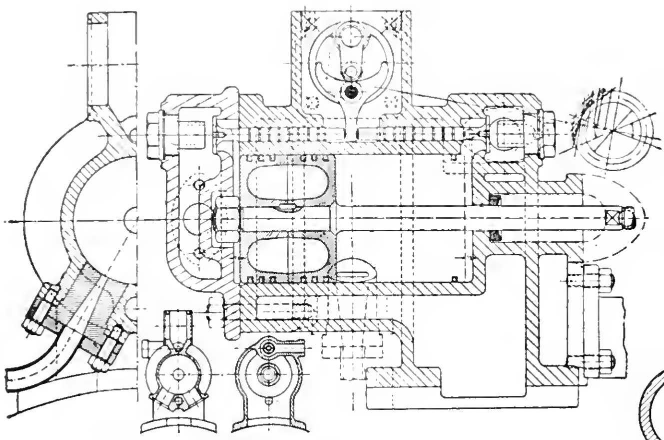


Fig. 12 New Design With Shorter Piston and Cylinder, Two Nozzles and No Compression Valves

Nozzle Arrangement

In multi-cylinder engines several different arrangements of exhaust pipes and nozzles suggest themselves. Perhaps the simplest is that often seen in gasoline-automobile-engine exhaust pipes, which may be called a series arrangement as shown in Fig. 14. This may have the disadvantage that the cylinders farthest apart should benefit by overlapping periods of exhaust, whereas the several nozzles between the end cylinders are likely to interfere with friction losses. Bringing a loop of exhaust pipe back behind the first nozzle, as shown dotted in the diagram, might improve this arrangement, if proper length is used.

Another disposition of nozzles is shown in Fig. 15. This may be called an arrangement in pairs, or in parallel. The pairs of cylinders which have the longest overlapping of exhaust, because of their crank-throw relations, should be connected to the same exhaust nozzles. The common discharge from these paired nozzles should then be connected in other pairs, finally to discharge through a common exhaust pipe and diffuser.

If it is desired to take off exhaust steam at a pressure above that of the atmosphere, the exhaust-pipe diffuser must be made part of a large receiver tank, from which a small pipe or pipes may lead steam to the heating system at nearly constant pressure. The volume of such a receiver must be large, or the changes of pressure in it will have too great a damping effect on the exhaust-pipe pulsations. It makes design by calculation still more difficult.

The practical application of long exhaust pipes, receivers, nozzles, etc., is by no means so difficult as their proper design. Experience with Humphrey pumping engines of all types and sizes has shown that the inertia effect of long pipes may be a decided detriment to efficiency in some cases, but may be turned to decided advantage if properly utilized and controlled. One of the writers has seen the capacity of these internal-combustion engines improved 50 per cent by simply changing the length of exhaust pipe. Fortunately the graphical methods of design developed for Humphrey pumping engines may be easily adapted to new uses. Ways must be found to take account of more variable factors (nine or ten in this case); but that is easier by graphical than by any other method. It may, however, take some time and experimental work to determine the practical coefficients.

Long exhaust pipes and proper nozzles, however, do provide a means of controlling compression, which in a uniflow engine serves to improve thermal conditions, as well as mechanical cushioning, for which it is mostly used in ordinary steam engines. They avoid large clearances in non-condensing engines, or the alternative of mechanically operated exhaust valves, which the condensing uniflow engine has already dispensed with. The writers of this paper will welcome a broad discussion of the subject.

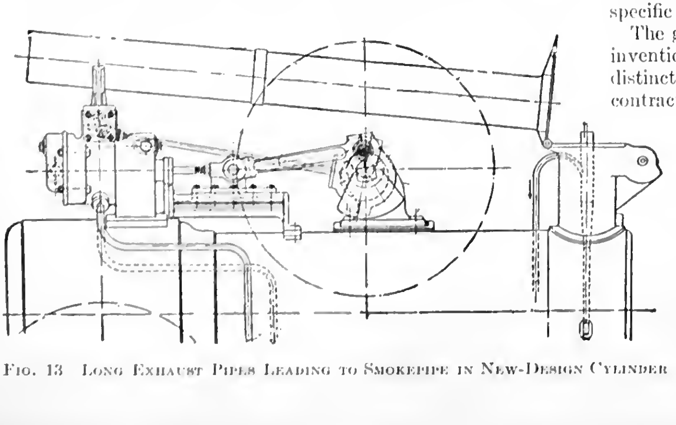


Fig. 13 Long Exhaust Pipes Leading to Smokepipe in New-Design Cylinder

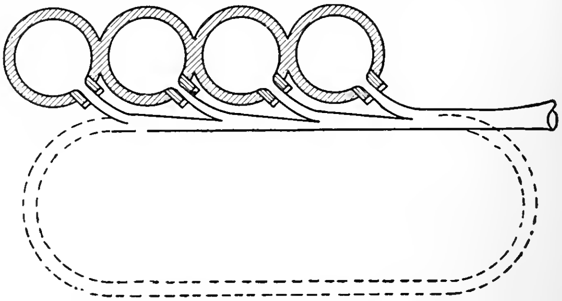


Fig. 14 Series Arrangement of Exhaust Pipes and Nozzles in Multi-Cylinder Engine

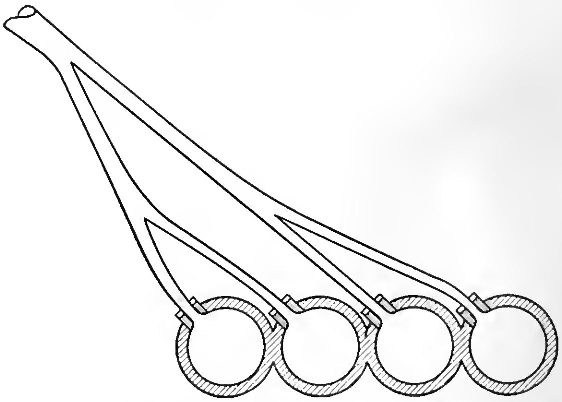


Fig. 15 Pair or Parallel Arrangement of Nozzles in Multi-Cylinder Engine

In a letter to the *Iron Age* (May 11, 1922, p. 1299), G. H. Benjamin cites several decisions of the Federal Courts to the effect that an employer has no right to a patent for an invention made by an employee in the absence of an express contract or agreement for the specific employment to make an invention.

The general principle employed is that if an employer made an invention after he entered the service and the invention was not distinctly specified and included within the terms of contract, the contract does not extend to such invention.

The rule followed by many corporations in making contracts with employees is to specify so much for their services in the line of their specialty and so much for any inventions that they make during the time of their employment. If such special compensation was not specified the employer has no right to the invention of the employee.

Unless the invention has been distinctly specified in the contract of employment it is accepted that the contract does not extend to the invention, as the invention was not "in being" or contemplated at the time the contract was signed and therefore was not within the terms of the contract or covered by the compensation.

Burning Bituminous Coal on Stokers

Importance of Keeping a Bituminous-Coal Fire Agitated—Coal Analyses and the Danger of a Low-Fusing Ash—Typical Stoker Installations and the Best Methods of Operating Them

AT THE Joint Fuel Conference held by the New Haven Branch of the Connecticut Section of the A.S.M.E., the New Haven Chamber of Commerce, and local sections of other engineering societies on November 14, 1921, of the five papers presented three bore on stoker operation with soft coal, namely: two entitled Burning Bituminous Coal on Taylor Stokers, by G. E. Wood, of the Connecticut Company, New Haven, and O. J. Richmond, of the United Illuminating Company, Bridgeport, Conn.; and Burning Bituminous Coal on Type E Stokers, by R. A. Sanders, of the Seamless Rubber Company, New Haven.

Among other things these papers point out those items of a coal analysis that, if not held within proper limits, will cause trouble. When operating at above 150 per cent of rated capacity it is most important that the coal should have a "high-fusing" ash; that is, the ash should not melt under 2400 deg. fahr. Where this precaution has not been observed the operation of the stoker has been seriously interfered with. Valuable hints on obtaining the best results from these two types of stokers are also included.

BURNING BITUMINOUS COAL ON TAYLOR STOKERS

By G. E. WOOD,[1] NEW HAVEN, CONN.

THE Taylor stoker is representative of the underfeed type which introduces the fuel into the furnace from beneath the fuel bed. The fuel is forced in by the action of rams and in this manner the whole fuel bed is kept agitated. As we all know, this is of vital importance to the successful combustion of bituminous coal, for in the initial stages of combustion this coal tends to soften, coke and run together. If it is left in a quiescent state it will solidify into a homogeneous mass that is highly resistant to the passage of air at ordinary pressures. It is due, therefore, to this agitating action that the underfeed stoker has been successful.

In operating a Taylor stoker it is fundamentally important to maintain a uniform speed so as to free the grates of the ash as it is formed. This condition willl insure clean fires. If the ash is allowed to accumulate, it is forced up into the fire, the inevitable result being clinker formation. In addition to uniform speed, care should be exercised in operating the lower rams and the extension grates. The long stroke should be used on the former to prevent the fire from piling too high and falling over on to the dump plates—the latter just before dumping to break up clinker, and after dumping to cover the grates and prevent air leakage. The thickness of fire depends on the load, but the contour should be maintained standard at all loads, i.e., high on the upper portion of the grates and sloping gradually off to the dump plates.

Under normal conditions it has been found that good results are obtained by leaving the air damper to the extension grates open at all times. The speed of the stoker and the plenum in the wind box best suited for various ratings are approximately as follows:

Rating, per cent	Stoker speed, time per rev.	Wind-box pressure, in. of water
100	3 min. 54 sec.	1.0
150	2 min. 38 sec.	2.25
200	2 min. 5 sec.	2.90
250	1 min. 35 sec.	3.80

These figures do not hold in all cases and should be checked by flue-gas analyses. They are of value, however, in that they give a close approximation of what the conditions should be.

The difference in the performance of coal of different analyses at an average rating of 150 per cent may be seen from Table 1 in the next column.

In the case of Sample A the speed of the stoker and the air pressure agree closely with the figures previously given, the speed being somewhat higher and the air pressure a trifle lower. No trouble was experienced from moderate clinker formations because they were small. Under 250 per cent of rating the results were equally satisfactory.

With Sample B, during the test considerable trouble was encountered from large clinkers forming on the tuyeres and freezing on the side walls, extension grates and bridge wall. This condition accounts for the long time required to dump. Holes in the fire were numerous on account of the clinker pulling the coke down. These holes were filled as best they could be by using the long stroke for the lower part of the grate and a hoe for the upper sections.

At 250 per cent of rating, clinkers formed so rapidly that they could not be kept moving. The shear pins let go and the stoker was put out of commission after $1^1/_2$ hours' run. At the end of the first hour it was necessary to dump and it required the combined efforts of 3 men for 45 minutes to accomplish this process. The coal was practically useless under forced firing.

TABLE 1 PERFORMANCE OF TWO DIFFERENT COALS AT AN AVERAGE RATING OF 150 PER CENT

	Sample A	Sample B
Moisture, per cent	4.8	3.4
Volatile matter, per cent	22.1	32.6
Fixed carbon, per cent	66.6	53.8
Ash, per cent	6.5	10.2
B.t.u. per lb. as fired	13,774.0	13,103.0
Sulphur, per cent	under 1	2.25
Rate of combustion, lb. per hr. per sq. ft. of grate	33.0	34.0
Refuse, per cent	9.5	16.3
Combustible in refuse, per cent	30.0	38.0
CO_1, first pass	12.9	13.8
CO_2, flue	11.8	12.8
Average speed of stoker, time per rev.	2 min. 13 sec.	2 min. 36 sec.
Average pressure in wind box, in. water	2.46	2.20
Time between dumps	3 hr.	2 hr.
Time required to dump	2 min.	20 min.
Combined efficiency, per cent	75.8	74.8

From the two examples cited the vastly different results obtained with coals varying but 4 per cent in ash, 10 per cent in volatile matter and $1^3/_4$ per cent in sulphur are evident. The ratio of refuse to coal fired increased, and the percentage of combustible in the refuse increased on account of the clinker formation. Nothing could be done to prevent this formation of clinker, but the "freezing" to the side and bridge walls can be alleviated. To accomplish this, many operators have employed the form of furnace construction which allows the air from the wind box to circulate through the setting walls so as to maintain a flow of air between the walls and the fire. Others use a steam jet instead of air, and in some instances both are used. Either method is effective and greatly facilitates the burning of badly clinkering coals.

Not only does the proportion of ash have a direct bearing on economy, but the temperature at which the ash fuses is an important factor. Tests have been made that show that the efficiency follows the ash-fusing temperature. From these tests it has been concluded that all ash fusing below 2400 deg. fahr. should be classed as low-fusing, and all above as high-fusing.

While it is possible to burn a coal with low-fusing ash under normal loads, it is difficult if not impossible to do so under heavy overloads. The ash invariably melts and runs into the air spaces in the tuyeres, shutting off the air supply. It also bends a crank or breaks a bearing bracket if the shear pin fails to shear. The only solution is to burn the fire down, take the boiler out of service, and send a man into the furnace to break the clinker out.

From these observations the following conclusions may be deduced:

a A good grade of coal with low ash, volatile and sulphur content can be burned efficiently with no trouble and moderate loss of combustible in the refuse;

b As the ash, sulphur and volatile content increase, trouble occurs and the avoidable loss of combustile in the refuse increases.

---

[1] Supervisor of Power Plants, The Connecticut Company, New Haven, Conn. Mem. Am.Soc.M.E.

BURNING BITUMINOUS COAL ON TAYLOR STOKERS

By O. J. RICHMOND,[1] BRIDGEPORT, CONN.

THE Taylor stoker utilizes the gas-producer principle. Green coal is fed by the rams to the lower strata of the fuel bed and is gradually pushed up toward the upper layer and coked, at this time giving off most of its volatile elements which have to pass through the incandescent zone. The coal works upward still farther and it becomes incandescent by the time it reaches the top layer. The grates are sloping, and as the coal gradually burns to ash, it works downward toward the refuse dump where it is discharged by the dumping process to the ashpit. These stokers are very flexible and well adapted to sudden overloads, since in a very few minutes they can run a fire from a banked to an overload condition. They employ forced draft at normal rating, from $1^1/_2$ to 2 in. of air pressure being used when 30 to 40 lb. of coal are burned per hour per sq. ft. of grate; 3 in. to 4 in. is used for higher ratings, and it is possible to burn 60 to 80 lb. per sq. ft. per hour for short peaks.

The plant whose operation the author has been asked to discuss consists of 18 B. & W. boilers each rated at 600 hp. by the builders. They have 294 4-in. tubes 18 ft. long and 6000 sq. ft. of heating surface. The pressure carried is 200 lb. gage. The stokers are of the Taylor type, 7 retorts wide, $8^1/_2$ ft. deep, and hand-dumped. The grate area is 95 sq. ft. Distance from stoker to lower row of tubes is 7 ft.

Draft is supplied by nine American Blower Co. fans of the high-speed type, all driven by Terry turbines. These blowers discharge into a common main air duct for all boilers. The air is carried from this main duct by small steel ducts to the stoker forced-draft damper. Regulation of blower is by steam pressure acting through an individual Mason regulator for each fan set.

The coal used is R.O.M. bituminous, a typical analysis of it being: moisture, 1.58 per cent; volatile, 21.40 per cent; fixed carbon, 71.37 per cent; ash, 5.65 per cent; B.t.u., 14,464 per lb. dry; sulphur, 1.06 per cent.

Coal is run from the bunker by gravity to the electrically driven weigh lorry cars. After being weighed it is fed directly through the lorry car chute to the stoker hopper.

The boilers are run from 125 per cent to 150 per cent of rating. This policy was determined by running different numbers of boilers for given loads on the station. It was found by trial that when the boilers were run above 140 to 150 per cent the efficiency dropped off. The apparatus which automatically speeds up the stoker with any increase of air pressure, and thereby tends to keep the proportion of air and coal constant, does not work satisfactorily. While it is admitted that for any given set of conditions, kind of fuel, construction of furnace and method of stoking, a definite volume of air will consume a definite weight of fuel, in practice this does not hold because the fuel varies. In the new Steel Point Station the regulation has been modified by the addition of the Keelhaltz regulator, manufactured by the A. E. Co., and every assurance has been given that this device will regulate satisfactorily even with variation of fuel.

Standard practice is to maintain as nearly constant an air pressure as possible for a given load. From 2 in. to $2^1/_2$ in. is used under fires and from 0.1 to 0.2 in. suction or negative draft over them. This suction over fires is kept at that point by the so-called balanced-draft regulators. These have been found to work very nicely with a minimum of upkeep, and help materially in keeping stack losses down. Fires are maintained from 20 in. to 30 in. thick, depending on the coal. For all ordinary coals 26 in. to 30 in. of fire and $2^1/_2$ in. air blast are used. With inferior grades it has been found that the Taylor stoker handles large clinkers readily, and they work down to the dump with little trouble. The clinker that makes trouble is the thin, soft, pasty variety that with some coals runs at times like hot tar on to grates and tuyeres, and even into tuyere air inlets, getting a firm grip and shutting off the air supply in such a way as to result in burned tuyeres. The only way to handle such coal is to run thinner fires and more air in proportion to coal burned, naturally at the expense of efficiency, but keeping the plant running.

Fires are banked by shutting off the air supply and pumping coal enough in to keep the fire away from the grates. Stokers with banked fires are turned over a few times every 2 to 4 hours to prevent so-called "freezing." This occurs when the coal cokes so hard in the bank that it is difficult for the stoker rams to break it up. Every other night boilers are cleaned of what clinkers are adhering to the side walls which are steel mixture blocks.

BURNING BITUMINOUS COAL ON TYPE E STOKERS

By R. A. SANDERS,[1] NEW HAVEN, CONN.

AT THE Seamless Rubber Company, steam is produced for heating and curing in the production of rubber goods and for operating boiler auxiliaries. Power to drive the machinery is purchased from the United Illuminating Co.

The boiler plant consists of four Babcock & Wilcox water-tube boilers of 393 rated hp. each, equipped with Foster superheaters each with a guaranteed performance of heating 19,788 lb. of steam from 150 lb. gage pressure and 1 per cent of water to 466 deg. fahr. or 100 deg. superheat. Feedwater is heated in a Cochrane open feedwater heater, equipped with a V-notch recording, indicating and integrating meter and forced into the boilers by two three-stage turbine-driven pumps. The output of the boilers is measured by G. E. indicating steam-flow meters on each boiler and an integrating meter on the main steam line to the factory. Flue-gas temperature is measured by a Brown recording thermometer on each boiler showing the temperature at the damper. Another Brown meter is used to record the temperature of the feedwater as it leaves the pumps.

Two No. $6^1/_2$ Buffalo conoidal fans, each capable of delivering 40,000 cu. ft. of air per min. against 6 in. water static pressure, furnish the forced draft necessary to operate the boilers. With maximum delivery the speed is 1260 r.p.m. Under the usual operating conditions, the pressure under the fire being 3 in., the speed is about 1030 r.p.m., the horse power $24^1/_2$, and one fan serves two boilers at 100 per cent rating.

Each boiler is equipped with a type E single-retort stoker made by the Combustion Engineering Co. These stokers are guaranteed to hold the steam pressure within 5 lb. of the specified pressure when the boilers are operated up to 200 per cent of normal rating and to give a combined boiler and furnace efficiency of 75 per cent when the boilers are operated between 100 per cent and 200 per cent of normal rating, the draft in the furnace not to exceed 0.15 in. at 200 per cent rating and to operate under conditions specified and at the same time conform to the smoke laws or regulations of the city of New Haven.

Bituminous run of mine coal is received in hopper-bottom cars and dumped directly into a truck hopper, passing then to a crusher, the capacity of which is 20 tons per hour, which reduces it from a maximum of 10-in. cubes to 2-in., the average being 1-in. A 15-hp. squirrel cage motor provided with remote control operates the coal crusher.

It is then carried by a bucket conveyor, driven by a $7^1/_2$-hp. induction motor, also remote-controlled, into the overhead bin in the power house. This bin holds about 120 tons and is provided with a belt conveyor which distributes the coal the length of the bin as required.

Four automatic recording coal scales are provided, which weigh the coal as it is fed into the spouts feeding the stoker hoppers. The motors driving the feeding mechanism of the scales are controlled from the boiler-room floor.

Motors driving the crushing, elevating, and distributing machinery are controlled from several points, as a precaution against injury to the installation.

Actual daily evaporation from feedwater which averages 210 deg. to 130 lb. gage, averages about 10.8 lb. of water per lb. of coal burned. No figures are available as to the amount of superheat in the steam, but it is estimated that it is about 50 deg.

(Continued on page 381)

---

[1] Chief Engineer, The United Illuminating Company, Bridgeport, Conn. Mem. Am.Soc.M.E.

[1] The Seamless Rubber Company, New Haven, Conn.

Weaving Machinery

Weaving Styles and Kinds of Fabrics Produced—Details of Methods Employed—Functions of Special Machine Devices—Different Types of Looms

BY L. B. JENCKES,[1] WORCESTER, MASS.

THE process of weaving consists of interlacing two or more series of fibrous materials or threads at right angles or nearly so, so that they will form a fabric. The threads running lengthwise of the cloth are called the warp or "woof," and those running crosswise of the goods are called the weft or filling.

Weaving does not include all fabrics and must be distinguished from those which are felted or plaited, and from netted lace fabric and knitted goods.

A felted fabric is made by bringing masses of loose fibers such as wool or hair together under the influence of heat, pressure, moisture and friction, under which conditions they become firmly interlaced in every direction and form a hard and serviceable fabric.

Plaited fabrics are composed of one set of threads interlaced, but not at right angles. A flat shoelace is an example of plaited fabric.

In netted goods the threads are held in place by knots where they cross each other.

Knitted fabrics are composed of one or more threads held together by loops, making a very elastic fabric, similar to the common Jersey cloth.

Laces are made by passing one set of threads around small groups of threads of a second set instead of passing them from side to side.

With these fabrics we have nothing to do as we are to consider only weaving.

MODERN PROCESS OF WEAVING

The process of weaving in a very general way is this. The warps are wound in a parallel manner on a roll or beam at the back of the loom, the roll being carried in gudgeons and held by friction from allowing the warp to run off too easily. The warp usually passes over two rods called "lease rods" and then through an eye in the center of a wire or cord called a "heddle." The heddles are attached at the top and bottom to a number of harness frames or "healds," being attached to different frames according to the pattern to be woven. Thus the threads can be separated into two planes or sheds forming an opening between, which allows a shuttle carrying the filling or weft to be passed between them. After the weft is passed a batten or lay carrying a reed is drawn forward, forcing or beating up a strand of filling against the next preceding one. The warp threads are then changed, those in the upper plane passing to the lower one and others taking their place in the upper shed. This forms one cycle and places one thread of filling or one pick in the cloth. The point at which the cloth is formed is called the fell. The edges where the filling returns and repasses into the cloth is called the selvage. After the cloth is formed it is drawn forward and wound onto a roll by the take-up.

ANCIENT ART

The art of weaving is a very ancient one. Very soon after the first inhabitants appeared on the earth they tired of using skins alone, and by interlacing fibrous material, grasses, strips of skin, etc., began to form woven fabrics. The spinning or twisting of fibers into threads was soon discovered and gave great impetus to the art of weaving. Colored threads and material of various lusters and characters were used; soft warm material for the cold climates, and lighter for warm ones, until now every kind of material that is known is woven into a fabric—wool, hair, flax, paper, grasses, metal and almost everything else. Woven fabrics are very largely used, not only for clothing but for manufacturing equipment such as belts, packings, conveying belts, filter cloths, and other products.

The ancient tribes of the East probably contrived the first loom very early in the history of the world. They hung a beam or stick in a tree or from some overhead support and from it suspended the series of warp threads. These warp threads were hung to another beam or log at the lower end. These warp threads were separated into two planes by means of a flat swordlike implement, the sword being given a quarter turn to separate the warps so that a shuttle carrying the weft could be passed. The implement was then drawn downward sharply, beating the line of filling against the preceding one, and the cloth was formed. The sword was then withdrawn and reinserted, separating the warp into different sets of threads, and the process was repeated. Probably in the first weaving, reeds and grass were largely used for the filling. This process was also used by the Egyptians and Greeks. The ancient tribes of India are believed to have laid the warp horizontally and fastened it to a beam, and used a crude heddle frame and heddles suspended from overhead, separating the warp into the two sheds, and also to have had a batten or lay swung from overhead to beat up the cloth. After passing the shuttle a few times back and forth the lay or batten was drawn forward and the cloth beaten into place.

The Chinese were the first to weave to any great extent. They are said to have cultivated silk long before the Christian era, and were weaving intricate designs such as dragons, flowers, fruits and other patterns which would be elaborate even today, and this was 200 B.C. While they were doing this the Egyptians and other races of the Near East were only just learning about silk—their experience in shuttle weaving having been limited to spun wool and flax—the ornamentation being almost entirely done by embroidering or darning. Far the greater part of the material woven was plain.

So far nothing has been said about the variation of color in the cloth. Cloth is colored in various ways. It may be dyed in the piece after it is woven, in which case it must all be practically the same color. The yarn may be dyed before it is woven, and woven in patterns, in which case the patterns are nearly all geometric in style. A pattern may be printed on the goods after they are woven, in which case it may be as elaborate as desired. The warp threads may be printed with a pattern before they are woven, that is, each thread may be of various colors throughout its length so that when woven the cloth will present a pattern.

STYLES OF WEAVING

Almost all the different styles of weaving or interlacing of threads may be divided into four classes: First, single cloth—that is, a cloth having one set of warp threads and one set of filling threads only; second, backed or compound cloth having more than one set of warp threads or more than one set of filling threads; third, pile fabric in which a part of the threads are caused to stand on end above the body of the cloth; and fourth, leno cloth where the warp threads are crossed or twisted.

KINDS OF FABRICS WOVEN

Of the single cloths the simplest is that in which the warp threads are divided into two sets only, one-half of the threads being passed through each of two sets of heddles, each set being carried on one heddle frame so that one-half of the warp is in the upper plane each time. Consequently the warp and filling pass over and under each other alternately. If the warp and filling are of equal size the cloth is perfectly plain and square, and it can hardly be told which is the warp and which is the filling. By varying the comparative size of the warp and filling a ribbed effect is produced. If the filling is the largest the ribs run across the goods, and if the warp is the largest the ribs run lengthwise of the goods. Very much of the greater part of all the cloth which is used is formed in this way. It makes muslin, sheeting, and all such common cloths. When colored and sized it makes cambric. When printed with pattern after being woven it forms calico. Gingham is made in

---

[1] Engineer, Compton & Knowles Loom Works. Mem. Am.Soc.M.E.

Abstract of paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

this way by using warp and filling of various colors. Canvas and duck are of this construction. Taffeta, pongee, and grosgrain silk are all of the same weave as well as the much-used crepe. In crepe the filling is of two kinds, causing the cloth to crinkle. Much of the cloth for men's and women's wear and other purposes is of this formation.

We now come to twill goods. In these the warp is divided into three or more sets and only one-third or one-quarter is brought into the upper shed or on to the face of the goods each pick. All these goods will show a diagonal rib or line on the face, the breadth of the line varying according to the order in which the harness is raised. With warp and filling of the same size the lines will make an angle of 45 deg. with the cloth. If the warp is larger than the filling the angle will be less, and if the filling is larger than the warp it will be greater. By varying the order in which the harness is raised the ribs can be broken and form broken lines, zigzags, diamonds or squares, making a variety of geometric patterns.

Another large class of goods is formed by the satins and sateens. The object in these goods is to present a smooth, patternless surface, and it is accomplished by using a great many very fine threads to form the face of the goods either in the warp or in the filling. For satin the warp is of the fine threads, and forms the face, while for sateen the filling is used for this purpose. In weaving satin from five to twelve harnesses are used, each filling thread appearing on the surface only once in five to twelve picks for about one pick only; the warp being so fine and so close together that the filling pick cannot be detected. In sateen the warp and filling are reversed. The combination of satin and sateen is greatly used in forming the pattern of table damask.

These weaves form almost all the plain cloth, and it is by using a combination of these that an endless variety of cloths is provided, stripes, checks, etc., of various kinds of weaves being combined in the same piece of goods.

It often becomes desirable, however, either for warmth or softness to add weight to a piece of goods without interfering with the pattern, and this is accomplished by using two sets of filling and one set of warp threads, or by using two sets of warp threads and one set of filling. The use of two sets of filling threads usually makes a soft piece of goods as the filling yarn is apt to be of soft character, but it is also the most expensive since it is slow to weave. The face of the goods is woven as before and the face yarn is always kept on the face of the goods, the backing yarn being under it and attached to it by passing just sufficient threads under each backing thread to hold it firmly in place. Sometimes the face and backing yarn are caused to exchange places, forming a pattern on the face, and the reverse of the pattern on the back. This is called reversible goods.

Two complete cloths may be woven and then stitched together by a separate set of threads called binder threads, or by a few threads of each set being woven into the other cloth. This makes a two-ply cloth, and in the case of belting and other cloths for use in manufacturing purposes as many as ten plies or ten separate cloths are woven one above another and stitched together. It is in this way the so-called "bullet-proof" cloth was made. The outside cloth or ply may be of fine material for appearance and the inside may be of a cheaper material for economy, or stronger material to give strength.

A pile fabric is one in which a portion of the yarn is caused to stand erect above the face of the goods. It is woven either single or double. In the double cloth—plush or velvet—two webs of the ground fabric are woven one above the other and a certain distance apart, and the pile warp is passed between the two, being held in each cloth, and later cut, forming two pieces of cloth with pile on the face only. Two shuttles are generally used, and both are thrown on each pick through the two separate sheds, one above the other. The cutting is done by a knife which passes back and forth between the two cloths while they are separated and drawn forward by two take-up rolls. In weaving the single-pile cloth the pile warp is raised above the rest of the warp on each pile pick, a wire is passed through the shed on this pick, and the pile warp is woven over it, the wire being afterward withdrawn. On the end of the wire is a knife which cuts the top of the loop as the wire is withdrawn, forming cut plush or velvet. If the knife is omitted and the end of the wire is pointed only an uncut plush is produced. By combining the cut and uncut plush and omitting the pile altogether, according to a pattern, very beautiful fabrics are produced all in one color. These are very much used for upholstery, both for furniture and for automobiles.

The greater part of all carpet weaves belong in the pile-fabric class: the Brussels carpet which when cut becomes Wilton; the cheaper tapestry and velvet carpet in which the warp is printed before it is woven; the Axminster in which each single tuft is set independently, and in which there is no expensive pile yarn concealed in the goods; and the elegant and costly chenille carpet in which the filling is composed of a narrow woven fabric having a deep fringe on each edge, which when woven into the carpet with the fringe erect forms the pile. The carpet is woven in any shape to fit any room, even circular, and in any width up to thirty feet. In the oriental rugs each tuft is set in separately and is knotted to the warp so that it cannot be pulled out. These rugs are still made almost entirely by hand, although a few looms have been built for this purpose. The Crompton & Knowles Loom Works has built a loom which ties the Persian knot in a rug 9 ft. wide, tying an entire row of knots across the rug at one time, or about 1200 knots.

In the leno fabrics the warp threads cross each other every time the shed is changed and the filling passes. In this way the threads are better held in place in open weaves such as gauze or marquisette. These fabrics are not very widely used.

This is an outline of the various fabrics which are in demand, and for which looms or weaving machines must be built.

EARLY NINETEENTH CENTURY HAND LOOMS

Before taking up the machines in detail it might be well to follow the art of weaving a little farther. Up to about 100 years ago almost all weaving was done by hand looms. These, however, had become very similar in their construction. All were built practically entirely of wood, and consisted of a heavy wooden frame with the warp beam or roll at the back with a friction let-off to prevent the warp from being drawn off too easily. The harness frames were suspended from overhead, and operated by a foot treadle by the weaver. The lay or batten was swung from overhead and carried the reed, and was drawn forward by hand by the weaver after the filling had been passed in order to beat up this filling. The shuttle was thrown by hand from one side and was caught by the hand of the weaver at the opposite selvage. The take-up roll was at the front of the loom, and was turned by the weaver to wind up the cloth after several picks had been woven. This was a very slow and laborious process, but by care and effort very handsome weaves were produced. There are some hand looms in operation today, largely for pleasure or for educational purposes, and a few commercially. There is a sufficient demand for the hand-made weaves by people who are looking for curious and artistic goods so that these looms may be run at a profit, and very handsome bedspreads, table covers and articles of this sort are produced in as elaborate patterns as can be woven on any power loom. A few improvements were made in the hand loom from time to time. The lay or batten was lengthened, and a shuttle box provided to catch the shuttle instead of the weaver catching it by hand, and a picking motion whereby the shuttle was thrown with a stick, actuated by the weaver, was substituted for the throwing of the shuttle by hand. Where a number of colors or shuttles were to be used, several shuttle boxes were arranged so that the weaver could move them by hand into the proper place and throw the shuttle with the picker stick instead of having the shuttles loose and operating them by hand. Almost all the weaving was done in the homes of the weavers. A few crude power looms were built, but they were not largely used. There seemed to be labor troubles even in those days and the weavers would not go into factories, and even destroyed them. Preparatory machinery was very crude, which delayed the production of power looms.

FUNCTIONS OF CERTAIN MACHINE DEVICES

All looms are composed of a number of separate motions, each motion complete in itself, and carried on one frame, and operating at the proper time. All of these are varied greatly according to the character of goods to be woven, the variations being principally as to the weight and strength and the general principles remaining very largely the same. The motions ordinarily used are as follows:

The let-off is a mechanism which carries the beam or spool holding the warp which has been carefully wound upon it in a parallel manner. This let-off allows the warp to be drawn off only as required. Usually a friction drum and band of leather, rope or chain is used to regulate the speed with which the warp is released, but for weaving accurate goods a worm and worm wheel are employed, regulated by the tension upon the warp, thus maintaining the tension somewhat more uniform.

For beating up the cloth or forcing the consecutive picks or rows of filling into place there is the lay which carries the reed. This is usually swung from below near the floor, and is moved forward and back by a crank and connectors. The lay carries on each end the boxes for the shuttles, one on each end when only one kind of filling is to be used; when more than one kind of filling is desired as many as six boxes on each end may be provided. With six boxes on each end usually six kinds of filling are used, although it is possible to use as many as eleven. The use of more than six causes great complication in the pattern for moving the shuttle box.

The shedding motion is used for opening the warp to allow the passage of the shuttle. This motion presents the greatest variety according to the cloth to be woven. Up to five harnesses and where the weave is balanced so that there is always one harness or more moving up and one or more coming down at the same time, a surface cam under the loom and a lever is used to draw the harness down while the corresponding ones are raised by straps and rolls overhead. For more than five, but not more than eight, harnesses a path cam at the end of the loom is usually employed, connections being made to the top of the harness from the top of the cam lever to raise it, and from the bottom of the harness to the lower end of the cam lever to lower it. For each change of pattern in this mechanism an entirely new set of cams is required, and it is necessary to change the cams and possibly the gearing operating them whenever the pattern is changed. When more than eight harnesses are used, and when frequent changes in patterns are to be made, some form of a head motion with a changeable chain or pattern surface which can be readily changed is desirable. The pattern surface is usually composed of a chain or a series of bars linked together, and of such form that the heights of any part of the links or bars can be varied, the height of the link or a portion of the bar indicating the action of the harness. In the so-called Knowles head the chain is composed of a series of round bars, every bar carrying a roll or a riser or ferrule for each harness. The action of the large roll or riser is to raise a vibrating gear into mesh with a toothed cylinder, which revolves the gear one-half turn, and through a series of connectors and levers raises the harness into its upper position. A sinker or a tube causes the gear to mesh with another toothed cylinder, revolving in the reverse direction, and lowers the harness. In a dobby, wooden bars fastened together by links form the chain. The levers which raise the harness are moved by hooks, which are normally hooked on to a reciprocating bar, raising the harness each pick. The pegs in the wooden bars lift the hooks from the bars and cause the harness to remain down or in the lower plane, the pegs being inserted in the wooden bars so as to form a pattern. These heads are made up to a capacity of thirty harnesses and are capable of weaving a pattern of any length up to many hundreds of picks.

The picking motion throws the shuttle across the loom through the shed to lay in place the lines of filling. It is nearly always composed of a quick-acting cam attached to a stick by levers and a connector, the upper end of the stick being behind the shuttle so as to throw the latter across the loom.

The take-up is the mechanism which draws the cloth forward as it is woven and winds it onto a roll at the front of the loom, the roll being given a slow revolving motion by ratchet and pawl or a worm and wormwheel connected to the roll by a train of gearing.

Looms when belt driven are always operated by means of a pulley which can be quickly connected. Formerly a tight and loose pulley was used, but more recently the usual construction is a pulley with a side-friction clutch which will release very quickly, although for the heavier types of looms an internal-expansion clutch is considerably used. The pulley is mounted either on the crank shaft or one parallel to it, and attached to it by gears, or the pulley shaft may be attached to the crankshaft by means of bevel gears and run at right angles to it, according to which ever method is best adapted to the shafting of the mill. At the present time looms are very largely driven by individual motors, in which case it makes no difference at which angle the pulley shaft is placed.

Box-Motion Mechanism

The box motion, so-called, is another important motion. It is the mechanism which determines which shuttle shall be thrown across the goods in a loom where several shuttles are in use. The boxes are moved up and down at each end of the lay, and the one from which the shuttle is to be thrown is positioned level with the shed on each pick. Also the box to receive the shuttle is placed in a similar position at the opposite end of the loom. In looms where only two or three boxes are used and where the number of changes are small, perhaps only three or four and then a repeat, this is accomplished by a simple cam and lever. The color or the box pattern is apt to be very long, longer even than the pattern for the weaving, and for more than a few changes a mechanism with a changeable pattern chain or surface is used. This is quite often very similar to the Knowles head-shedding motion, lifting the boxes in place of the harness, and oftentimes it is composed of a gear with a sliding tooth or a sliding intermittent gear which is moved into mesh by the use of the pattern chain, and turns the gear one-half a revolution, raising or lowering the boxes. For two boxes only one gear or one set of gears in Knowles head is required. For four boxes two sets of this mechanism are required, and they are attached to the boxes by compound levers so that four positions can be obtained, and for six boxes three sets of compound levers are used.

The color patterns are apt to be very long, particularly in the case of towels, blankets, scarfs, etc. Usually each color is used for a number of picks, and the various groups of colors usually can be made multiples of each other. This fact is taken advantage of to reduce the amount of pattern chain required. The mechanism which accomplishes this is called the multiplier. If for instance the common divisor of all the groups of colors is ten picks, a small chain of ten bars is added to the loom, and each revolution of this small chain changes the main chain one link, thus dividing the amount of pattern chain required by ten. Where the pattern runs as far as the middle of the piece of goods and then reverses, as is quite customary in towels and goods of that character, this fact is taken advantage of by reversing the chain for one-half the pattern, thus cutting in half the amount of chain required.

Automatic Stopping Devices

When power looms came into use it became necessary to apply various devices for safety and for stopping the loom in order to prevent damage to the cloth or to the machine in case of a failure to operate correctly. A filling stop motion, so-called, is applied to stop the loom in case of a breakage of the filling or weft in order to prevent a defect in the goods. A warp stop motion is applied which answers the same purpose in the case of breakage in the warp.

A protection is added to the loom which stops it instantly in case the shuttle should fail to pass entirely through the shed. If it remained in the shed and was beaten up against the cloth by means of the lay it would cause serious breakage in the warp, and very likely break the shuttle or some other part of the loom.

In the ordinary looms the weaver is required to remain close enough to the machine so that she will notice when the filling in the shuttle becomes exhausted, and replenish it before it becomes entirely used up, and she is obliged to put each bobbin in the shuttle by hand. This limits to some extent the number of looms which one weaver can operate, and to overcome this and make for greater efficiency the automatic or magazine loom has been developed. This is made suitable for two, four, or six colors, and by means of a so-called filling detector it notes the approaching exhaustion of the filling before it is entirely gone, and replaces the empty filling bobbin or carrier in the shuttle without stopping the loom, selecting the proper color for each shuttle. This enables one weaver to operate as many as sixteen looms, the number depending upon the character of the warp and filling. These looms are of course equipped with warp and filling stop motions, and are so nearly automatic that in many mills where the power is kept in operation during the noon hour the weavers fill the magazines and leave the looms running when they go to dinner, and find many of them in operation when

they return. Some of them will be stopped due to fault in the warp or filling, but without damage to the fabric, and it is only necessary for the weaver to piece up the warp and filling and start them going again.

In heavier and slower-running types of looms another device is frequently used for automatically supplying the loom with filling. This is known as a shuttle changer. In this device the entire shuttle is removed from the loom when the filling is practically exhausted, and a new shuttle with full filling is substituted. This takes place as in the magazine loom while the loom is in operation, and without interrupting its motions in any way. This type of mechanism is of particular advantage when applied to looms in which the filling is customarily wound on a butt instead of on a bobbin.

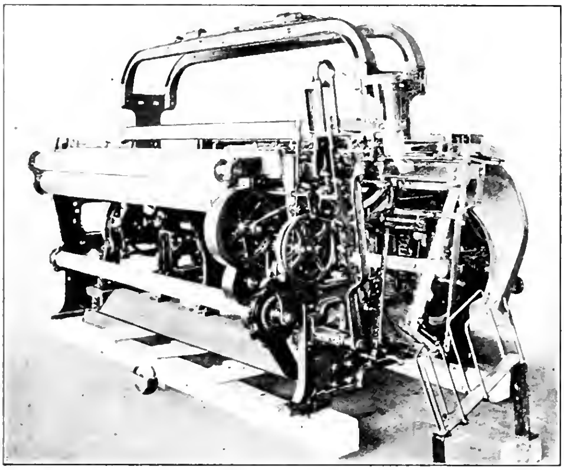


Fig. 1 Automatic Tire-Fabric Loom

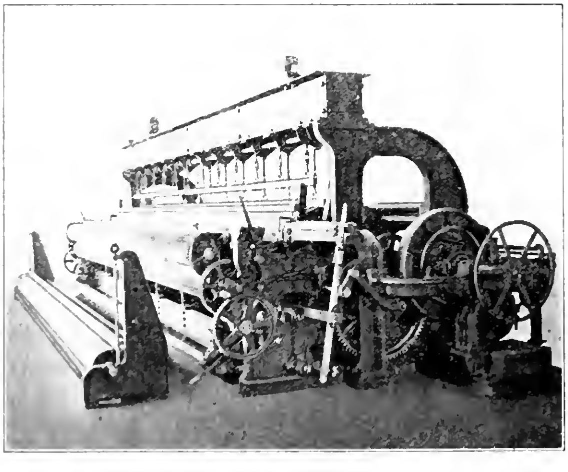


Fig. 2 Special Extra Heavy Duck Loom

The Jacquard

Another very interesting and clever device for use with these looms is the jacquard, which was invented by a Frenchman of this same name in about 1800. When complicated patterns or patterns of great length are to be woven there is no combination which can be made so that the warps can be grouped and handled by heddle frames. Each single warp thread must at times be individually raised and lowered, and to accomplish this each thread is passed through a "maileye" in a heddle. At the lower end is a weight or "lingo" to draw it down. The upper end is passed through a board above the warp in which holes are drilled for each cord to hold it in place. Where the pattern repeats itself across the goods the similar cords from each pattern are brought together into one neck cord, and these cords pass to the jacquard machine above the loom. Here the cords are attached to the lower ends of upright wires in the upper end of which a hook is formed. These hooks are arranged in rows, and in front of each row is a knife or "griffe" which is constantly moving up and down in the proper time. Normally the hook is free from the griffe. Near the top of the hooked wire is a projection on a horizontal wire bearing against the upright wire in such a manner that if the horizontal wire is moved lengthwise it will place the hook in engagement with the griffe. There is one horizontal wire for each hook. They are arranged in horizontal and vertical rows. At the outer end of these horizontal wires is a rectangular cylinder mounted so that it can be revolved, and moved to and from the wires. This cylinder carries on it a series of cards, and presents one card to the wires each pick. The card is pressed against the ends of the wires, and unless there is a hole in the card the wire is moved lengthwise, causing the upright to engage the griffe, which moving up raises the cord and its corresponding warp thread. Holes are punched in the cards so that only the wires which are selected will move lengthwise, and the holes are punched in such an arrangement that they will weave the desired pattern. This machine is a development of a so-called old draw loom in which the cords were bunched together and pulled by the hand of

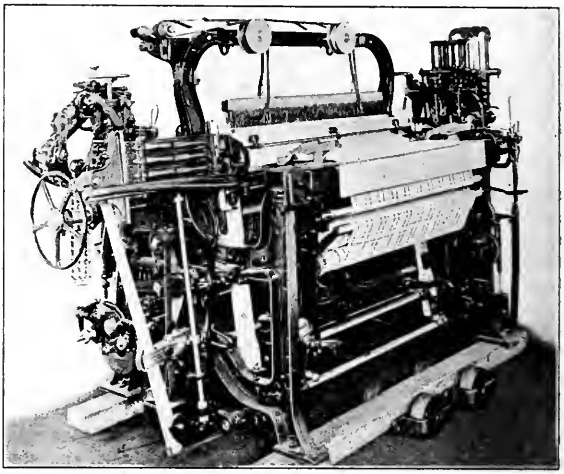


Fig. 3 Automatic Gingham Loom

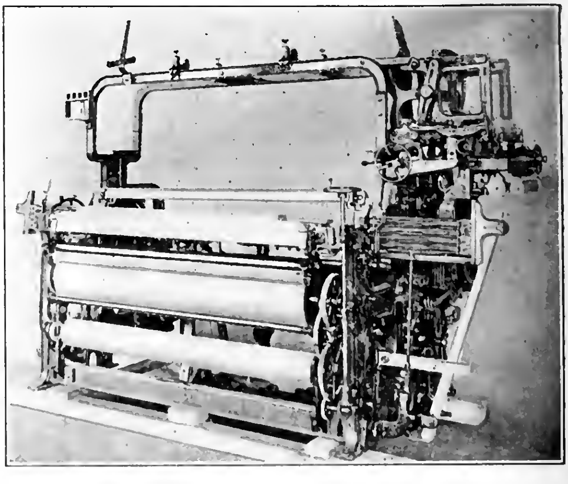


Fig. 4 Dobby Silk Loom

a draw boy who attended to this part of the process while the weaver attended to the remainder.

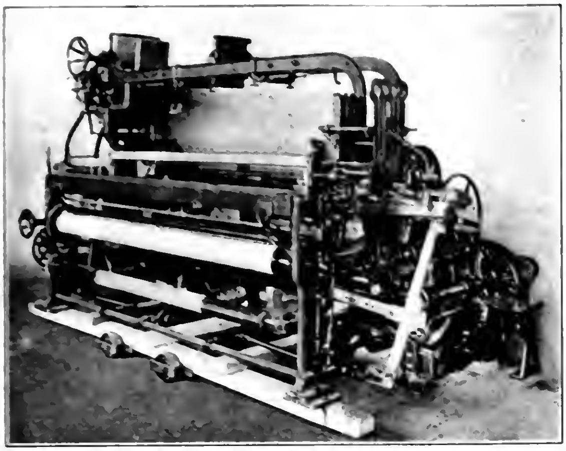


Fig. 5 Automatic Intermediate Worsted Loom

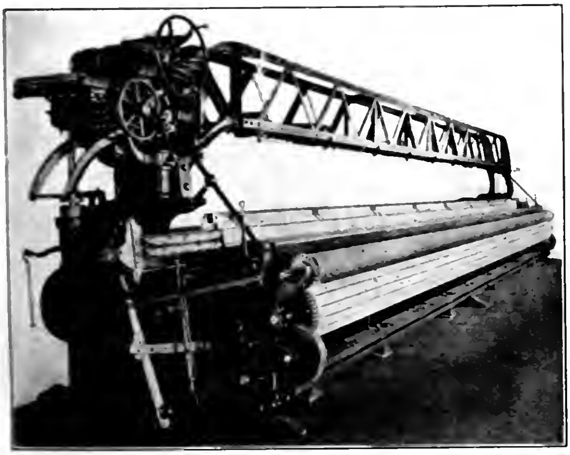


Fig. 7 Extra Heavy Felt Loom

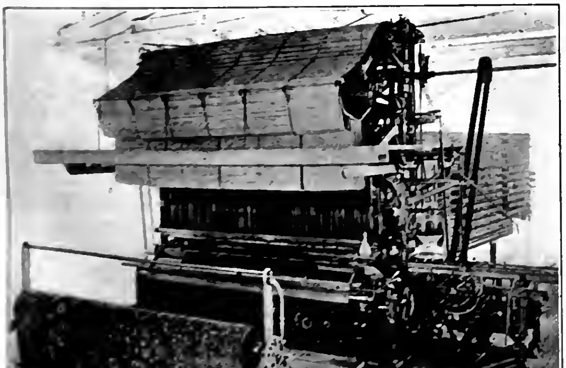


Fig. 8 Costiktan Persian Carpet Loom

Different Types of Looms

To weave all the various fabrics which were first mentioned a great number of different types of looms are of course required.

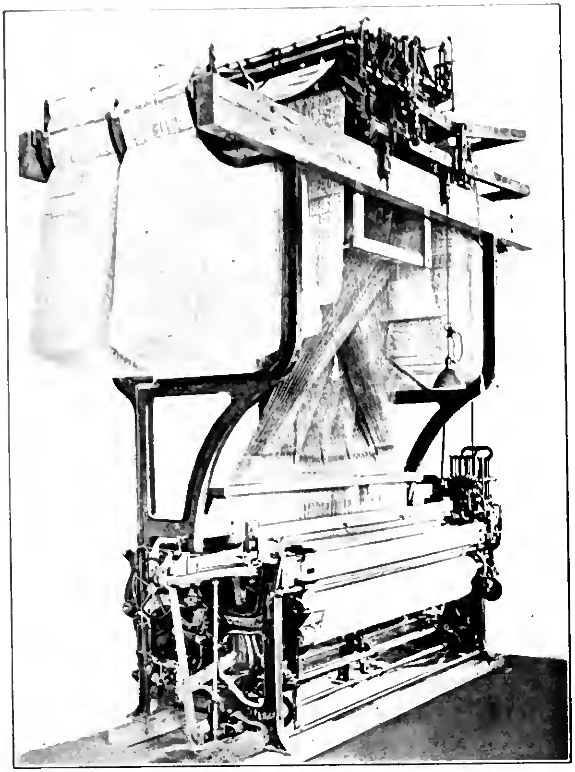


Fig. 6 Automatic Table-Damask Loom

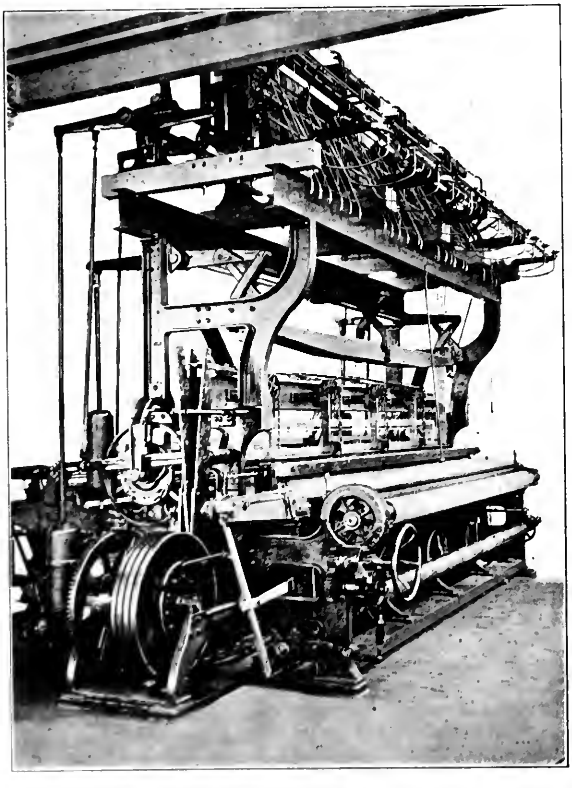


Fig. 9 Stationary Wire Wilton Loom

The simplest are naturally those for the plain weave. The shedding motion for this class is the face cam under the loom, pulling one harness down, and straps and rolls raising the opposite ones. The principal variation in these looms is in the weight and strength. They run all the way from the light cotton loom weaving print cloth or muslin 27 in. wide up to those which are suitable for ducks and tire fabrics (Fig. 1), and finally to those machines for the heaviest or 12 0 duck up to 240 in. or 20 ft. in width. This is probably about as heavy fabric as is woven. The loom (Fig. 2) for this purpose weighs about thirty tons. This fabric is used for receiving wet-pulp and paper-making machines.

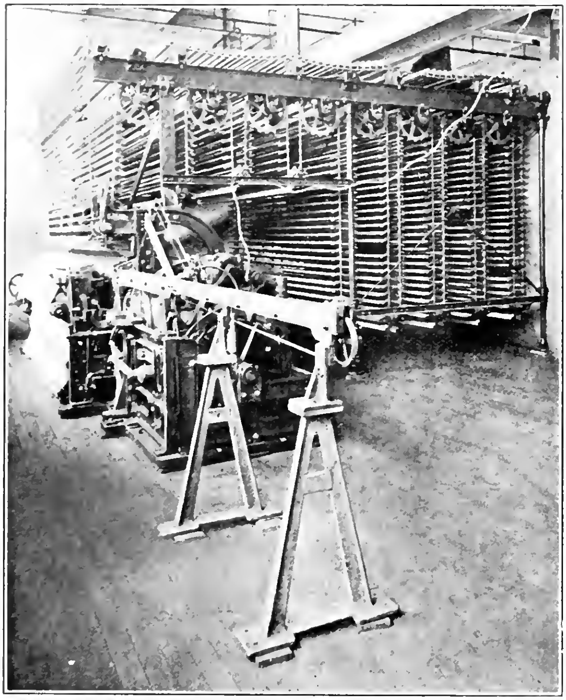


Fig. 10 Smith Axminster Carpet Loom

The gingham loom (Fig. 3) is very similar in construction to this. It is equipped to handle two, four, or six colors, and is therefore equipped with a box motion. The pattern for the weaving is only two, three, four or five harness, and so the simple cam shedding motion is employed. The color pattern, usually being checks, etc., is of great length, requiring a very long pattern chain, and therefore the loom is equipped with a multiplier.

Looms for weaving silk (Fig. 4) are of great variety, plain looms where the cloth has only one kind of filling, and two shuttles for weaving crepe, requiring two kinds of filling up to four and six colors for the fancy silk. They are almost always built for many harnesses, usually twenty or more, not only so that the fancy patterns can be woven, but also so that in weaving plain goods the warp ends can be divided into more groups and placed on more harnesses on account of their fineness and the great number.

For weaving the ordinary fabric of clothing for men's and women's wear there are the heavy-worsted looms, intermediate and dress-goods looms. These are all very similar except in weight and strength. The first loom is suitable for heavy cloth such as overcoating and men's wear in general.

The intermediate-worsted loom (Fig. 5) is similar in almost all respects except being of lighter weight for the lighter weights of men's wear, etc., and the Gem loom or dress-goods loom is still lighter, but in general is similar to the other looms, and is intended mostly for material for women's wear. These looms nearly always have the full fancy Knowles head so that almost any pattern can be woven. They carry four shuttle boxes on each side of the loom so that it is possible to use a maximum of seven shuttles although more than four shuttles adds greatly to the complication of the pattern chain for the boxes, and are not generally used.

Looms for table damask (Fig. 6) are usually plain looms, but having very large jacquards on account of the large and complicated patterns which are woven, there being seldom any repeat in the pattern in the entire table cloth.

Looms for weaving blankets are usually built with the cams at the ends of the loom, as many as eight harnesses being used for weaving double blankets. They provide for a great length of pattern for the colors or boxes as blankets usually have a border on each end. For fancy blankets a jacquard is almost always used.

Felt looms (Fig. 7) are very similar to the ordinary looms for weaving worsteds, and are notable only for their great length; the longest loom being 480 in. in length or 40 ft., and weaving a cloth in the form of a tube, which when cut would be equivalent to an endless belt about 76 ft. long. These cloths are used to form a paper-conveyor belt in paper-making machinery.

There is an endless number of looms for more or less special purposes: the cane loom for weaving rattan seats for trolley cars and similar material in which the filling is drawn across the loom by means of a nipper carried on the end of a needle; looms for weaving various kinds of grass and straw matting, which are comparatively simple and have special requirements for the kind of matting which they are intended to weave, those for weaving grass rugs having a very large shuttle; looms for weaving hammocks, and looms for weaving mosquito netting, which products are of the leno type.

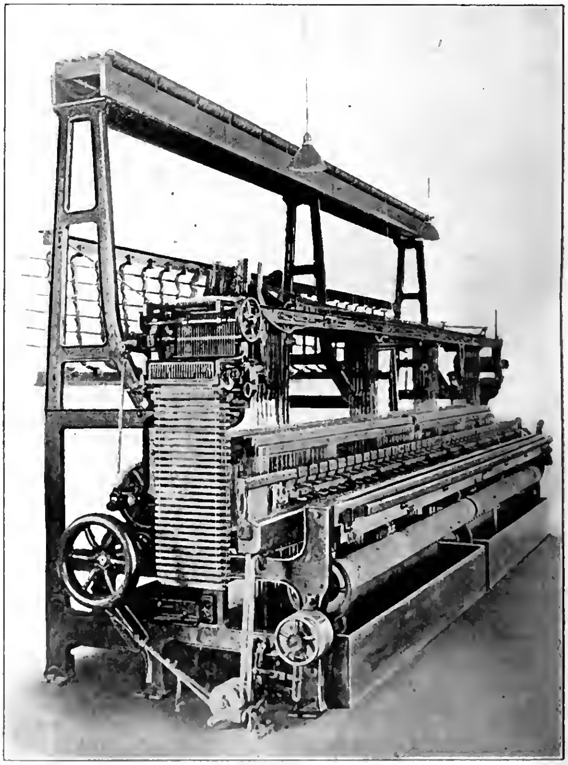


Fig. 11 Ribbon Loom

There are also the looms for weaving terry or Turkish toweling. In these looms the reed or the lay is held back from making its full travel forward for two or three picks according to the character of the goods. These two or three picks bind a portion of the warp to the filling and on the third or fourth pick when the lay is allowed to complete its travel a portion of the warp is carried forward and formed into a loop; The portion of the warp which makes the loop being released from any tension in the let-off at the proper time.

The looms for weaving velvet and plush are similar in construction except, for the double plush or double velvet, the lay carries two shuttles one above the other and these shuttles are thrown through two separate sheds, one from above the other. The pile is controlled by a separate let-off which releases a certain specified amount of pile at each pick and holds the two pieces of goods a certain distance apart. They also have in addition the cutter motion which passes a knife forward and back between the two pieces of cloth each time, the cloth being stretched tightly and held apart by the take-up rolls. Single plush is woven on a loom very similar to those used in weaving carpet, a wire being passed through on each pile pick. They are similar in other respects except that they have the wire motion which passes the wire through the shed.

The constant demand for new fabrics and for very special materials make the combinations and varieties of looms which are demanded almost endless.

There are also looms for weaving the various kinds of carpets (Fig. 8). The Brussels loom, with a knife placed on the end of the wire, makes a Wilton carpet (Fig. 9). In this loom there is a jacquard and a wire motion. The wire motion passes the wire through the shed on each pile pick, and the looms are built to weave carpet up to 12 feet in width or 16/4. In this carpet there is a set of worsted warp threads for each color which appears in the pattern, four, five or six sets of worsted yarn or frames, as they are called. There are seldom more than six frames or more than six colors used. The pattern is formed by raising the color required over the pile wires so that it will appear on the face—the balance of the worsted yarn being buried in the back of the carpet, the different threads being raised so as to form the pattern in color. Thus the greater part of the expensive yarn is buried in the back of the carpet and cannot be seen, and while it makes a very soft and beautiful carpet it is also very costly.

The tapestry loom for weaving tapestry carpet, which when cut forms the Wilton, gives a similar effect in a much cheaper way. This loom is very much the same as the Wilton loom except that no jacquard is employed, and there is but one set of worsted-yarn threads, and on these the pattern is printed on the warp before it is woven; each thread being of different colors throughout its length, and each thread is always on the face of the goods, but put together in such a manner as to form the pattern, the thickness and body of the carpet being provided by a stuffer. The warp is printed on a printing drum, each single thread being wound on a drum of such circumference that one turn carries sufficient yarn to make one repeat of the pattern. A printing wheel carrying the color is then drawn across the face of the drum, coloring just sufficient length of thread to form one tuft or loop. The proper number of threads to form the entire warp are printed on different drums and they are then matched together so as to form the pattern, wound on a beam and made ready for weaving.

In weaving the Axminster carpet (Fig. 10) each tuft is set into the carpet separately, and there is no worsted thread running lengthwise of the carpet or concealed in the body. The pile or tuft yarn is wound on small spools of sufficient length to make the entire width of the carpet. There is one spool for each row of tufts and there are as many threads on the spools as there are to be tufts in a row. These threads are of various colors so arranged on the spools that they will form the pattern. They are carried in a chain and one spool is presented to the loom each pile pick. The loom lifts the spool from the chain, lays the yarn in the carpet, the warp binds it in place, and the loom cuts it off from the spool and returns the spool to the chain. The chain moves forward one station and presents the next spool to the loom, the process as noted above being repeated. For a rug 9 ft. by 7 ft. there would be from 500 to 700 spools in accordance with the fineness of the carpet, and there would be from 400 to 600 threads on each set of spools.

In the chenille carpet two looms are required to produce the carpet, one to weave the weft for the main loom. The weft looms are small machines of plain construction and they weave a number of lines of fringe or chenille, which when spread lengthways makes a narrow fabric only a few threads wide with a wide fringe on each side. This in turn is used in the main loom as filling. The loom weaving the carpet runs for three picks and then lays a row of the chenille in the loom and stops, and the weavers comb the fringe or pile into a vertical position by hand, when the loom is started again. In much of the chenille where the pattern is at all complicated the chenille is put into the loom by hand, the chenille being wound on a stick and passed from one weaver to the other lengthwise of the loom.

For weaving ribbon (Fig. 11), tape and all narrow fabrics many pieces are woven at one time in one loom. There is a shuttle and a weaving space for each piece of goods, but the shuttles instead of being thrown across the loom by a picker stick as they are in what is known as a fly-shuttle loom, are moved positively from side to side. There is a block about the length of the shuttle on each side of the weaving space, and on the bottom of the shuttle is a rack. In this rack is meshed a pinion turning on a pivot in the block. Below the cloth and meshing with the lower side of the pinion is another rack passing the whole length of the loom and meshing with the pinions which drive each shuttle the whole length of the loom. As the rack is moved lengthwise it turns the pinion and forces the shuttle from the block across the weaving space. On the other side of the weaving space is another shuttle turned by the same rack which picks up the shuttle before it leaves the first mentioned pinion and carries it into the block. The motion of the rack is a reciprocating one and when it is moved in the reversed direction it carries the pinion back across the weaving space and into the first-mentioned block. The other motions of looms of this type are practically the same in construction as those for weaving broad fabrics, and are varied to suit conditions.

BURNING BITUMINOUS COAL ON TYPE E STOKERS

(Continued from page 374)

Care is taken to have the fire from 10 in. to 12 in. thick, keeping the draft over the fire as indicated by the draft gage at about 0.5 in. Under these conditions the draft under the fire will average from 3 in. to 5 in. and the draft in the last pass about 0.4 in. to 0.6 in. These figures are for our usual running conditions at 100 per cent rating.

The variations will depend on whether the coal is largely dust or in small lumps and whether it cokes to form a crust which prevents air supply. The greater the tendency to coke, the greater the air pressure required.

The firemen are instructed to keep the fire level and to use the fire tools as little as possible and to keep the draft above the fire uniform. The fires are dumped every $2^{1}/_{2}$ hours and very little trouble from clinker in the ash dump is experienced.

Approximate analysis of coal fired in two boilers which, operated at from 125 to 150 per cent rated capacity, are sufficient to carry our load at all times, is as follows: carbon, 71.17, volatile, 20.04, ash 7.70, sulphur 1.09, moisture 1.20, B.t.u. 14,643.

About 1500 lb. of coal is burned per hour during the day in each furnace, which has a projected area of 71 sq. ft., and about 1050 lb. per hour during the night. The stoker speed is hand-controlled. Two of the boilers are equipped with the Bernitz furnace walls for admitting air above the fire all around the furnace, the other two admit air through openings in the rear wall only. We have had very little trouble with clinker on the walls of any of these boilers. Ash is wet down in the ashpit immediately after dumping and is removed from the ash hoppers in basement by cars of about 1000 lb. capacity. No scales are provided to weigh the ash regularly, but occasional weighing indicates about 12 per cent ash by weight of coal burned. This includes water in ash.

Operation is practically smokeless. There is no dense black smoke at any time, and light smoke during short periods only. Air is admitted over furnace to secure good combustion between fuel bed and tubes. The lower side of the front header is 10 ft. from the floor line and combustion is complete before the hot gases reach the lower tubes.

During the fifteen months the stokers have been in operation, no trouble due to manufacture or design has been observed. When first put into service, however, several grate bars were burned out, due to the failure of the firemen to remove the siftings from the central air box promptly.

Management Applied to Textile Plants

The Organization of a Cotton Plant and Its Management—Comparison of Cotton-Manufacturing Development in the North and South

By GEORGE S. HARRIS,[1] ATLANTA, GA.

A COTTON mill is a highly organized plant consisting of four or more distinct departments, all quite different, and to master the details of any one requires long study. The departments in order are, mechanical, carding, spinning, weaving, and cloth. The last named includes the classification, branding and packing.

The stock in process, cotton, consists of fibers very sensitive to atmospheric conditions and easily damaged in working. This fiber under a microscope appears like a minute glass tube slightly flattened and slightly twisted. It is covered with a very thin coating of wax, normally has a moisture content of about 8 per cent and beyond the carding process works better when the moisture content is held at or about normal. The effect of picking and carding is to dry out the moisture and as it is in these processes we attempt to separate the good fiber from the dirt, leaf, and short and immature fiber, we need to have the stock dry to properly effect this separation. Beyond the carding we begin the parallelization of the fibers and evenly drawing down the stock through different processes until the required yarn sizes are ultimately reached.

During these processes the atmospheric conditions must be controlled, as it is quite apparent that unless the correct percentage of moisture is maintained in the air surrounding the fibers at the prevailing temperature, the air is going to extract from or deposit on the fiber the shortage or surplus of moisture as the case may be. It has been determined by engineers experimentally just the percentage of moisture necessary to be maintained in the mill atmosphere throughout the range of temperatures to effect the necessary regain in moisture content of the cotton fiber. It naturally follows that a certain moisture content in air at one temperature would not be correct at another.

In addition to the departments referred to we very often find a finishing department, including bleaching oi dyeing or both. In fact, with some few exceptions, all cotton goods are given some kind of finish after leaving the loom before they are ready for consumption.

Department Personnel

To properly man such an institution as this we must have at our command men of various qualities and training—the master mechanic, the carder, the spinner, the weaver, and finally the finisher. In the older countries where competition is keener and men progress only by specialization, we seldom find a manufacturer attempting the whole works as we do here, especially in the South. There, one mill produces yarn only and attempts only carding and spinning. Another mill attempts weaving only, buying its yarns from a man devoting his whole time and attention to carding and spinning. Likewise the cloth is sold as it comes from the looms to a converter who has it finished by a man who possibly doesn't know a loom from a card but has spent his years training in the arts of chemistry, of dyeing and allied subjects. Whether the one system is better than the other is a question for debate, but as the industry is successful under both systems, probably local conditions in either case had their influences in its development.

The mechanical department consists principally of power plant and shops, but in reality extends over the entire plant to reach all power-transmission equipment, fire protection, service lines, steam and water, sanitary system, machine repairs, building repairs, etc. All of this very naturally requires for its directing head a man trained in the many branches of engineering, mechanical, electrical, and otherwise. In the South the plants are often isolated and the mechanical department sometimes finds itself in deep trouble and thrown absolutely on its own resources. The head of the department must be competent to demand and hold the respect of the heads of other departments who are not mechanics, and to stand firmly in the organization as his title implies—master mechanic. No position in a textile plant is of more importance.

The general appearance, or we might call it the tone, of a textile plant depends on the character of the master mechanic, and frankly only a small percentage of the men who have come under my observation fully meet the requirements.

Continuing our trip through the plant, we find the carder. He has his picking, carding, drawing, slubbing, and roving—all different processes—with every pound of the stock passing through each process in the order named and in constant danger of being damaged. The carder, as do all department heads, has his department divided into sections, with each section under the care of a "section man."

In the next department we find the spinner, who receives the stock from the carding department in the form of roving wound on wooden bobbins. This roving is specified as a certain "hank" roving. By this is meant that a certain number of hanks will weigh a pound. For instance, a four-hank roving means that the stock has been drawn down to such a size that four times 840 yards (one hank) will weigh a pound. The roving must be evenly drawn. That is, it must be reasonably free from thick and thin places, it must be properly carded free from specks of leaf and have the greater portion of the short fibers removed, and it must have only sufficient twist to make it hold intact while being wound on the bobbin and off again. The head of this spinning department must see that this roving (his raw stock, so to speak) is up to specifications. He has in this department spinning, spooling and warping and delivers to the weaving department warp yarn wound on large spools, or beams, as they are called, and filling yarn wound on wooden bobbins or cops, in condition to go directly to the loom shuttle.

Next as we follow the stock through, we find the weaver, who usually has in his division of the plant slashing or dressing, warp preparation, and finally weaving. To fully meet requirements he must know cloth analysis to be able to positively determine yarns, harness, reeds, and loom "set-up" necessary to produce a cloth without unnecessary cutting and fitting, which unfortunately is common practice with many. In the slashing of warps, to produce not only the correct finish on the cloth but a good running loom, requires a knowledge of starches, fats and various chemicals brought together in making up the finished size which is pressed into the yarns and dried over large copper drums.

The finishing department, whether it be bleaching, dyeing, or both, finally finishing the cloth into one or more of the thousands of finishes given to cotton piece goods, is a department very different from any we have yet seen. In this department you will probably find a chemist with his laboratory prepared for testing the great number of dyestuffs and chemicals required to produce the different finishes. You will find the dyer, trained by experience and experience only, to produce the great number of shades required, and then the finisher, who takes the dyed or bleached cloth and gives it the feel, sheen, etc., required.

A department head lacking in the mental capacity, training and industry necessary to hold up his end will surely drag down all other department heads to his level—and this can often be accomplished in a remarkably short time. This is due to the fact that cloth manufacturing consists of a long series of processes through which this very sensitive cotton fiber must pass on its way from the bale to the case of finished goods, and to the fact that at any point serious damage can occur which is very difficult to detect at once but which readily shows itself in the cloth-testing laboratory. Many a mill manager has been worried for months with the knowledge that certain of his fabrics are not up to standard quality and yet has been unable to locate just the process that is causing the damage.

---

[1] President, Exposition Cotton Mills.

Presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

Management and the Manager

The general subject of management has always been an interesting one to my mind, and I believe that during the next few years managers as a class all over the globe are to meet trials never before encountered. We are all familiar with the three-legged table supporting industry—the labor leg, the capital leg and the management leg. It is generally conceded that no three-legged table can stand on only two of its legs, but occasionally we hear of a labor leg somewhere deciding that his particular table is fully able to stand without the management leg, or in some cases the labor leg feels that the table might be more substantial if we take some of the stock out of the management leg and put it into the labor leg. Naturally the table is weakened directly in proportion to the amount of stock removed from any one of the legs.

Management, to my idea, is more or less a matter of compromise and it is just as erroneous to uncompromisingly dictate to men without feeling their sensitiveness, as it is to attempt to twist a cotton fiber in a way it will not twist without damage.

Men—and of course I mean men who have not been advanced beyond their capacity—should feel their responsibility and should be allowed to work out their problems in their own way. A manager to stand firmly as such must have had the necessary experience in all the various departments, and he finds it difficult at times to see an assistant apparently wasting time by taking a circuitous route to an object, but the man should be allowed all possible leeway and be checked only when he is about to do some real damage. It is to my mind poor management to feel that every man must be made to do my way. Unless a man is given an opportunity to try out his ideas without fear of being discharged for mistakes, he stops thinking and becomes a machine.

Men should be taught to feel that it is their duty to train other men. They should be taught by the management that their advancement depends always upon their having ready an understudy. I recall reference in a paper once to the "three-point system of promotion" and have always remembered my impression. Picture an organization from manager down where each man in line is trying to promote himself by making the man ahead so good that he must outgrow his shoes and at the same time training an understudy for his own work. You have then an ideal organization.

When a vacancy occurs a good man will comb thoroughly his own organization before going outside, but I don't think a manager should ever promote a man unless that man can show that one or more of his assistants is ready for his work. When a man is fully filling his part in an organization he is continually pushing forward the man just ahead and pulling the man just below. No man, regardless of his competency, should ever receive promotion who has ever attempted to drag down another in his organization or in any manner attempted to interfere with his progress.

Plant managers require the full loyalty and attention of every man on the staff, and a manager who does not possess that personality so necessary to develop loyalty and interest in his assistants, is surely unfortunate and so are his stockholders.

There is hanging on the walls of my office a card bearing this inscription by Elbert Hubbard: "Men are valuable just in proportion as they are able and willing to work in harmony with other men." Please get this firmly in mind. Several years ago I had copies made and posted them throughout our plants and have been interested in seeing its effect on the men. I commend this to employee and employer alike as carrying a lesson well worth any man's careful consideration.

In industrial management today we have two extremes. On the one hand an uncompromising autocrat who sits at the head of an organization dictating without regard to the thought or feeling of the men in charge of departments, and on the other hand the recently developed industrial democracy with the governmental bodies of men from the works either appointed by the head of the establishment or elected by the workers en masse, or both.

I feel that either one of these extremes is just as bad as the other and both with few exceptions will eventually go on the rocks. I have more tolerance for the industrial democracy plan of management than the autocratic management, but neither is good nor necessary. Somewhere between the two ideal management is found.

Here you find a man firmly in his position by reason of his personality, capacity and training. He knows his work and can intelligently direct with an understanding of the difficulties ahead of the men when they attempt to carry out his instructions. He is naturally careful and thinks out his plans after discussing details with the men who are ultimately to do the work. This is not possible for any man to do before he has mastered details in the plant. An industrial plant is not a military establishment and cannot be successfully handled as such. The main object in any army, it seems to me, is to "pass the buck," while in industry every man in authority should be prompt to stand firmly on his responsibility and never attempt to shift his burdens to others.

The industrial democracy idea is pleasant to think about as it carries beautiful ideas of the brotherhood of man, etc., but human nature is the same the world over and in my opinion this plan generally will not succeed. There will be found an occasional exception where local conditions or some man or men in the organization are gifted with certain qualifications that make it all a success. But these exceptions are and will be rare. Men of today have developed through a long process of the "survival of the fittest" and the result has been a certain amount of selfishness in all men. Those who had no selfishness in their make-up and insisted upon giving away to others everything they gained, were stamped out before our day and left no posterity.

Southern Cotton-Manufacturing Development

It has been suggested that you might be interested in a few ideas on the development of cotton manufacturing in the South as compared to that in other sections. As you know, for a term of years our development was phenomenal, until today the cotton-growing states are making into yarn or cloth considerably more than half the cotton manufactured in this country. Of the 37,000,000 spindles in the United States, the cotton-growing states have 16,000,000, or more than 43 per cent. The mills of the cotton states are now consuming 55 per cent of the cotton consumed in the country, with a steady increase. This has been accomplished in comparatively a very short time and it might be interesting to see how it was brought about.

Before the successful development of the humidifying apparatus, cotton mills were confined to certain localities in which could be found natural atmospheric conditions permitting weaving and spinning. This very largely accounts for the mills of England and later those in our New England States. In the Southern States the hot, dry summer so necessary to the growth of cotton did not encourage the spinner and the few mills we had in the old days were located on the banks of rivers for the dual purpose of supplying power and natural humidity. Some mills were scattered over the South, but the real growth was in New England.

In 1881 a few leading citizens of Atlanta conceived the idea of creating something that might stimulate cotton manufacturing, and the result was the Industrial Cotton Exposition. This was held in Atlanta and exhibited everything from the cotton growing in the field to the finished cloth, with the actual manufacturing being demonstrated. As a finishing feature a real wedding ceremony was performed in the building with both the bride and the groom wearing clothes made of cloth produced with the machinery on exhibition from cotton grown in the surrounding fields. Immediately following the close of the exposition a new company, the Exposition Cotton Mills, was organized and began the manufacture of cotton goods on a commercial scale in these same buildings, and from this nucleus the present Exposition Mills have grown.

As the real growth of mills in the South dates from a time soon after this exposition, it seems fair to assume that it was quite largely responsible for this growth and those of us who have the honor today of occupying official positions in the Exposition Cotton Mills feel proud of the part our mills played in the development of our industry. We have today, framed in our office, one of the original certificates of the capital stock of the International Cotton Exposition. More than this, a part of our present equipment is now running in the original wooden buildings that housed the exposition.

The development of southern cotton mills was assisted greatly in later years by the perfection of humidifiers which made it possible

to build a mill anywhere and operate it successfully through the summer months.

It might well be asked why the southern mills advanced so much more rapidly than those in any other section, and I will attempt to answer, in part at least. We will take for comparison a mill in Georgia and another in Lowell, Mass., without any intention of discrediting what has been achieved by our friends of New England. As a matter of fact, we of the South marvel at their ability to show such financial results under their conditions.

First, in the matter of cotton the Georgia mill has the advantage. When the mill in Lowell requires cotton it first deals with a local broker who will probably place the order with one of the many cotton shippers maintaining a large organization covering more or less the entire cotton belt. These shippers in turn will buy the cotton from smaller shippers operating in one locality who might buy direct from the producer or from a merchant who has taken in cotton on account of supplies furnished during the growing season. The cotton, before it can start on its journey, is concentrated at some point for compression. Here it receives considerable handling and is compressed to a high density. By the time it reaches New England it not only has accumulated a very high freight charge, but the percentage of tare has been increased at the compress.

In contrast to this long process with its three to four necessary profits, the Georgia mill will buy generally from the local shipper and might buy directly from the large responsible producer, with transportation cost usually only a few points. In addition to this the mill in Georgia can handle uncompressed cotton, saving the extra tare and expense incident to compressing, besides the extra mill expense in opening compressed cotton. I have never been in a position to make a dollar-and-cents comparison of this cost of cotton, which would naturally vary with the seasons, but the difference must always be there and in some seasons it must be considerable.

The labor cost has always been in favor of the Georgia mill, due as much as anything else to climatic conditions. The long, hard winters of the North necessarily make the cost of living very materially higher, which must be borne finally by the manufacturer in his payrolls. In the South from the beginning the mills found it necessary to provide homes for the operatives as this proved to be a decided economic advantage, both to the mill as well as to the operative. The village plans today are given the same consideration as the mill plans in the original layout. This has given the operative a far more comfortable home at a much less cost to the mill than if supplied by outsiders who haven't the same interest in the operatives or the mill. Furthermore, this scheme of things has tended to keep the relationship between employer and employee closer. Contrast this with the operative in New England who lives in a house probably one or more miles from his work and which he rents from a landlord who has no interest in him beyond that of keeping his property occupied profitably.

There was a time when this was very largely offset by the higher efficiency of the labor in Massachusetts, but this advantage has now been shifted about. With every year our labor has been growing more and more efficient, while the original labor of Massachusetts has been replaced each year at a steadily increasing percentage with untrained immigrants. I recall my first day in Lowell as a boy where I went to take courses in the Lowell Textile School. Standing near a mill gate at noon and observing the help passing out, I had to listen carefully to hear the English language spoken. Instead what I did hear was, as it seemed to me, every language of the world. I learned afterward that twenty-six different nations were represented in the mills of Lowell at that time, and that was more than twenty years ago. This, together with the advent of labor organizations, has created a condition that tends toward anything but efficiency.

In contrast to this, in a Georgia mill is a class of labor, all American, recruited from the farming class. The manager has grown up with them and knows them in their homes. In many cases the mill, being a comparatively young institution, was built from a small unit by the present owners. The manager, living in close touch with the labor, is in a position to talk freely with them. I know of instances in Georgia, during the recent depression, where values depreciated so fast that it was impossible for a mill to continue operating without tremendous losses, but the employees quickly sensed the entire situation and voluntarily submitted to reductions in their pay in order that the mill might continue to operate. Do you hear of such actions in the union-ridden mills of New England? I have not. The result is that while the Georgia mill is in position to sell its product today in line with the depreciated value of raw products, the New England mill has its manufacturing cost held up fictitiously and is forced to take heavy losses in current values or shut down.

In conclusion, allow me to refer again to the legs supporting industry, with special reference to the management leg and American industry. Do you fully realize your responsibility during the next few years? It is up to the management to attract, hold and keep employed labor and capital. They are both free and when management fails to function they both withdraw and industry becomes stagnant. Our recent road has been a hard one, but now the capital is here, the labor is here, and world competition is also here; and it is going to take brains, and active brains in the heads of management, to direct capital and labor so as to place American industry in the front rank and hold it there.

Bleaching

Bleaching, Being a Résumé of the Important Researches on the Industry Published During the Years 1908–1920, by S. H. Higgins, Head of Research Department, Bleachers Association, Ltd., London, England, is a comprehensive monograph. It is limited to the subject of bleaching and the discussion of factors that may affect it, exclusive of the purely technical processes of bleaching. The following is cited as possibly giving the scope of the treaty. Many questions have been raised as to proper way of handling mercerizing. Must the fiber be kept under a condition of strain during part of the process, and to what extent might the mechanical treatment be replaced by chemical action? And if, as some assert, a long staple cotton is necessary for success, is this success due to a change in the chemical or molecular nature of the cellulose, or to an alteration in its physical characteristics induced by the initial processes to which it has been submitted? Among the multitude of advisers it may not be indiscreet to ask whether we know the cause or causes of the peculiar appearance of the fabric following mercerization. One authority states that the fibres untwist during mercerization, and retwist often in opposite directions, and that the luster produced depends largely on the reflection of light by the swollen and retwisted fibers. From this hypothesis the conclusion is drawn, that the mercerizing agent, which is able to produce the highest degree of swelling, shrinking and untwisting of the fibers, gives the maximum lustre. Another view is that luster is due to the smoothness of the surface of the mercerized fibers as compared with ordinary cotton fibers. Mr. W. C. Balls declares that luster is almost synonymous with twist. If all the hairs in a sample are well and evenly twisted, there will be an infinite number of convex surfaces, each reflecting a spot of light. In quoting these various authorities, the object has been to show that other causes than chemical change may operate in producing the desired effect; but if adherence to purely chemical guides had been strict, the same diversity of opinion would have been apparent.

As regards removal of wax by saponification the chemist and the practical man have long been at issue, the former maintaining that caustic soda is the best saponifying agent, while the latter insists that the lime boil cannot be replaced for certain classes of goods. The author seems to agree with the bleachers in upholding the value of lime boiling, at least in some cases. He points out and, as it would seem rightly, that in the lime boil and "sour," that unsaponifiable portion of the wax and free fatty acids are left on the fiber, and in the lye boiling a soap is readily produced by the alkali and the fatty acid, resulting in the emulsification and elimination of the unsaponifiable portion. The difference of opinion probably arises from the various classes of goods and their variety of composition, to which the method is applied.

The author's work may be particularly valuable in preventing the repetition of many experiments that have been thoroughly tested: in suggesting ones along which progress is likely to reward research; and in delineating the limitations which the practical man may expect to encounter. (*Engineering*, Mar. 31, 1922.)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS See Internal-Combustion Engineering)

AIR ENGINEERING

Calculation of Pressure Losses in Conduits Carrying Air, Steam or Water. V. LeBeau. According to the author's statement, the formulas given for pressure losses in fluid conduits are incomplete and lack precision because of their failure to take into consideration to a greater extent than is done the nature of the inner surface of the walls of the conduits; and further, because of lack of sufficient attention to such obstructions, as, for example, pipe joints. Thus, for example, Lorenz' formula in the Huette Engineering Handbook is found to be valid only for the case of compressed air, and then only for conduits from 50 to 350 mm. (1.96 to 13.7 in.) diameter.

The method adopted by the author is based on the use of the Reynolds coefficient, and a general formula for loss of pressure is developed in which certain coefficients are introduced to take care of the variations in the roughness of the conduit walls.

As regards the roughness, the author divides all conduits into four classes, viz., smooth conduits (drawn lead, copper, brass, or other tubing, the surface of which has been worked to a smooth finish); "first-class rough" conduits, which are iron and sheet steel tubes; "second-class rough" conduits, viz., cast-iron and cast-steel pipe, in which the resistance to the flow of fluid is greater than in conduits of the preceding two categories; "third-class rough" conduits, to which class belong wrought-iron, cast-iron and cast-steel pipes bearing incrustations or deposits on the inner surface.

Each of these four categories is discussed in detail and a formula derived for it, in addition to which the author has worked out curves from which pressure losses in a given type and diameter of conduit may be read off at once.

The article is of very considerable interest, but unfortunately cannot be abstracted more completely owing to lack of space.

As an appendix is given a brief discussion of the formula for determining the specific volume of superheated steam. The author rejects the formulas of Linde, Callendar and Tumlirz and expresses a preference for Zeuner's when so corrected as to bring it into conformance with modern views as to the variability of the specific heat of superheated steam with pressure and temperature.

In this way he obtains the following formula:

$$V = v + 100 \times C_{pm} \times \frac{t_1 - t_2}{P}$$

where V = the specific volume of superheated steam; v = specific volume of saturated steam; C_{pm}, the average specific heat of superheated steam; P, absolute pressure in kilograms per square meter; t_1, temperature of superheated steam in degrees centigrade; t_2, temperature of saturated steam in degrees centigrade. (*Revue Universelle des Mines*, Series 6, vol. 12, no. 4, Feb. 15, 1922, pp. 301-327, 8 figs., 2 charts, *tmA*)

AIR MACHINERY

Rotary Compressor with Disk Piston Moving in a Conchoid

Planche Rotary Compressor, Lucien Fournier. Description of a rotary compressor designed by a French engineer, R. Planche, based on a mechanical movement in which the transverse section of the cylindrical body of the pump is a circle enveloping a conchoid of a circle, the properties of which will appear from the following description.

The principle of action is as follows: A and B, Fig. 1, are the points of intersection of a straight line CD with the circumference of a circle about the center O. If, now, we lay off on this straight line on both sides of B two distances of lengths BC and BD equal and constant and greater than the diameter of the circle about O, the loci of the points C and D obtained by turning the straight line around the point A will be a conchoid of a circle, symmetrical with respect to the diameter passing through the point A which is the pole of the conchoid. All the chords of the conchoid passing through its pole are equal. In order that the two extreme points of the straight line CD of constant length should describe a conchoid, it is sufficient to make the point B the middle point of the line to move at a constant angular velocity about the center O in such a manner that it should describe the circumference of a circle, and at the same time the line CD about its middle point B in the same direction but at an angular velocity only half as great.

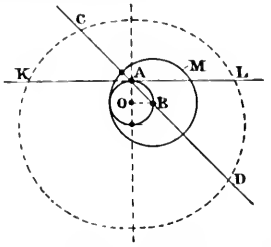


Fig. 1 Diagram Showing the Principle of Generation of a Conchoid

In order to obtain the combination of these two movements all that is necessary to do is to roll along the circle O without any slip, the circle M of double radius, this latter circle moving in one piece with the straight line CD. In this manner, while the straight line passes through a semi-rotational movement, its center B performs a complete rotation, as a result of which the totality of the areas located on both sides of the straight line in the interior of the conchoid is inversed.

If we substitute for the straight line CD a blade moving in the interior of a cylinder having a conchoidal base, we obtain in each period of complete rotation of its center B an intake and an exhaust, notwithstanding the fact that the blade has described only half a rotation in its enclosure. This is the principle on which the Planche rotary compressor is based.

In actual practice, however, in order to make the machining somewhat easier, the conchoid of a circle is replaced by an enveloping circle of a shape fairly close to the theoretical curve. Instead of the blade a disk piston (Fig. 2) is used, which in one view has the shape of a rectangle, and in its longitudinal section appears as a symmetrical spindle, such that its median axis should occupy the position KL in Fig. 1, which corresponds to the dead center. Its outside surface is tangent to the cylinder.

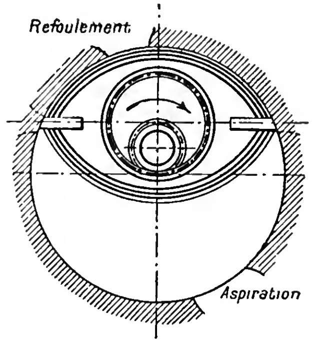


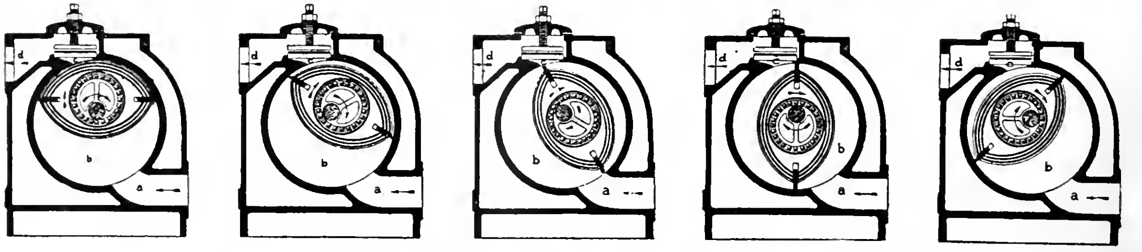
Fig. 2 Diagram Showing the Principle of Design of the Disk Piston, Its Relation to the Dead Center and the Relative Positions of the Intake and Exhaust Ports

(*Aspiration* = intake; *Refoulement* = exhaust.)

The movement of the piston is obtained by means of an eccentric, the interior of which is constituted by the disk piston itself. The disk piston carries on both sides of its surface two internal gears which during the rotation of the shaft (Figs. 3 to 7) mesh with two rigidly held gears of half the diameter mounted on the engine frame. In this way the center of the disk piston describes a circle of uniform movement, while the disk piston itself turns around its own center in the same direction, but at half the speed.

Since, further, the disk piston is entirely symmetrical with respect to its own middle point, the centrifugal forces and the pressures are uniformly distributed on all sides and their resultant passes through the center of gravity of the disk piston which coin-

cides with the center of the eccentric. Hence, there is no torsion couple which might tend to oppose the motion of the disk piston around its center. The crankshaft and its eccentric alone absorb all the pressure reactions; two flywheels at both ends of the crankshaft are used to insure the balance of the machine. The question of stresses is discussed in greater detail in the original article.



Figs. 3 to 7 Timing Diagrams for the Disk Piston of a Planche Rotary Compressor.

(In Figs. 3, 4 and 5 the air under its own inertia enters through orifice *a* into the space *b* where it is compressed. The gas compressed in the clearance space *c* expands and restores to the piston the power which it has absorbed during previous compression. In Figs. 6 and 7 the air is taken in on one side of the piston and compressed and exhausted on the other side, the exhaust taking place through *d*.)

The cylinder, as shown in Figs. 2 and 3 to 7, has two ports—intake and ignition—lagging with respect to the dead center of the machine and therefore not passing through the points *K* and *L* of Fig. 2. The lagging position of the ports is given in order to secure a better filling of the cylinders due to the fact that time is given to make use of the inertia of the column of gases flowing into and out of the cylinders.

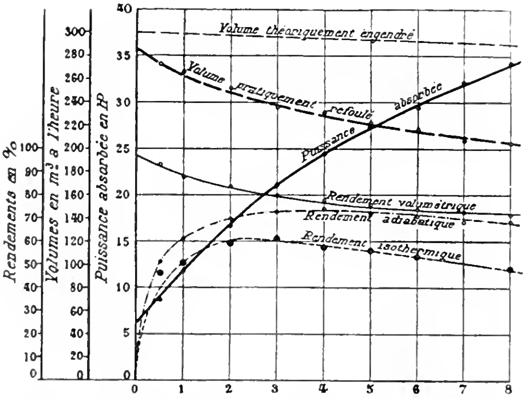


Fig. 8 Curves of Tests on a Planche Rotary Compressor

(*Rendements en %*—Efficiencies in per cent; *volumes en m³ a l'heure*—volumes in cu. m. per hour; *puissance absorbée en HP*—power consumed in hp.; *pression en kgs/cm² (au dessus de la pression atmospheric*—pressure in kg. per sq. cm. gage; *volume théoriquement engendré*—volume theoretically generated; *volume pratiquement refoulé*—volume actually delivered through the exhaust port; *puissance absorbée*—power consumed; *rendement volumetrique*—volumetric efficiency; *rendement adiabatique*—adiabatic efficiency; *rendement isothermique* isothermal efficiency.)

Tests of the device were carried out at the Laboratory of the National Museum of Arts and Manufactures on a unit rated at 300 cu. m. (10,594 cu. ft.) of air per hour, and have given the results shown in Fig. 8.

From this it would appear that the volumetric and isothermal efficiencies of the compressor are very high. At first glance it would appear that because of the high speed of the apparatus the compression should be a little too adiabatic. Actually, however, it is not so, as in these machines the compression and exhaust take place during one complete rotation, and the surfaces which are generated during the rotation are very large as compared with the volume of air which is exhausted, which factor assists good refrigeration.

It is interesting to note that the unit above referred to has also been tested as a vacuum pump and has given a vacuum of the order of 98 per cent. (*Le Génie Civil*, vol. 80, no. 12, Mar. 25, 1922, pp. 275–277, 10 figs., *dA*)

ENGINEERING MATERIALS (See also Railroad Engineering, Machine Parts, Testing and Measurements)

Stainless Nickel Alloy. Description of an alloy recently developed in England. It is known as "newloy" and is composed of 35 per cent nickel, 1 per cent tin, and 64 per cent copper, its peculiar characteristic being the absence of spelter and presence of tin.

It is said that it has already found extensive application for use as tableware. The alloy is very ductile and is made in rods, sheets, stampings and wires. In the latter form it appears that it may be used as a high-resistance wire. (*The Metal Industry* (London), vol. 20, no. 12, Mar. 24, 1922, p. 270, *g*)

HYDRAULICS (See Air Engineering, Machine Parts and Pumps)

INTERNAL-COMBUSTION ENGINEERING (See also Motor-Car Engineering)

Working Fluid of Gas Engines

Some Properties of the Working Fluid of Gas Engines, Prof. W. T. David. The following abstract is given in the words of the author of the article. An attempt is made in the article to clear up certain obscure points in the working of gas engines, and to describe some of the properties of the working fluid which have been ascertained recently from experiments made by the author. Before passing on to a detailed statement it will be convenient to summarize the main conclusions reached.

The article is divided into four sections. In the first section it is shown that incomplete combustion, increasing specific heat and cooling are all important factors in limiting the pressures developed during the explosion of mixtures of coal gas and air contained in a closed vessel. Experiments show that only 90 per cent of the coal gas is burnt by the time the maximum pressure is reached, and it is estimated that were it possible to check all heat loss and burn all the gas within the explosion period the maximum rise of pressure would be increased by 14 per cent in the case of a 15 per cent mixture of coal gas and air and by 31 per cent in the case of a 9.7 per cent mixture.

In the second section after-burning in a gas-engine cylinder is discussed. It is inferred that with normal ignition only about 70 per cent of the fuel charge is burnt at the moment indicated by the peak of the indicator diagram, and there seems little doubt that incomplete combustion ranks equally with increasing specific heat as a primary cause limiting the maximum pressures developed in gas engines. The distinction between inflammation and combustion is emphasized, and it is suggested that with normal ignition setting the maximum pressure occurs more or less in the neighborhood of complete inflammation. In strong mixtures which give vertical explosion lines in the indicator diagrams, the bulk of the after-burning appears to be completed in the early stages of the expansion stroke, owing to the fact that the rate of change of volume is small in this epoch. Consequently, in strong mixtures after-burning does not affect the thermal efficiency very much. In the case of

weaker mixtures giving sloping explosion lines the rate of change of volume after the maximum pressure is reached becomes fairly rapid, and after-burning continues for some considerable distance down the expansion line. The thermal efficiency is therefore considerably affected both on account of slow inflammation and on account of after-burning. The conclusion is reached that the defect of the actual efficiency of an engine from the ideal variable specific-heat efficiency is to be attributed mainly to heat flow from the working fluid into the cylinder walls when it is working on strong mixtures and mainly to slow inflammation and after-burning when it is working on weak mixtures. The possibility of speeding up after-burning is discussed and suggestions are put forward for a research directed to this end.

In the third section it is shown that the curve prepared by the British Association Committee on Gaseous Explosions connecting the internal energy of a typical gas-engine mixture with its temperature requires modification at the higher temperatures. Assuming the correctness of the curve at the lower temperatures, a modified curve has been prepared which gives at 2000 deg. cent. a value for the internal energy about 4 per cent less than that given by the British Association Committee.

In the fourth section it is shown that the heat loss in any given engine working at a constant speed may be calculated approximately by means of the formula $KT^2_{max.}$, in which K is a constant for the given engine and $T_{max.}$ the absolute maximum temperature developed on explosion of the charge. It is also shown that, although the heat loss by conduction per unit area of wall surface at any given gas temperature is independent of the dimensions of the cylinder, the loss by radiation per unit area increases greatly with the dimensions. The reason for the unreliability of the large gas engine is thus made clear. (*Engineering*, vol. 113, no. 2932, Mar. 10, 1922, pp. 281–284. 2 figs., *tA*)

Heavy-Oil Two-Cycle Garuffa Motor. Description of what is claimed to be an extra light heavy-oil aeronautical engine based on the Diesel cycle. It is stated that it can be built with stationary cylinders disposed starwise, in V or in a single row. The type specially designed for aeronautic use consists of nine cylinders starwise and it is said that one such motor worked on the testing stand for 28 hours and without interruption, notwithstanding the fact that the weight of the motor is only 800 gr. (1.76 lb.) per horsepower.

The Garuffa motor has no valves but is provided with ports, intake and exhaust, which are opened and closed by the piston. Fuel injection is secured by a direct-acting atomizer. It begins a little before the piston reaches the dead center and continues for a little while afterward, thus giving a cycle composed of an explosion phase followed by a gradual combustion phase. The atomizer is designed with the idea of breaking up the liquid as much as possible, partly by means of passing it through a series of capillary holes in the cylinder and also by applying pressure directly to the fuel. In this case the single pump gives a gage pressure of from 7 to 10 atmos. in all the cylinders. (*L'Aerophile*, vol. 30, no. 3–4, Feb. 1–15, 1922, pp. XVIII–XX, 4 figs., *d*)

Some Aspects of Air-Cooled Cylinder Design and Development, S. D. Heron. An extensive paper reviewing some of the salient points arising in the design and development of the modern high-output air-cooled cylinder, and based to a large extent upon the work of previous investigators.

The problems of an aircraft cylinder of approximately 40 b.hp. are dealt with primarily, but some aspects of automobile-engine cylinder design are considered.

The first point treated is the heat to be dissipated, this being followed by a consideration of how to secure an even temperature distribution in the various parts of the cylinder. Cooling by a direct air blast and by conduction is discussed, the importance of removing the heat from the cylinder at the point where it is given to the head, the ports and the barrel being particularly emphasized. The effects of mixture strength and cooling-air supply upon the cylinder temperature are commented on, the text being supplemented by a number of tables. Methods of finning different forms of cylinder, the cooling surface required; the effect of the compression-ratio on the output, fuel consumption and wall temperature; cylinder materials; types of cylinder, with a summary of the advantages and disadvantages of the different forms of construction, valve-seat inserts in aluminum cylinder heads; exhaust-valve cooling; and valve gears, all receive attention.

The conclusions reached are that (*a*) successful air cooling is not limited to 50 b.hp. per cylinder; (*b*) fragility of the fins is a disadvantage of air cooling; and (*c*) the compromises necessary in the design of air-cooled cylinders have been made at the expense of the cooling efficiency.

The effect of the position of the spark plugs on the power output and the fuel consumption is discussed in an appendix and the use of two spark plugs located on a common horizontal axis that passes through the vertical axis of the combustion chamber in such a position that neither plug can project a flame wave against the exhaust valves is commended. The influence of gas velocity through the valves on the performance of an air-cooled engine is the subject of a second appendix. In this, as throughout the paper proper, numerous illustrations and tabulations of test results supplement the text. (*The Journal of the Society of Automotive Engineers*, vol. 10, no. 4, pp. 231–260, 35 figs., *etA*)

MACHINE PARTS

Tangent Rack Gearing

Hotchkiss-Taylor System of Tangent Rack Gearing. Investigation of system of gearing in which the rack is arranged in a plane tangential to a cylinder as shown diagrammatically in Fig. 9. The basic gear form of this system is a ground wheel, the teeth of which are involute curves in a plane normal to the axis of the crown wheel. Fig. 9 shows the crown-wheel involute-curve teeth and to the left an extension representing the tangent rack of similar tooth profile.

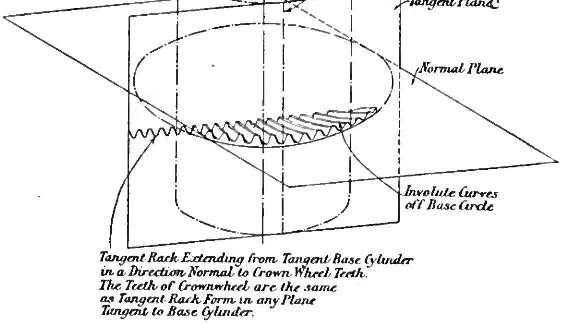


Fig. 9 Hotchkiss-Taylor System of Tangent Rack Gearing

The original article shows modifications of the same system, for example, the spiral bevel and the double helical bevel, and it is said that it is possible to produce bevel sets with non-intersecting axes.

In the tangent rack system any gear whether cylindrical or conical can be meshed with any other provided it is conjugate to the basis tangent rack crown wheel, and base circle or normal pitches are equal. The end thrust with this system of gearing is small in the case of crown wheels, and practically nil in the case of the pinions, being due to the rack-section pressure angle only, so that heavy thrust bearings are not required. For tangent involute worm gears it is desirable to employ a fairly high pressure angle, in order to mitigate the interference which would otherwise occur arising from the curvature of the crown-wheel teeth. The spiral of tangent bevel gears is involute, and in action the load component of the torque is applied tangentially to the base cylinder at any position of engagement of the pinion teeth with the crown wheel. (*Engineering*, vol. 113, no. 2935, Mar. 31, 1922, pp. 400–401, 10 figs., *d*)

Manganese Bronze for Valve Stems, Wm. R. Conard, Mem. Am.Soc.M.E. The author believes that the best bronze for valve

stems is that which has the characteristics of high yield point or elastic limit, moderate ductility, and high ultimate strength, but not more than 100 per cent higher than the yield point.

This is comparatively easy to obtain as there are bronzes which have a yield point of not less than 40,000 lb. per sq. in., an ultimate strength of 60,000 to 70,000 lb. per sq. in., an elongation percentage of 10 in 2 in. and a reduced-area percentage of 10.

To overcome the causes of failures of valve stems as far as possible, the calculations for stem diameter should be based on the following:

Allowance for the fact that the metal at the base of the thread does not have as great a strength as near the surface or the top of the thread; a further allowance for the use of tools for operating, which will exert greater stress than the usual tool used; together with allowances for friction due to corrosion or sediment in the water, and other factors mentioned earlier, of weight of mechanism, friction of gates and seats in operation, and friction in stuffing box, control the area at the base of the thread, and also that a liberal allowance should be made the governing feature for factors of safety, and the metal should have a high yield point, a fairly high ultimate strength, and moderate ductility.

In order that the physical qualities of the bronze may be known and kept uniform, it is very important that frequent tests be made. The proper way to get the pieces for testing so as to have them as truly representative as the stems themselves, is, where the stem is cast and large enough to do so, to have the piece for testing cast attached to the actual stem, and where the stem is of a size to make this impossible the test piece should be cast in the same heat and in the same flask as the stems. In the case of hammered or forged stems, the test piece should be a prolongation of one end of the stem reduced to a cross-section that will show a close approximate of the metal in the stem itself. It is unnecessary to go into the details of the methods of making the physical tests.

For smaller and medium-sized valve stems up to and including those for, say, 24-in. valves, a cast stem is entirely proper, but for stems for valves 30 in. and larger they should be of forged manganese bronze. Forging adds very little to the cost and adds some to the physical qualities, but its main value lies in that the forging on stems of heavy cross-section makes the metal homogeneous and of uniform texture throughout, makes a perfect metal for the threads and eliminates the uncertainties that are apt to be present in the case of large castings, where the central section is subject to different cooling stresses than the outer section. (*Journal of the New England Water Works Association*, vol. 36, no. 1, pp. 32–36, and discussion pp. 37–39, *p*)

MACHINE SHOP

Hand- and Machine-Lapped Surfaces as Seen Through a Microscope. The production of highly efficient lapped surfaces is of considerable importance in precision-gage manufacture. From an investigation carried out by a manufacturer of gages by means of photomicrographs it would appear that there is a material difference between hand-lapped and machine-lapped surfaces; the latter not only appear to be smoother but the scratches on machine-lapped surfaces are short and either parallel with the axis of the plug or slightly inclined. On the contrary, scratches on hand-lapped gages extend diagonally around the work, due to the use of ring lap which is given a traversing movement. In lapping machines the finer surfaces are obtained by performing the lapping operation between two flat cast-iron plates having very true surfaces and operating in such a way that the plugs receive a combination of rolling and sliding action.

Among other things, it is stated in the article that lately a modified process has been developed for lapping of true cylinders between flat plates, of which no details are given though it is stated that by this means a number of cylindrical gages for other parts are lapped simultaneously and by systematically and repeatedly transposing them and averaging the errors the entire lot is finished to a true cylinder form to within, say, 0.00001 in. or less. (*Machinery*, vol. 28, no. 8, Apr., 1922, pp. 638–639, 6 figs., *dc*)

Production Figures on Locomotive Fusible Plugs. It is said that in England the capstan lathe was recently successfully used in connection with the production of locomotive-boiler fusible plugs. The special-tool layout for these plugs is shown in the original article and comprises, among other things, a starting and facing drill, a straight-flute drill, a double-knee tool holder with pilot, a taper boring bit and a special taper running steady. The machine is fitted with a chasing-arm attachment and the sequence of operation is as follows:

Grip plug on square end with special jaws in two-jaw chuck.

Start drill and face end of casting to length, with special starting drill and holder.

Drill-tapping hole with straight-flute drill in drill chuck.

Turn external diameter of plug (parallel) to remove scale, with double-knee tool holder, cut being steadied by plain pilot fitting in hole already drilled.

Open out end of hole with taper boring bit.

Steady with special taper plug in standard running center steady, and form external diameter to correct taper with wide form tool on rear of cross-slide.

Retain running center steady in operative position and cut thread with chasing tool in swing-over chasing arm. Approximately six cuts are necessary to cut the full thread.

Tap center hole, using $^5/_8$-in. tap in standard releasing tapholder.

Remove from chuck.

The maintainable production time on this sequence of operation is 1 min. 15 sec. per plug, or 48 plugs per hour. It should be realized that this production time applies to the complete machining of the plug from the rough casting, screwing it both internally and externally to the usual standard gages, so that no further machining work is necessary. (*British Machine Tool Engineer*, vol. 2, no. 14, Mar.-Apr. 1922, p. 452, *p*)

MEASURING APPARATUS (See Railroad Engineering)

MOTOR-CAR ENGINEERING

Nitrogen as a Tire-Filling Material. The Roland Machine Construction Co. of Berlin has experimented with rubber tires filled with pure oxygen and find that they deteriorate with great rapidity under these conditions. As this tended to point to the possibility that it was oxidation phenomena that caused the destruction of the tires, experiments were carried on in the opposite direction, namely, with oxygen-free, that is, inert materials, in particular, nitrogen as tire filler. The results have been very interesting. Nitrogen-filled tires maintain their hardness for over a year in cars driven over thousands of miles on open roads. The loss of nitrogen proved to be surprisingly small and the state of the rubber far better than in air-filled tires. Similar tests have been carried out by the Continental Caoutchouc and Rubber Co. (German) and have given substantially similar results. The explanation offered by Prof. K. A. Hoffmann is based on the sensitiveness of rubber to oxygen and particularly ozone. A contributing factor is the oxidation of the sulphur contained in vulcanized rubber.

It would appear that if the advantages from filling tires with nitrogen instead of air are as great as would follow from the above described experiments, the question of added cost would not be of material importance. (*Motor und Auto*, vol. 19, no. 5, Mar. 15, 1922, pp. 73–74, *epA*)

Mercedes Car with Supercharged Engine. In the Targa Floria race held on April 2, 1922, on the island of Sicily, the Mercedes car covered 269 miles in 6 hr. and 50 min. at an average of 39.3 miles an hour. The speed does not appear to be large unless it is taken into consideration that the race was around a mountain side with a number of bends and holes, testing the endurance of both cars and drivers to the utmost.

The Mercedes car used a supercharger about which very few particulars were given out at the race. The engine had four valves per cylinder driven by a couple of overhead camshafts in aluminum housings. The camshaft drive was by vertical shaft and bevel gearing at the rear, with the magneto also at the rear, and the spark plugs placed in the center of the cylinder head. The design makes it possible to throw the supercharger into and out of engagement as desired. Nothing definite has been published about the power

output of the engines, but the author learned on reliable authority that they run up to 5000 r.p.m. (*The Autocar*, vol. 48, no. 1382, Apr. 15, 1922. The entire article covers pp. 622–628, illustrated; the part referring to the Mercedes engine described in the abstract, pp. 627–628 with no illustrations, d.A)

POWER-PLANT ENGINEERING (See Also Air Engineering)

Setting Valves of Marine Engines by Elliptical Diagram

Setting Valves by Elliptical Diagram, Arthur O. Gates. Description of a method employed on marine engines. The common method of setting valves on marine engines after an overhaul is by the use of rods or trams which have marked upon them the positions of the valve points and the openings into the cylinder casting. One of these rods is held upon the outside of the cylindrical casting; the other is set upon the end of the valve at some designated point. The engine crank for that cylinder is brought to dead center and the valve adjusted to the designated lead. The process is clumsy as the trams may be easily lost and there is always a chance for uncertainty in the measurement and adjustment of the lead.

In January, 1918, the U. S. S. *Marblehead* was released from the Mare Island Navy Yard after a short overhaul of her engines which necessitated resetting of the valves. On the run down the California coast it was found that the valves were not properly set and the writer was assigned to the duty of planning and making the proper changes. He did this by the application of the elliptical diagram.

The diagram given in Fig. 10 is for one low-pressure cylinder and is reduced to about half size. In the original plotting the actual movement of the valve was shown at all points, while the piston movement was plotted to scale. After the plot was made the distance that the valve was open at the top when in its lowest position for one block setting was measured upon the diagram and a horizontal line drawn through this point. The valve traveled upward this amount and closed the port. This is the point of cut-off. The valve continued to travel upward and after a distance of about $1^{1}/_{2}$ in., as may be calculated from the drawing of the valve and ports, the port to the bottom end was closed; this determined the compression point of the bottom end. Travel continued for about $1^{1}/_{8}$ in. and the release of the top end occurred. Then, as the valve traveled upward $1^{9}/_{16}$ in. further, steam was admitted to the bottom cylinder and the valve continued upward until the port opening of the bottom end became $2^{3}/_{4}$ in. by the old setting and 3 in. by the new. These were measurements calculated from the drawing as there was no way (or need) to get under the valve without dismantling the engine.

Following the valve on its return stroke, on closing the port for cut-off of the bottom cylinder the valve had of course traveled back the $2^{3}/_{4}$ in. or 3 in. mentioned above; then down $1^{9}/_{16}$ in. to compression of the top end; then down about $1^{1}/_{8}$ in. to release of the bottom cylinder, then $1^{1}/_{2}$ in. down to admission to the top end, and on to the end of the stroke of the valve, which gave a full valve opening of $2^{3}/_{16}$ in. by the old setting, and $1^{15}/_{16}$ in. by the new.

The other curves were obtained by changing the block setting, screwing it in the number of inches indicated by the number on the curve. The valve gear of this engine was of the Stephenson link type using the double bar link of a type common in marine practice, and the control of the expansion of the cylinder was obtained by adjustment of the position at which the rod connecting the Stephenson link was secured to the reversing gear. An adjustable block at this point determined the point of application of the eccentric motion to the valve stem.

From these diagrams indicator cards may be constructed. Among the points brought out by this diagram is the relative unimportance of lead. With a new setting the lead at the top end (bottom of diagram) measures about $^{5}/_{16}$ in. and for the bottom end $1^{3}/_{16}$ in.

The author believes that this diagram could be applied to the settings of valves of a Corliss engine by plotting the movement of the wristplate measured along the arc of the pins of the rods connecting to the valves; on some engines two sets of diagrams would be required—one for the steam valves and one for the exhaust valves. The theoretical indicator diagram which has been added below the valve diagram is intended to show how the adjustments would affect the points in the card, and without regard to the pressures, clearances and distribution between the different cylinders. (*Power Plant Engineering*, vol. 26, no. 8, Apr. 15, 1922, pp. 410–413, 1 fig., p.A)

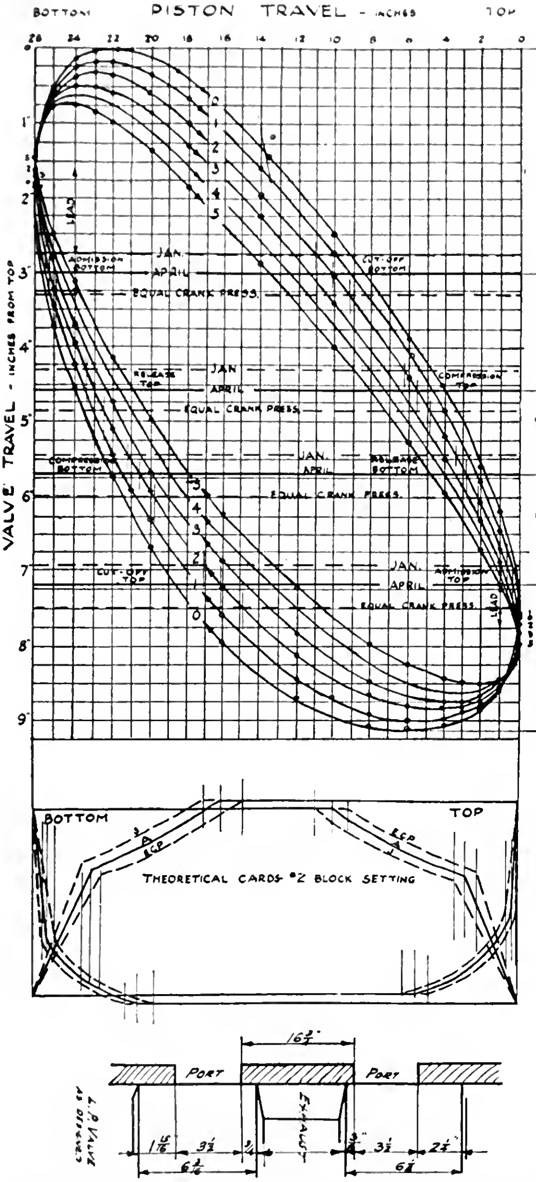


Fig. 10 Elliptical Diagram Used in Setting Engine Valves

PUMPS

Tests on Impact Losses of Water Jets

Impact Losses of Jets, J. J. Burnell. Description of tests and experiments on water jets from centrifugal pumps carried out at the pumping station of the State Rivers and Water Supply Commission of Victoria, Australia. The article describes fully the method of carrying out the tests.

The first set of experiments was designed to determine the loss of kinetic energy in the jet due to varying deviations. The results obtained show that the loss of velocity due to sudden deviation of the jet through any angle up to 90 deg. is practically negligible. The greatest loss of kinetic energy occurs between 20 and 25 deg.

deviation and is of the order of 2 per cent only. It was observed, however, that for angles of deviation of 10 deg. and upward a certain portion of the total flow took place along the vein in the direction opposite to the main flow. The results are given in Fig. 11.

The three curves in Fig. 11, in which the proportion of back flow is plotted against the deviation of the jet in degrees, show a curious inflection extending from 15 to 30 deg. Such an inflection might be suspected as due to experimental error were it not very similar in all three curves, and did not correspond almost exactly to an inflection in the curves purposely shown below, in which the kinetic energy after impact or deflection is similarly plotted against the deflection of the jet in degrees.

Formulas for the relative proportion of back flow to forward flow are given in the original article, and are compared with the results obtained by Prof. A. H. Gibson. (Hydraulics and Its Applications, p. 368.)

While the experimental results do not fall exactly on this curve they do follow it more or less closely, and conform generally to the law it expresses. From 0 deg. to 10 deg. there is considerably less back flow than indicated by the theory; exact agreement occurs at about 15 deg., beyond which the back flow is always greater than indicated by the theory. Above 15 deg. the discrepancy is greater the greater the head. In practice, however, the results between 0 deg. and 15 deg. are those of greatest importance. The proportion of back flow up to 10 deg. deflection is so very small—about one part in 1000—as to be quite negligible in ordinary practice. For 15 deg. it may be taken as 1.8 per cent.

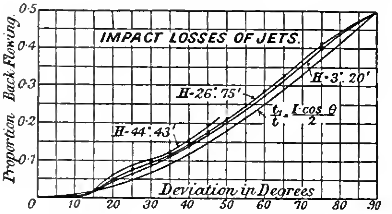


Fig. 11 Impact Losses of Water Jets Due to Deviations

Friction losses in bends were also investigated and were in general found to be quite small. (Paper before the Melbourne Division of the Institution of Engineers, Australia, Oct. 26, 1921, abstracted through *Engineering*, vol. 113, no. 2935, Mar. 31, 1922, pp. 404–405, 4 figs., *e*)

RAILROAD ENGINEERING (See also Machine Shop and Varia)

Studies on the Design for a 150-Lb. Rail Section, W. C. Cushing. The crux in rail design is the width and depth of head necessary to perform its work with safety and economy. There are two sets of conditions which determine the designs of rail sections, the sections being known as types RA-A, and RA-B. The one set of conditions is heavy tonnage carried in a territory of crooked alignment and steep grades, while the other set is centered in territory with better alignment and grade with the duty of carrying traffic of more moderate tonnage.

After all rail design had been brought to these two general types, the Rail Committee of the American Railway Engineering Association, after years of study, succeeded in having the set of designs known as the RE rail sections accepted as recommended practice, with weights varying from 100 to 140 lb. Lately a 150-lb.-per-yard section has been designed and recommended to the Rail Committee for presentation to the Association. While it has not yet been considered by the Rail Committee, it is of interest.

It has been proved many times that a heavy deep head is necessary for bearing safely and economically all heavy tonnage in territory of crooked alignment and steep grades. This has been confirmed practically by tests on the Pennsylvania Railroad. The first thing, therefore, to decide upon is the quantity of metal for the head deemed essential for carrying the load-bearing relation to wheel thread and allowing for considerable wasting away of metal before loss in strength requires removal. It is then necessary to decide upon the suitable thickness of base to avoid fractures and make a proper balance of metal with the head so as to render the problem of rail straightening easier by a medium punishment of the metal. It is next desirable to have proper relation between the thickness of web and its height in order that the column should be suitably proportioned.

Actually, the practice of the companies principally in the northeastern part of the country with great density of traffic carried over crooked alignment and steep grades leans toward rail design with heavy head and moderate height, while the western and southern companies having less dense traffic and larger percentage of tangent alignment with easy curves favor the thin head and great height.

As regards the cost per mile per unit of weight (10,000,000 tons) of traffic borne by the different weights and sections of rail, there is no reliable information, but from careful observations it has been estimated that the 130-lb. rail on the Pennsylvania System in its heavy-curvature districts outlasts by $2^1/_2$ times the 100-lb. section, and is worth 23 per cent more in reduced maintenance.

The conclusion to which the author arrives is that the time has not come yet for making any change in the present RE sections, especially as the 100-lb. and 130-lb. sections are now rolled. (Paper before the Annual Meeting of the American Railway Engineering Association, abstracted through *Railway Review*, vol. 70, no. 13, Apr. 1, 1922, pp. 447–449, 3 figs., *g*.—The author is Engineer of Standards, Pennsylvania Railroad System)

Test of Siphon Locomotive on Spokane International Railway. The Spokane International Railway in operation over its main line has to deal with conditions of local work and severe grades of such a character that it proved to be difficult to maintain the schedule with 10-wheel locomotives having cylinders 19 in. by 24 in. and 22,000 lb. tractive effort handling 5-car trains. This situation is still more aggravated by the poor quality of the coal and the limited grate area.

In an effort to remedy these conditions the railroad decided to install a Nicholson thermic siphon (Compare Mechanical Engineering, March, 1919, p. 284) on one of these passenger locomotives and to test this locomotive in comparison with another locomotive of the same class having a plain firebox.

The original article states the main reasons why the thermic siphon was selected in preference to other devices, among these factors being its ready adaptability to the locomotive and low maintenance charges, since the siphons become virtually a part of the firebox and necessitate no repair work outside of the ordinary firebox maintenance. Moreover, the application of this device has proved to be a relatively inexpensive means of increasing locomotive capacity and efficiency. The original article gives some data on the method of applying a single thermic siphon to the narrow firebox of the 10-wheel type locomotive.

The results are given in the original article in the form of curves and tables. From these it would appear that the application of the thermic siphons increased the tractive effort and cylinder horsepower, the former from 22,000 to 31,160 lb. and the latter from 1202 to 1264 hp. In addition to this, decidedly better firebox and boiler conditions have been obtained. The increased boiler and cylinder capacity of the siphon-equipped locomotive made it possible to handle the same train with greater ease, while the additional heating surface and improved water circulation caused by the siphon made a marked improvement in the steaming capacity of the locomotive. Maximum steam pressure was maintained at all times and the boiler was fully supplied with water during all of the runs with the siphon-equipped locomotive, while with the non-siphon locomotive it was necessary to trade water for steam in hard places. The coal consumption per sq. ft. of grate area was reduced to 133 lb. as compared with ordinary consumption which frequently exceeded 160 lb., and as a result of these tests the Spokane International Railway has ordered siphon equipment for a freight locomotive, which will enable the railway to increase the diameter of the cylinders on this locomotive 1 in., thus materially increasing the tractive effort and cylinder horsepower. (*Railway Review*, vol. 70, no. 15, Apr. 15, 1922, pp. 522–524, 3 figs., *cc*)

Ramsay Condensing Turbine Electric Locomotive. The locomotive was built for the Ramsay Company at the works of

Sir W. G. Armstrong, Whitworth & Co., Ltd. In this locomotive a condenser of novel form is applied in conjunction with the steam turbine. Superheated steam is expanded down from boiler pressure to a vacuum of 27½ in., the condensate being drawn off from the condenser by a rotary extracting pump and returned to the hot well, from which a feed pump delivers water into the boiler, thus completing the cycle.

The front engine, both as regards the boiler and underframe, differs but little from accepted locomotive practice, except that the reciprocating engine is displaced in favor of a turbo-generator made by the Oerlikon Company, of Zurich. The main turbine is of the impulse pressure compounded multi-stage type, connected through a flexible coupling to a three-phase generator capable of sustaining a 25 per cent overload for half an hour. This generator is separately excited by an auxiliary turbine-driven direct-current generator. The three-phase generator supplies power to four three-phase slip-ring motors arranged in two groups on the front and rear parts of the locomotive, respectively. The two motors of each group are bolted to a common stretcher carrying a countershaft, to which the motors are geared. The power is then transmitted from the countershaft to the six driving wheels on each part of the engine by coupling rods in the ordinary manner. Each of these motors is capable of developing 275 hp.

The rear engine contains the coal bunker and cooling-water tank, as well as the condenser and its appurtenances. The condenser forms one of the novel features of the engine. It is of the evaporative type supplied with air by a fan at the rear of the engine. The steam tubes of the condenser are arranged in the form of a cage, which is caused to revolve in water at slow speed and through which the air is impelled by the fan in a radial direction over the tubes. A flexible pipe between the two portions of the engine connects the turbine exhaust to the condenser.

The boiler is hand-fired and is fitted for forced draft. The driver operates the locomotive by means of a master controller placed in the cab. (*The Engineer*, vol. 133, no. 3456, Mar. 24, 1922, pp. 328–329, 2 figs., *d*)

Dynamometer-Car Tonnage Tests, O. O. Carr. The article is based on an experience of several months on a dynamometer car engaged in carrying out tonnage-rating tests on the Illinois Central Railroad.

One of the conclusions to which the author arrives is that office ratings of engines are entirely unreliable. Actual test observations show that train-resistance formula calculations are at variance with different track conditions. For instance, an 85-lb. steel track laid 12 years and worn down pretty well on a gravel bed through a cut on a 26-ft. grade will stall an engine loaded to maximum, and yet the same engine will have no difficulty whatever in going over a 26-ft. grade, 90-lb. rail, rock-balanced bed, the difference being due to the greater track resistance of the former.

Among the important factors affecting tonnage capacity of freight trains are mentioned individual locomotive characteristics and personal characteristics of the engine crews, as well as the kind of cars and their loading.

A comparison of results shows false economy of reducing tonnage. There is no economy in giving engines a 100 per cent train over a 130-mile district where there are a number of heavy grades to contend with and keep a train on the road 14 or 15 hr., but it may be profitable to keep a train on the road 12 hr. with a 100 per cent loading if this can be done without impairing the coöperation of the train crew in getting over the road.

Large train loads mean not only decreased number of train units running in both directions but decreased number of locomotives to handle and maintain, enabling more expeditious train movement and a corresponding increase in the capacity of the railroads. (*Railway Review*, vol. 70, no. 13, Apr. 1, 1922, pp. 451–455, *pA*)

Water Treatment as Affecting Locomotive Performance, W. A. Pownall. This article is based on the experience of the author for the past ten years on the Wabash Railway, where he occupies the position of mechanical engineer. There soda-ash treatment is being used and favorable results secured.

As regards the cost of water treatment, the waste of fuel and water in blowing off is possibly the major part, but there is no guesswork as to this item of expense. On an ordinary division where the treatment averages 0.6 lb. of soda ash per 1000 gal. of water, the fuel waste in blowing off is approximately 1.1 per cent of the coal used, and the total cost of the coal and water wasted is about $0.026 per 1000 gal. The average cost between washouts will be less than this since very little blowing is done after washout until the concentration has reached the foaming point. Under ordinary conditions it is usually cheaper to blow out a boiler than to wash it out at the terminal, but the cost of blowing out is much more than offset by fuel saving from clean heating surfaces and by other attendent benefits.

The writer emphasizes the fact that it is very essential to the successful use of treated water to have the support of the enginemen.

Some practical suggestions as to the details of operation are offered in the original article. In particular, it is stated that on the Wabash the foaming point is reached when the concentration of dissolved solids is about 240 parts per 100,000. (*Railway Mechanical Engineer*, vol. 96, no. 4, Apr., 1922, pp. 191–192, *p*)

Steel Rails Embrittled by Welding Bonds. According to tests made by a private laboratory it was found that decided weakening of steel T-rails is produced by attaching electric rail bonds by welding.

On some lines of the Mexico City Street Railway System loss of exposed copper bonds by theft became serious enough to make a concealed bond desirable. A bond was therefore designed to fit under the standard splice bar passing around the bolts and was to be attached to the rail web by means of electric arc welding of the steel facing to the rail metal.

In tests made to determine whether this method of attaching a bond affected the strength of the rail, samples were submitted to comparative drop tests. In these tests the unbonded specimens broke on the third and fifth blow, where the bonded specimens drop on the first blow. Moreover, quite abnormal shapes of fracture resulted in the case of the bonded specimens. It is believed, however, that attaching the bond to the head or base of the rail by welding instead of to the web may not be injurious, owing to the more massive shape of the sections affected. (*Engineering News-Record*, vol. 88, no. 13, Mar. 30, 1922, pp. 524–525, 2 figs., *d*)

SPECIAL PROCESSES

The Manufacture of Brass Forgings, C. T. Roder. Description of a process which is also called die pressing or hot forging. The method of forging brass was initially developed in Germany and Great Britain about 1900. In this country it did not reach the stage of commercial-development until after the United States went into the war. The process requires the highest type of skill in the art of forging.

A brass pill or slug cut off from extruded rod is heated in a specially constructed furnace open at both ends to a cherry-red heat (approximately 1300 deg. fahr.), though the temperature varies with size and construction of the piece to be forged. The pill is then fed into the press. The ordinary small shapes (up to 4 in. in diameter) are forged under 400,000 lb. pressure; for larger pieces presses are used having capacities up to 600 tons. With the continuous operation of a press and a skillful operator one press can average from 5,000 to 10,000 forgings per day.

Small forgings of simple design where the metal does not have to flow far are produced in a single-acting press. Where the shape is very intricate and where it is necessary for the metal to flow over a long distance, double-acting presses are used.

Brass forgings are 80 per cent stronger than sand castings and show a tensile strength and yield point, respectively, of 55,000 and 28,000 lb. per sq. in. and an elongation of 30 per cent, though the writer knows of instances where forgings have been made with a tensile strength of 105,000 lb. per sq. in., this being accomplished by a special mixture of metals. Dimensions can be held to 0.005 in. on diameters and 0.010 in. on length, in addition to which the metal is easier to machine than sand castings.

The original article gives some practical suggestions as to die design and expresses a belief that the forging process will extend in its applications. (*The Iron Age*, vol. 109, no. 13, Mar. 30, 1922, pp. 857–858, 2 figs., *dp*)

STEAM ENGINEERING (See also Air Engineering and Power-Plant Engineering)

Laws of Similarity as Applied to Steam Turbines

The Size Factor in Steam Turbines. Laws of similarity have been found to be applicable to reciprocating steam engines and it is generally accepted that while the output of engines run at corresponding speeds increases as the square of the scale, the weight increases as the cube, and hence the weight per horsepower developed should increase directly as the cylinder diameter.

The corresponding law of similarity applies to steam turbines, with the distinction, however, that while in engine practice the dead weight carried by the shaft is commonly small compared with the load imposed by the steam pressures or by the inertia of the moving parts, in a steam turbine the bending stresses are entirely due to the weight of the rotor which increases as the cube of the scale. Hence, with geometrically similar rotors the bending stress on the shaft will increase in direct proportion to the scale, but as regards output the same rule applies as in the case of the reciprocating engine, namely, that at corresponding speeds the output increases as the square of the scale.

The effect of change of scale on the efficiency of geometrically similar turbines does not appear to have received much study as yet, and evidence is much less direct than is desirable.

A large turbine is not generally a replica of a small one to a larger scale, a condition of affairs for which commercial considerations are largely responsible. The cost of valves, governor gear, oil pumps, tachometers, gages and other accessories forms a far greater proportion of the total cost of a small turbine than it does of a large one. Some interesting information on this head was given in a paper read before the Rugby Engineering Society in 1913 by J. P. Chittenden, from which it appears that in the case of a turbine rated at 500 kw. the cost of accessories amounted to 45 per cent of the total. With an output of 10,000 kw. this figure was reduced to 30 per cent. Hence small turbines have in general been constructed with a lower ratio of blade speed to steam speed than large ones, so as to keep down the cost per kilowatt of rated output.

For this reason the data for a direct determination of the effect of size on the efficiency hardly exist. In actual fact the published test data for small turbines and for large ones plot down very fairly on the same efficiency curve, but this constitutes by no means conclusive evidence that the effect of size on efficiency is unimportant, since for the reasons stated the large turbines and the small ones correspond to different regions of the curve and are not therefore similar turbines run at equivalent speeds.

That the test results do in general plot down with fair regularity is very satisfactory from the practical standpoint as it simplifies the work of the designer, but it is not what would have been anticipated from general considerations, almost all of which would lead us to anticipate that the element of mere size should have a by no means negligible influence on turbine efficiency. For example, from the theory of dimensions it appears that in geometrically similar turbines run at corresponding speeds the waste of thermodynamic head in guide-blade and bucket friction should vary as d^{-n}, where n is unknown, but is in all probability a small positive fraction, and d denotes some characteristic dimension of the similar guide blades. In the actual practice of today, however, the dimensions of the guide blades and buckets hardly increase as fast as the diameter of the turbine, and this will tend to reduce the difference between the relative steam friction losses in large and in small machines.

The question of relative clearance losses is a difficult one. In general engineering work clearances vary rather as the square root of the scale than in direct proportion thereto, and if this rule held in steam-turbine practice the larger the machine the smaller proportionately should be the losses by leakage. On the other hand, if the main proportions of the machine were strictly geometrically similar, the deflection of the shaft would increase directly as the scale and the limiting value of the clearances to which it is practicable to work must be a fraction of the shaft stiffness. If we attempt to obtain further light on this matter by a comparison with experience, we are again confronted with the lack of data which are fairly comparative, since in general the smaller machine will have fewer stages, and thus be relatively shorter than the large one, and the stiffness of shaft increases very rapidly as its length is reduced.

The subject of waste of energy in disk friction and fan action is also discussed largely on the basis of a paper by Eskil Berg read in 1919 before The American Institute of Electrical Engineers. (*Engineering*, vol. 113, no. 2935, Mar. 31, 1922, pp. 395-396, editorial article, *g*)

TESTING AND MEASUREMENTS

New Theory of Tensile Strength of Metals

Tensile Strength of Plastic Metals, Dr. Friedrich Koerber. This paper presents a method for computing the tensile strength of plastic metals from the curve of "true" stresses. It also discusses the mechanism of the tensile rupture test and proposes a theory of tensile stresses based on an assumption of slip and torsion effects of crystalline elements in the metal. Confirmation of the theory is sought for in X-ray photographs.

In tensile tests it is usual to compute the load on the basis of the initial cross-section of the test piece. The tensile stresses $\sigma = P/f_0$ computed in this manner, however, increase with increasing load up to a certain maximum value for cold tensile strength, and then fall off up to the breaking load at which the test piece ruptures. On the left-hand side of Fig. 12 is shown the stress-elongation curve as usually plotted. In this process the cross-section of the test piece decreases practically uniformly over its entire length; it is only after the maximum load has been reached that local contractions occur.

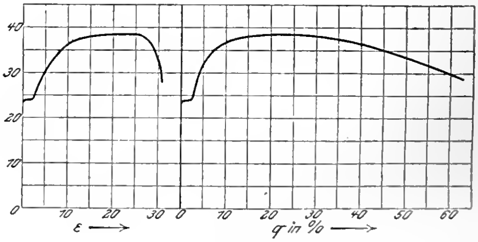


Fig. 12 Stress-Elongation and Stress-Reduction of Area Curves

On the right-hand side of Fig. 12 the variation of stress is shown for the entire test piece as a function of reduction of area at the thinnest obtaining section of the test piece. From such a curve it would likewise appear that the stress passes through a maximum value.

The stress values computed in this way do not, however, give a basis of measurement of the actual stresses produced in the test pieces by the load applied to it, and in particular it is difficult to express the physical meaning of tensile strength as the maximum load is being expressed in terms of a cross-section of test piece, which does not actually exist at the time when the maximum load is being applied.

A more complete idea of the state of stress in a material may be had by referring the load to the minimum area of cross-section in a test piece that may obtain at any given moment, which, in other words, means by computing the "true" stress $\sigma' = P/f$.

If the stress σ' obtained in this manner be considered in functional relation to the reduction of area, it will appear that in the region of the greater form variation of material these values lie very nearly along a straight line. This fact has already been observed before by the author and other investigators, and the author gives in the original article curves for pure iron-carbon alloys and technically pure copper, which illustrate the straight-line character of the stress-reduction of area curves.

In Fig. 13 the heavy line gives the ideal σ' curve. The point e shows the beginning of the reduction of area process. In the region of the greater plastic alterations of shape, the following law holds good: *The increase of stress is proportional to the alteration of shape of material expressed by the reduction of area.* If we select the initial area $f_0 = 1$, then the load or the stress σ referred to a unit of the initial cross-section of a material is a product of the "true" stress σ' and the area $f = (100 - q)/100$. While the cross-section f decreases gradually and in accordance with a straight-line law until it reaches a value of zero corresponding to a reduction of area $q = 100$,

the true stress σ' gradually rises from zero and, for the regions of greater stresses, follows likewise the straight-line law. From this it follows that the stress σ is equal to zero for those values for which σ' or f are equal to zero, and between these two values it passes through a maximum value σ_{max}. This particular value of tensile strength may be expressed by the formula:

$$\sigma_{max} = \left(\frac{\sigma'_0 + 100\,\alpha}{2}\right)^2 \times \frac{1}{100\,\alpha}$$

which permits computing the constants σ'_0 and α for the straight-line part of the $\sigma' q$ curve. The meaning of these constants may be seen from Fig. 13.

The parts referring to the theory of slip and torsion of the crystals in plastic metals cannot be reported here owing to lack of space. It is of interest, however, in view of the slip-interference theory proposed by Zay Jefferies and R. S. Archer, for which compare the abstract in Mechanical Engineering, August, 1921, p. 543 from *Chemical and Metallurgical Engineering* (vol. 24, no. 24, June 15, 1921, pp. 1057–1067). (Abstract from the Bulletin of the Kaiser Wilhelm Institute for Iron Research (Kaiser Wilhelm Institut für Eisenforschung) vol. 3, no. 2, in *Stahl und Eisen*, vol. 42, no. 10, Mar. 9, 1922, pp. 365–370, 8 figs., *etA*)

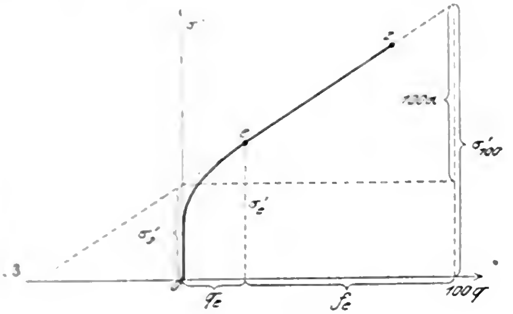


Fig. 13 $\sigma' q$ Curve

VARIA

Locomotive Construction by the British Government. The scheme for building locomotives by the Government originated with the Woolwich Shop Stewards' Committee (in America, Walking Delegates' Committee). After the Armistice an attempt was made to introduce commercial work into the arsenal production as a means to obviate unemployment.

Under this scheme all sorts of things, such as milk churns, medals, etc., were manufactured at the arsenal, the largest thing being, however, the manufacture of locomotives. There were initially no shops or machinery suitable for this and no officials who understood the business, nor was there any guarantee that the engines when manufactured would be purchased by the railway companies. Nevertheless, under the auspices of the Ministry of Munitions huge areas of existing factories at Woolwich were pulled down, machinery was transferred at great expense to other parts of the arsenal and the new plant was laid down at a period when both machinery and materials were at almost their highest price. The total expenditure in this connection is conservatively estimated at £500,000.

Shop managers who had no knowledge of locomotive manufacture were sent to railway engineering centers to obtain it. It took some time to organize the production and when the shops were ready the market began to fall. It is still falling owing to the cheapening of labor and materials, and English railway companies will not look at the engines at the prices the Government asks for them. At one time there was a hope that the locomotives could be sold to Russia until it was discovered that the gage was unsuitable for the railway systems in that country.

The result of this adventure in Government manufacturing is not encouraging. The Government has on its hands 45 locomotives it cannot sell; it has lost £900,000 in the business and has a further loss in view; it has a large plant of a very expensive character for which in the near future it will have no use; and the benefits to labor are more than doubtful. (*Daily Metal Trade*, vol. 12, no. 77, Apr. 19, 1922, p. 7, *g*)

Soundproof Partitions, F. R. Watson. Data of tests on transmission of sound through partitions, of interest in that, among other things, they present the theory of transmission of sound through a partition.

Sound may be transmitted from one side of a partition to the other in three ways: it may progress through continuous air passages; it may pass as an elastic wave length through the solid structure of the partition; or, by setting the partition in vibration, it may originate sound waves on the further side.

These actions are quite readily understood by remembering that sound consists of a series of compressions and rarefactions that progress rapidly through a medium without interruption unless they meet a new medium with a different elasticity or density. For instance, sound waves in air proceed without hindrance through air passages, such as ventilation openings in a partition. If, however, the passages are small in cross-section, as in the case of a porous material, the progress is hindered and a certain amount of absorption of the energy takes place, due to the friction set up between the vibrating air column and the sides of the pores.

In case the partition is impervious to air, the direct progress of the waves is interrupted. A thin partition is set in vibration and thus originates new waves on the side opposite the incident sound. For a thicker, more rigid partition the vibrations are smaller and a very considerable part of the energy is reflected. The transmission in this case takes place by compressional waves communicated to the solid material of the partition. The amount of energy thus transmitted is usually quite small.

In view of these considerations a soundproof partition should be as rigid and free from air passages as possible. For effective soundproofing of a group of rooms, the partitions, floors, and ceilings between adjacent rooms should be made continuous and rigid. Any necessary openings for pipes, ventilators, doors, and windows should be placed in outside or corridor walls where a leakage of sound will be less objectionable.

In case the sound is generated in the building structure, as the vibrations set up by a motor fastened to the floor, the compressional waves proceed through the continuity of solid materials. In order to stop them, it is necessary to make a break in the structure so as to interpose a new medium differing in elasticity and density. For instance, the vibrations of a motor may be minimized by placing a layer of hair felt, or similar air-filled material, between the supporting base and the floor. Where the machinery is quite heavy, footings may be made of alternate layers of asbestos, lead, and leather. Bolting through this material will reduce the insulation, because the vibrations in this case will pass easily through the bolts to the floor. The insulation should thus be left without any bridging over of the discontinuities. Air gaps in masonry will be effective if the air space is not bridged over at any point. A floor floated on sand, sawdust, or hair felt would approximate this condition. The edges of the floor should be insulated from the walls by felt or similar material.

Especial attention should be paid to the ventilation system. All effective soundproof constructions either omit entirely a ventilation system or else construct it in some special manner to avoid transmission of sound. In some buildings air is supplied and withdrawn from rooms by individual pipes that are small in diameter and extend without break from the air-supply chamber to the rooms. This results in considerable friction between the walls of the pipes and the air, with a resultant weakening of the sound waves. Without some efficient control of the transference of sound through the ventilation system it is a waste of effort to construct soundproof walls, double doors, and other contrivances for insulation.

When soundproofing a building all details should be considered with respect to the likelihood of transmission of sound. Each room, as far as possible, should be made an insulated unit by means of air spaces or air-filled materials that separate it from surrounding walls. Pipes and ventilators should be so installed as to minimize the chance of transfer of sound. Patent doors are now available that will close the door at top, sides, and bottom. In case a troublesome sound is generated in the room, it may be minimized by installing absorbing material on the walls.

The absorption of sound is an essential feature for soundproofing. Reflecting sound and scattering it still leaves it with energy. It must be absorbed; that is, converted into heat energy by friction, before it is eliminated as sound. This means that carpets, furniture draperies, etc., should be present, or if greater absorption is desired, hair felt or similar materials must be installed.

The insulation of sound is a complex problem and a successful solution is obtained only when all the possibilities of transfer of sound are anticipated and guarded against. (*University of Illinois Bulletin*, vol. 19, no. 28—same also as Bulletin 127 of Engineering Experiment Station, Mar. 6, 1922, pp. 1–178, 30 figs., bibliography pp. 77–78, *etA*)

Calculating the Efficiency of Boiler Seams, R. J. Finch. The article offers two tables worked out to shorten the labor necessary for finding the efficiency of a seam.

Table 1 shows what the author calls "value of rivet holes in plates;" in other words, the strength removed from the plate for various sizes of holes and thicknesses of plate. Table 2 gives the shearing value of iron and steel rivets for the different sizes of rivets shown in Table 1. Examples are given showing the rapidity with which the efficiency of seams can be calculated by the use of these tables.

As regards the design of seams, the author compares a decuple seam with a diamond seam. The latter under certain conditions and properly designed can have a theoretical efficiency as high as 98 per cent, but the author points out that there are certain drawbacks to a seam of too high an efficiency as well as to a seam requiring a wide side welt like the diamond seam. Among these drawbacks is the difficulty to properly design the brackets to hold locomotive accessories and still retain a proper efficiency for the studs attaching these brackets to the boiler shell. (*Railway Mechanical Engineer*, vol. 96, no. 4, Apr., 1922, pp. 193–196, 5 figs., *pA*)

WASTE PREVENTION

Utilization of Exhaust Steam from Electric Generating Stations, C. Ingham Haden. Discussion of prevention of waste of exhaust heat. The attitude which the author takes is that while the problem of lessening the waste of exhaust heat is a complex one, it is not impossible of solution.

The first main difficulty is to find a market for the heat; and if this is obtained the further difficulty arises of coördinating the loads, and from the point of view of economy he considers the heat load as a deciding factor.

Passing to the subject of super stations the author claims that the usual system of locating big generating stations at a supply of water for condensers is incorrect and it is the possibility of usefully employing exhaust heat that ought to be first considered in selecting their location. He further proposes the conversion of some of the existing generating stations which would be shut down under the superpower scheme but which are conveniently situated, into heat-distribution stations generating electric current as a by-product, and the linking up of such stations with the super stations.

While the superpower scheme considers generating stations from a comprehensive or national basis, it is equally important to consider the supply of heat upon a large scale. In practically all manufacturing localities there are industries that require heat in some form for boiling or drying purposes apart from the heating of the factories. Special arrangements would have to be made in such instances from a central source to supply steam at a suitable pressure, and this service could be maintained by live steam for continuous processes when the power plant was not running.

Utilization of exhaust steam for heat purposes, even at a pressure of 2 lb. per sq. in., would considerably reduce the electrical output and also render useless expensive condensing plants expressly designed to increase this output. The question resolves itself into one of economics, namely, would such a scheme be practicable and a paying proposition? The paper gives some practice of a typical district showing the probable heating and lighting loads, and finally describes installations which have already been carried out in England.

In the discussion which followed several references were made to American practice of district heating.

As an example of the author's method of calculation, the following may be cited. To take one example in London: a careful survey of the district within an approximate radius of half a mile from the generating station shows a possible heat load of 160,000 lb. of steam per hour, dealing only with buildings provided with existing installations for heating and hot-water supply, and those of suitable size for the steam service. If a further proportion of new buildings were erected within this area, this load could easily be doubled.

Taking the above figure as the demand, this would require additional steam at the station to allow for radiation losses, thus making the figure, say, 165,000 lb. of steam. With a boiler pressure of 150 lb. and superheat of 100 deg. fahr., and with generating plant designed for a back pressure of 60 lb. per sq. in. the steam consumption would be at the rate of about 115 lb. per kilowatt-hour, so that it would be possible to obtain power at the rate of about 1450 kw. Exhausting at 60 lb. per sq. in. there would still be some superheat in the steam, which would assist in reducing the radiation losses in the mains. The consumer would also benefit by any superheat remaining in the steam delivered to the calorifiers.

The net integrated load for the same district and buildings, allowing for average winter and summer conditions, amounts to 452,000,000 lb. of steam per annum. The gross income derived therefrom would amount to £90,400 if charged at the rate of 4 s. per 1000 lb., and the approximate number of electrical units obtained from the heat load to 3,930,000, which, at an average price of 2 s. 2 d. per unit, would amount to about £36,000.

The cost of the distributing mains, including all necessary work in the station and the formation of ducts, would depend upon the length of main required to serve the particular district, and the earning capacity of any main laid down would vary in like manner. Taking the same district, the total expenditure for engineers' work would be about £82,400, covering over 4 miles of streets, an average cost of £17,800 per mile, and an average earning capacity of £19,500 per mile.

The total load per mile is low, as one particular main a little over half a mile in length has an earning capacity of £23,800, equal to £37,000 per mile, showing that in districts where large buildings line the streets the income per mile would be still larger.

In addition to the distribution of heat by steam mains, it is possible in some cases to use hot water with advantage. (*The Journal of the Institution of Electrical Engineers*, vol. 60, no. 307, Mar., 1922, original paper pp. 265–271, discussion pp. 274–286, illustr., *pgA*)

WELDING (See also Railroad Engineering)

The Dependability of Cast-Iron Welding, G. O. Carter. In welding cast iron preheating and annealing are essential, and before welding the complete casting must be brought to a red temperature. This makes the welder's job strenuous; nevertheless, good men can be secured to do the work.

The article cites facts to show that good results can be and are being obtained with cast-iron welding, especially where this work has been properly systematized. The subject of preheating of castings is briefly discussed in a practical manner.

In the opinion of the author the difference between perfect success in some instances of cast-iron welding and failure in others lies in the various degrees of preparation for welding and treatment subsequent to welding. Cast iron not prepared by adequate preheating is apt to crack, and the crack does not always take place at the weld. For best results, the entire casting should be at a red temperature, though there are cases where partial preheating is sufficient. (Paper read before the Cleveland Section of the American Welding Society, abstracted through *The Iron Age*, vol. 109, no. 14, Apr. 6, 1922, pp. 928–930, 8 figs., *p*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Bearings A1-22. FRICTION AND CARRYING CAPACITY OF BALL AND ROLLER BEARINGS. The experiments which are recorded in this Technologic Paper No. 201 were carried on at the Bureau of Standards by H. L. Whittemore, mechanical engineer, and S. N. Petrenko, assistant mechanical engineer. Their purpose was to determine the maximum safe load and the static friction under load of ball and flexible roller bearings.

Tests were made on balls of 1.00, 1.25 and 1.50 inches diameter in grooved races and on rollers 1.25 inches in diameter and 5.25 inches long in flat and cylindrical races.

The total deformation and area of contact of bearings and races were measured and compared with Hertz's theory.

Conclusions: 1 The results agree roughly with Hertz's theory. The differences are ascribable to inhomogeneity of the material.

2 The ratio of friction to load is practically constant and equal to 0.00035 for all three sizes of balls up to a "critical" load, which varies with the diameter of ball: 1300 pounds for 1.00-inch, 1700 pounds for 1.25-inch, and 2200 pounds for 1.5-inch balls.

3 A similar "critical" load, 25,000 pounds, was found for the roller bearings with a ratio of friction to load equal to 0.00075.

4 This "critical" load at which the friction began to increase more rapidly was in all cases lower than the safe load as determined by permanent deformation and as calculated from Stribeck's law.

The complete paper may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 10 cents.

Cables and Ropes A1-22. TEST OF MANILA ROPE. The results of some tests of manila rope which had been conducted at the Bureau of Standards by Ambrose H. Stang and Lory R. Strickenberg are reported in Technologic Paper, No. 198. This paper summarizes the results of tensile tests of 368 specimens of manila rope. Most of the material was submitted on purchase orders for Government departments. They were all 3-strand, regular lay manila rope having diameters from $^1/_2$ in. to $4^1/_2$ in.

A summary of the results is given in tables and graphically. A formula is given for determining the average breaking load as a function of the diameter of the rope. The test results cover sufficient range and show such consistency that it is believed that the formulas may be used safely for 3-strand, regular lay manila rope of the sizes indicated. The ropes showed a continually varying modulus of elasticity and no well-defined proportional limit. This paper may be obtained by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy 5 cents.

Electrical Communication A2-22. HIGH-FREQUENCY RESISTANCE OF INDUCTION COILS. See *Electricity, General A1-22.*

Electricity, General A1-22. HIGH-FREQUENCY RESISTANCE OF INDUCTION COILS. On account of the importance of inductance coils in radio communication, careful studies, both theoretical and experimental, have been made at the Bureau of Standards on capacity effects and other effects in inductance coils at radio frequencies. Some of the results of these investigations are contained in a new publication, Bureau of Standards Scientific Paper No. 430, The High-Frequency Resistance of Inductance Coils. In this paper a formula for the resistance of an inductance coil is derived which takes into consideration both the skin effect and the capacity effect for the case of a short single-layer solenoid, and the results of experiments are given which check this formula. Other more general formulas for current distribution and resistance are also derived.

A copy of this paper may be purchased for 5 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Foundry Equipment, Materials and Methods A1-22. MOLDING SAND RECLAMATION. The Committee on Molding Sand Research through the courtesy of the American Steel Foundries Company has prepared a digest of the sand reclamation work carried on by the engineering staff of the A.S.F.

Because of the scarcity of steel-molding sand of the best quality and the problems arising from having to dispose of large quantities of refuse sand, this company has carried out an extensive investigation of methods of reclaiming the good material which is usually lost whenever the so-called refuse sand is thrown away. After experimenting along different lines and thoroughly going over methods employed in other plants, a process of reclaiming old sand called "centrifugal scrubbing" was developed.

The report covers the theory of sand reclaiming, centrifugal air-scrubbing process, cost of reclaiming sand by the latter process, and a description of the proposed sand-reclaiming unit. Address Alfred D. Flinn, Chairman of Division of Engineering, National Research Council, 29 West 39th Street, New York.

Fuel, Gas, Tar and Coke A8-22. COAL AND COKE MIXTURES AS WATER-GAS GENERATOR FUEL. The scarcity of high-grade coke and the great rise in price of all grades of coke have made it almost necessary for some gas companies to consider the substitution of bituminous coal for coke as generator fuel, even though grave difficulties were expected in maintaining the capacity of the plant with the new fuel.

The experiments conducted at Streator, Ill., in 1918, in operating a 6-ft. set 6 to 7 hours a day did not solve some of the important questions in the use of coal fuel, namely, the effect of a stand-over period on capacity and possibilities in the use of the blow-run method of operating with mixed fuels, coal and coke. The chief purpose of this paper, therefore, is to present information bearing on these problems and the results obtained during six weeks of experiment at Davenport, Iowa, using mixed generator fuel with the blow-run method of operating. Data are included on the behavior of the various fuels used in the generator, the clinker conditions, the use of fuel high in ash, and on the use of coal high in sulphur.

This pamphlet which consists of 32 pages and is fully illustrated was prepared by W. W. Odell and is known as Bureau of Mines' Technical Paper 284. It was, however, prepared under a coöperative agreement with the Illinois State Geological Survey and the Engineering Experiment Station of the University of Illinois through its department of Mining Engineering. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy 10 cents.

Glue A1-22. COPPER SALTS IMPROVE CASEIN GLUE. It has been found that copper salts added to casein glues greatly increase their resistance to moisture and also make them more durable when exposed to the action of molds and fungi. Casein glues containing copper are nearly as moisture-resistant as blood albumin glues.

In the preparation of copper-casein glue at the Forest Products Laboratory, 2 to 3 parts by weight of copper chloride or copper sulphate are dissolved in about 30 parts of water and are added to every 500 parts of the ordinary casein, lime and water-glass glue. The copper solution is poured into the glue in a thin stream. The violet-colored lumps formed at first by the coagulation of the glue by the copper solution are reduced by stirring vigorously for about 15 minutes, and a smooth violet-colored glue results. It is necessary to add the copper salts after the other ingredients are thoroughly mixed, in order to obtain beneficial results. Copper added to the casein before the lime and water glass is ineffective.

Glues containing little lime are especially improved by the addition of copper. A low-lime glue with copper may be as resistant to moisture as a glue with more lime in it, and copper does not shorten the "life" or period of workability of the glue so much as more lime would. Address the Forest Products Laboratory, U. S. Forest Service, Madison, Wisconsin.

Iron and Steel A1-22. THERMAL STRESSES IN CHILLED-IRON CAR WHEELS. See *Railroad Rolling Stock and Accessories A1-22.*

Petroleum, Asphalt and Wood Products A4-22. SPECIFICATIONS FOR PETROLEUM PRODUCTS. A set of specifications for petroleum products have been officially adopted by the Federal Specification Board for the use of the various departments and independent establishments of the Government. They contain specifications for (*a*) various grades of gasoline, (*b*) naphthas, (*c*) burning oils, (*d*) fuel oils, (*e*) lubricants of all kinds. These specifications are printed in full as Technologic Paper No. 305 of the Bureau of Mines. Address H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

Railroad Rolling Stock and Accessories A1-22. THERMAL STRESSES IN CHILLED-IRON CAR WHEELS. For over half a century most of the freight cars in this country have been equipped with chilled-iron car wheels. These wheels have given general satisfaction, even under the present existing conditions of greater speeds and increased stresses due to the use of heavier wheel loads. It has been observed, however, that failure of chilled-iron wheels occur occasionally at the foot of long, steep grades, and the greatest cause of such failures appears to be the heating of the tread by the prolonged application of the brake shoe.

A method was developed at the Bureau of Standards for testing car wheels in the laboratory under conditions approximating severe service. The wheels were heated by passing an electric current through a band of iron encircling the wheel; the resulting stresses were calculated from

strain-gage measurements after correcting for thermal expansion.

Twenty-eight wheels of varying weights and design from three manufacturers were tested in this manner, of which sixteen failed by cracking in the plate. Although the total number of wheels tested is too small to draw any definite conclusions, the results seem to point to the following generalities which should be confirmed by a greater number of tests:

1 The maximum stresses developed are very close to the tensile strength of the cast iron and are some function of the strength of the iron.

2 The maximum tensile stresses occur in a radial direction near the junction of the double plates in the M.C.B. or Washburn type of wheel. In the arch-plate type the maximum stress is somewhat nearer the hub. This seems a desirable condition in that it lies in the region where it is counteracted by the strains due to forcing the wheel on to its axle.

3 The stress in a tangential direction on the outer face and also the stress in both the radial and tangential directions on the bracket side of the wheel are relatively small when compared to those in a radial direction on the outer face of the wheel.

4 By proper distribution of metal in the single-plate type of wheel there would appear to be a possibility of securing a wheel more capable of meeting service requirements.

5 With identical rates of heat input the heavier-weight wheels withstand the effect of tread heating with less strain than the lighter wheels.

6 The tests also lead one to believe that the operating conditions to which wheels are subjected may be as important a factor in the safety of the wheel as are the problems arising in their manufacture.

G. K. Burgess and R. W. Woodward conducted these experiments and have described them in Technologic Paper No. 209. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.

Ropes and Cables A1-22. TEST OF MANILA ROPE. See *Cables and Ropes A1-22.*

Sound A1-22. SOUNDPROOF PARTITIONS. The results of an investigation of the acoustic properties of various building materials with their practical applications by Prof. F. R. Watson have recently been published as Bulletin No. 127 of the University of Illinois, Engineering Experiment Station, Urbana, Ill. The purpose of this investigation was to meet the demand for quiet rooms in hospitals, hotels, and office buildings and the desirability of insulating music studios and other rooms where disturbing sounds are produced; the necessity for solving other problems for the control of noise has led to repeated requests from architects and builders for reliable information on effective methods for insulating sound. Although present knowledge of the subject is incomplete, nevertheless, on account of the pressing need for guidance in such matters, it is thought desirable to collect and present the available information in a systematic way, giving the methods and results of various investigations relating to the action of materials on sound describing practical installations of soundproofing, and setting forth in accordance with existing knowledge recommendations that may be applied where sound insulation is wanted.

Wood Products A1-22. RED HICKORY AS STRONG AS WHITE HICKORY. The insistence of the public on having only white hickory in tool handles and vehicle parts causes a large part of the hickory grown in this country to be used for fuel or for other purposes where the exceptional strength properties of this wood are not needed. Usually only a small outer portion of a mature hickory tree contains white wood; the inner part, or heartwood, is red. Many people think that this red wood is not so strong or tough as the white wood. This belief, however, is discredited by actual strength tests made at the Forest Products Laboratory upon many specimens of red and white hickory. The tests show conclusively that, weight for weight, sound hickory has the same strength, toughness, and resistance to shock, regardless of whether it is red, white, or mixed red and white. Address the Forest Products Laboratory, U. S. Forest Service, Madison, Wisconsin.

Wood Products A2-22. WHEN PRESERVATIVE TREATMENT OF WOOD IS AN ECONOMY. Although any set of timbers may be made more resistant to decay by preservative treatment, such treatment may not always be economical, even though the timbers are to be exposed to the most severe fungus attack. If the timbers are to be in service for a short time only, durability is unimportant, and any kind of preservative treatment would obviously be a waste of money. If, on the other hand, the wood is naturally of low durability and is to be used in a permanent location, it is easy for preservative treatment to show great savings. Between these two extremes there are any number of instances in which it is a more difficult problem to determine whether or not preservative treatment will pay.

If a timber user knows the average life that treated and untreated timbers are giving and the cost of each in place, he can easily compute, with the use of a table recently published by the Forest Products Laboratory, the relative annual cost of maintaining the two.

If untreated timber is giving long life, treatment might not result in great savings. However, very often it might be possible to substitute for such timber a treated lower-grade material that would give as long or longer life with an annual maintenance charge which would compare very favorably with that of the better-grade, untreated timber. Address the Forest Products Laboratory, U. S. Forest Service, Madison, Wisconsin.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Corrosion B2-22. CORROSION OF CHROMIUM STEELS. See *Steel, Its Treatment and Products B3-22.*

Foundry Equipment, Materials and Methods B3-22. MOLDING SAND. The Committee on Molding Sand Research, the organization of which was reported in the Engineering Research section of the February issue of MECHANICAL ENGINEERING, is making good progress. A Sub-Committee under the chairmanship of Prof. H. Ries, of Cornell University, is undertaking through the coöperation of the U. S. Geological Survey and the various state geological surveys a comprehensive survey of the molding-sand resources of the country.

The work on the standardization of tests is well under way. Questionnaires have been sent out to gather information on the present methods of testing the physical properties of molding sand and a digest of the replies to these questionnaires is expected to be available shortly.

Many firms and universities have offered to coöperate in the research work. Every endeavor will be made to maintain their interest and to assign problems to those universities and industrial laboratories offering to coöperate; due regard being given to the facilities and talent available. A list of research subjects has been compiled, which is given in part below.

1 Recovery of used molding sand through restoring bond to the sand by subjecting it to contact with water vapor under high pressure
2 The effects of additions of certain chemical reagents upon the physical properties of clays and clayey materials, such as molding sand
3 Effects of water content on the bond and permeability of a molding sand
4 Effects of different water per cents in molding sand and on the milling and drilling speeds of light gray-iron castings
5 Research on fusion quality of facings (Function of "peeler")
6 Tests of various kinds of clays for restoring bond to molding sand
7 Comparison of lives of different molding sands
8 Effects on plasticity of bond in molding sand and reduction of water content when using oil
9 Effects of wet and dry storing of sand on bonding quality.

Fuels, Gas, Tar and Coke B1-22. WATER-GAS TAR EMULSIONS. In Reports of Investigations, No. 2331, William W. Odell, gas engineer of the Bureau of Mines, outlines the essential facts so far brought out in an investigation into the causes for emulsion difficulties as experienced at many water-gas plants. The investigation was conducted under a coöperative agreement between the University of Illinois Engineering Experiment Station, the Illinois State Geological Survey, and the U. S. Bureau of Mines. Funds of the Illinois Gas Association were used to defray a part of the costs.

Active assistance was rendered by the Peoples' Gas Light and Coke Co. of Chicago, who furnished a laboratory at Chicago for conducting the experiments, and loaned the services of E. A. Thiele to help with the laboratory work.

A full report on the results of this work will be published by the Bureau of Mines later, but it is believed desirable to bring the principal results now to the attention of the industry.

This report discusses the subject under the following heads, (*a*) Water-Gas Tar—What it really is, (*b*) Water-Gas Tar Emulsions and Their Formation, (*c*) Quality of Water-Gas Tar, (*d*) Factors Affecting the Settling of and Formation of Tar Emulsions, (*e*) Summary and Conclusions.

Copies of this report may be obtained by addressing H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

Heat Transmission B2-22. HEAT TRANSMISSION THROUGH ENGINEERING MATERIALS. The Annual Report of the Engineering Division of the National Research Council contains a statement concerning the effort which is being made to organize a committee for the purpose of investigating the problems of heat transmission. These problems are important and fundamental to many industries. At the present time, however, there is no exact information on the heat conductivity of many materials. This is due largely to a lack of standardization of apparatus and methods which has resulted in a wide divergence of experimental results. Several societies now have committees organized for investigations of this kind and numerous investigators are at work in the university, industrial and governmental laboratories. The Division of Engineering with the coöperation of the Division of Physical Sciences plans that the new committee will coördinate all the present activities into a comprehensive program. Address Alfred D. Flinn, Chairman of Division of Engineering, National Research Council, 29 West 39th Street, New York.

Magnetism B1-22. MAGNETIC MEASUREMENTS ON SMALL SAMPLES OF MATERIALS. The standard methods of making magnetic measurements which are now in use require relatively large samples of material. While these methods are fairly satisfactory for most purposes, many

cases occur where it would be desirable to make reliable measurements on smaller samples. For example, in researches on the properties of different materials and in the development of materials for particular purposes, the expense would be very greatly reduced if small samples could be made to serve. In order to meet this need, a special study has been made at the Bureau of Standards, and apparatus has been constructed which requires a sample only 10 cm. long and 6 mm. in diameter. This work is not yet complete, but the data already obtained indicate that the apparatus will give very satisfactory results.

Steel, Its Treatment and Products B4-22. Corrosion of Chromium Steels It appears from a series of tests on the corrosion of chromium steel that the behavior of the material when subjected to the acid test is not a sure criterion of its resistance to atmospheric corrosion. Of all the alloys examined, a high nickel-chromium steel, invar, pure iron, and medium-carbon steel (very slowly cooled from a high temperature) were the most resistant to hydrochloric acid as measured by the loss of weight per unit area per day. High-chromium steels (for example, 13.70 per cent Cr, 0.29 per cent C) were found to be attacked by acid very much more readily. However, when the same specimens were subjected to a weathering test, consisting of a partial immersion in water and exposure to the air, the order of resistance was almost completely reversed. The high-chromium steels were the ones to withstand the treatment best, the low-chromium ones and the pure iron showing rust spots early in the test. The combination of both nickel and chromium appears to make the steel resistant to both acid and weather attack. In general, the steels which were quenched were found to resist corrosion better than the same material in the annealed state, but the differences found were much less than the differences resulting from composition changes, thus indicating that composition rather than treatment should receive primary consideration. Address Dr. S. W. Stratton, Department of Commerce, Bureau of Standards, Washington, D. C.

Steel, Its Treatment and Products B3-22. Cutting Tests of High-Speed-Steel Tool Bits. The Bureau of Standards has completed during the past month about 60 more tests on $\frac{1}{2}$-in. tool bits made of several grades of high-speed steel which had been subjected to various heat treatments. A preliminary summary of a portion of these tests for one steel containing 0.62 per cent carbon, 3.5 per cent chromium, 15.5 per cent tungsten, and 1.6 per cent vanadium was made. An interesting feature of these tests is the effect of the temperature of preheating on the cutting qualities of the tools as expressed in pounds of metal cut away. This is shown in the following table:

Preheating (Time for cut. 20 minutes)	Hardening (Time for cut. 5 minutes)	Lb. of metal cut per tool (4 tools tested)
1400 deg. fahr.	2417 deg. fahr.—oil	9.1
1500 deg. fahr.	2417 deg. fahr.—oil	10.1
1600 deg. fahr.	2417 deg. fahr.—oil	5.1
1600 deg. fahr.	2417 deg. fahr.—water	5.1

(All testing conditions were the same)

The results obtained when using water as the quenching medium are about the same as when using oil for this particular purpose.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

Forest Products D1-22. The Forest Products Laboratory, Madison, Wis. The Decennial Celebration of the founding of the Forest Products Laboratory at Madison, Wisconsin, is the immediate reason for the publication of a handsomely printed booklet, descriptive of the history and work of this well-known laboratory. This book, which is fully illustrated, contains 196 pages and has chapters on the following subjects, (*a*) Wood and Human Progress, (*b*) Early Perspectives of Forest Utilization, (*c*) The Forest Products Laboratory, (*d*) Ten Years of Research in Forest Products, (*e*) Financial Value of Research Results, (*f*) Future Research in Forest Products, (*g*) How to Use the Laboratory.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Fuels, Gas, Tar and Coke, F1-22. Bibliography of Literature on Sampling. So far as known there is no complete bibliography on sampling so one recently compiled by W. J. Sharwood and M. W. von Bernewitz should be of value. It contains nearly eleven hundred references, some dating back 30 years, on sampling at mines, mills, smelters, power plants, pumping stations and refineries. For convenience, it includes a few references to methods for sampling such materials as leather belting in mills, salt-impregnated soils, and mine waters. All the important technical journals, including some of those published in foreign countries, and mining and metallurgical textbooks, have been studied for anything concerning sampling. The arrangement is alphabetical by authors' names, and the items are numbered serially. A copy of this bibliography can be obtained on application to H. Foster Bain, Director, Bureau of Mines, Washington, D. C. It is known as U. S. Bureau of Mines, Reports of Investigations No. 2336.

Machine Design F1-22. Oil Films in Bearing. A bibliography of $3^{1}/_{2}$ pages. Search 3471.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 391 to 394 inclusive, as formulated at the meeting of April 6, 1922, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 391

(In the hands of the Committee)

Case No. 392

Inquiry: If the holes in a plate are drilled full size in the plate before the sheet is rolled and holes in butt straps are also drilled full size before being attached by tack bolts to the plate, would this meet the requirements of Pars. 253 and 254 of the Code?

Reply: The intent of the requirement in Par. 253, that the plates shall be firmly bolted in position for drilling, is to make the holes match perfectly and it is the opinion of the Committee that this can be accomplished only by reaming or drilling the plates after rolling and with the butt straps in position.

Case No. 393

Inquiry: Should the factor "E," in Par. L-43*b* of the Locomotive Boiler Code, be calculated in a longitudinal direction, or transversely, as is "s?"

Reply: "E" refers to the minimum efficiency of the wrapper sheet through joints or stayholes located on a longitudinal section, as explained by the paragraph immediately following the formula.

Case No. 394

Inquiry: Is it permissible to stamp A.S.M.E. Standard on a low-pressure heating boiler which has autogenously welded joints and stays but complies with all requirements of the present Code?

Reply: At the time the heating boiler code was adopted, the use of autogenous welding in the construction of boilers for this service was not contemplated, and no permission for their use is contained in the Code. However, it is the opinion of the Committee that properly designed and constructed welded steel-plate boilers built of material in accordance with the specifications in the heating boiler section of this Code, when constructed, tested and operated in accordance with the rules in that section may safely be used and may be stamped A.S.M.E. Standard, for a working pressure not to exceed 15 lb. per sq. in. steam pressure, or 50 lb. per sq. in. hot-water pressure. The decision whether such boilers may be used thus necessarily rests with the authorities having jurisdiction.

Part I, Section 2 of the Code is now being revised and this interpretation is subject to the rules for welding of heating boilers which will be incorporated therein.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*

William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie

Ralph E. Flanders John T. Wilkin

O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*

Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Intermittent Operation of American Industry

THERE are two forms of intermittent operation in American industry: First, that which obtains every seven to ten years and is commonly referred to as the Business Cycle or Cyclical Depression; second, that form usually referred to as Intermittent Employment or Seasonal Operation.

L. W. Wallace

The wonder is that these forms of business depressions have not been given the consideration and constructive thought that their magnitude and their seriousness demand.

The ill effects of the cyclical depression are immeasurable. It is known in a general way that through the workings of the business cycle millions of men and women are forced out of employment for months at a time, yet at no time or place has there been accumulated authoritative information as to the primary causes of such depressions. There is no source that one can turn to for helpful suggestions as to what measures may be invoked to forestall the evil day or to mitigate its destructive influences once it has arrived.

Federal and state legislative bodies, fond though they appear to be of passing legislation pertaining to business, have not evolved any constructive legislation bearing upon this serious economic and social phenomenon.

Senator Kenyon, in the last days of his service in the U. S. Senate, did introduce a bill which contained a fundamental conception of the problem and which did at least suggest a means of preparing for cyclical depression. The preamble to this bill stated:

> Whereas a sound economic policy requires that a larger percentage of the public works and projects of the United States be undertaken and prosecuted during a period of major industrial depression and unemployment, when labor and capital are not fully employed in private industry, that a smaller percentage of such works and projects should be undertaken and prosecuted during a period when industry is active and competing for the same men and material with resulting business strain and overextension, and that the prosecution of such works and projects should be utilized as a stabilizing force during a period of overexpansion as well as during a period of depression, it is the purpose of this Act to grant the authority necessary to carry out this policy.

This bill met with such opposition that Senator Kenyon moved that it be referred back to the committee. This was done and thus one earnest effort to undertake some solution of the problem was disposed of. Future efforts, it is hoped, will be more successful.

The Permanent Committee of the President's Conference on Unemployment has recognized the problem as one of great importance and seriousness. It has therefore secured sufficient funds to finance a comprehensive study of the business cycle. This study is now being conducted by Dr. Wesley Mitchell and associates, assisted by a number of organizations.

The Federated American Engineering Societies is conducting one phase of the study. It is being assisted by over one hundred and twenty different groups of engineers. This is the first comprehensive study of business cycles ever undertaken. The results to be disclosed, when the work is completed, promise to be of very great importance. It is expected that from this study there will come such concerted action as to greatly reduce the ill effects of cyclical depressions in the future.

It is the belief of some, which belief is based upon a large amount of data, that the economic, civic and social losses due to seasonal operation are even greater than those due to business depression such as is now being experienced. This phase of American industry has not challenged the thought of those concerned as its seriousness demands. For instance, but few have known or realized that—

(1) In 1919, the employees in the paper box, women's clothing, confectionery, overalls, brick, chemical and glass industries lost from 10 to 15 per cent of the possible working days

(2) Bituminous coal mines have operated on an average of only 214 days per year since 1890, the loss in time being an average of 90 days per year

(3) The annual loss in the shoe industry due to seasonal operation is approximately $65,000,000

(4) In the clothing industry there is an extensive unemployment period twice a year which averages 31 per cent of the possible working days and affects from 80 to 90 per cent of the workers

(5) The worker in the construction industry works on the average of only 190 days in the year, that is, he is idle 33 per cent of the time. Many other examples might be cited.

It is a safe assumption that in most of the industries the plant equipment and the materials in stock are idle the same percentage of the time that labor is. All of this contributes a large amount of the unearned overhead account.

In this connection it is of importance to note that it is in the most highly seasonal industries where bitter and costly labor difficulties occur the most frequently. In 1919 in New York state 32 per cent of all the strikes were in the construction and clothing industries, the two that operate largely upon a seasonal basis.

It is recognized that it is a difficult task for some industries to avoid seasonal aspects. But it is also known that some industries that were once considered unalterably seasonal in character now operate on a uniform schedule throughout the year. These industries carefully analyzed the problem, thereby disclosing the changes necessary to be made in practices and policies in order to eliminate the evil. When these necessary changes were adopted, a greatly improved condition obtained.

This aspect of American industry requires careful study upon the part of some authoritative, competent and unbiased group. It would be of great assistance for all concerned to have full information as to what each individual plan has done to reduce the seasonal aspect of its operation. This information would stimulate others to make a similar effort.

The elimination of the losses due to cyclical depressions and to seasonal operation of American industry will require earnest, continued and persistent effort. They are not common to one plant or industry, hence the manager of no one plant or industry can adequately deal with them. They can be adequately dealt with only through collective action.

The best means of accomplishing the necessary collective action is through the coöperation of trade associations and engineering societies. These problems should challenge the efforts of such organizations, because in their solution lies a very large economic and social advancement of the body politic. L. W. Wallace.[1]

---

[1] Executive Secretary to the American Engineering Council.

The Growing Importance of Safety Codes

THE engineering profession has always been one of the leaders in the development of anything of service to the human race, ready to further every sensible means or method which has for its object the safeguarding of the worker against the hazards of his occupation or the safeguarding of the public against the risks that it must take in connection with the use of public or private conveyances.


John W. Upp

The engineer cannot condone the lack of safeguards which, if used, would eliminate unnecessary risks and reduce the number of injuries. For the workman will do more and better work if he is relieved of the nervous strain which he must continually undergo when he knows that, as in the case of unguarded machines, the slightest slip or inattention may result in temporary or permanent injury.

The number of preventable accidents which are constantly taking place is of real concern to the designing engineer and is an incentive for him to improve the operating efficiency of the inanimate machine as well as to secure the efficiency of human endeavor by reducing to its lowest point the harmful results that come from the operation of such a machine improperly safeguarded. He desires to increase efficiency in operation, but the loss of hands, legs, eyes or earning capacity is to him more objectionable than loss in horsepower.

The engineer has often acted individually to introduce safeguards which could be successfully financed through the coördination of the adverse interests involved. But progress has been slow because the individual as well as the corporation has a well-understood tendency to follow the old and accustomed standards unless some concerted action is taken to get them out of the beaten path. Because of established practice it often takes a long time before satisfactory results can be accomplished.

We have reached the point, however, where the efforts of the engineer to introduce his own ideas and measures for safety in the individual installation can now be combined with the efforts of practically the entire fraternity working along similar lines. We can codify for general use the knowledge of the group, and with the backing of a Society such as ours and the help of other interested bodies of national standing, we can disseminate that knowledge for the guidance of all concerned in the operation of the machinery coming under the classification of a given code.

The code brings together for easy reference and use the combined practical experience of the recognized leaders in the profession. It greatly assists in the application of safety devices because it lists only the rules and regulations which have been put to the test and proved of value.

An adopted code is a definite help in the process of standardization because when the code is accepted the devices which meet the specifications are uniformly manufactured. This means that the design will be in the hands of the manufacturer—where it belongs, but the inefficient and troublesome practice of making changes in details of construction to satisfy the varied personal ideas of the many individuals authorized to give approvals in the different sections of the country will be eliminated.

A code decreases the cost of manufacture and the price to the user because of the reduction in the number of special devices, and it will improve the quality and the performance of the devices themselves. For when the manufacturer feels that his equipment will be passed as satisfactory if it meets the degree of safety called for in a uniform set of regulations, he will naturally spend more time and money in the development of devices or machines which he can sell in comparatively large quantities. More attention can be paid to economical design, important tool equipment can be introduced, and a more satisfactory article produced and at a lower cost.

The safety code grows in importance as its purpose and benefits become better understood, for from whatever angle the subject is approached, the conclusion must be reached that the code, properly prepared, is the best means so far developed for assisting in the application of safety devices and the reduction in the accident hazard.

We should not leave this subject without paying respect to the excellent work that engineers connected with the Society have done in the development of safeguards for use on moving machinery, but we may be pardoned for suggesting that there is much more to be done in this direction. We hope that every member of the Society will consider himself responsible in some measure for carrying on this useful work, and when a code has been sanctioned by the Society that each member will familiarize himself with its contents and give the weight of his good will to the rules and regulations on every suitable occasion.

John W. Upp.[1]

Engineers Again Needed in Patent Legislation Situation

DURING the month of March there were introduced into the Senate two bills seeking to amend the patent laws, which, in the opinion of the writer, are exceedingly dangerous and which, if passed, would be destructive of the American patent system. These are Stanley Bill, S-3325, providing for the granting of compulsory licenses where patents have not been worked to a reasonable extent within a reasonable time, which amended Section 4887 of the Revised Statutes of the United States; which bill was replaced by Stanley Bill, S-3410, which applied the same amendment to Section 4886 of the Revised Statutes. The former Stanley Bill might, in effect, apply only to foreign-owned American patents, but the substitute bill would unquestionably apply to all United States patents, whether owned by American citizens or aliens. The questions of whether a patent had been worked to a reasonable extent and within a reasonable time, are to be decided by the Commissioner of Patents or such other governmental agency as the President shall designate. The Ladd Bill, S-3297, was also introduced, and this bill provides that patents shall lapse if not worked within five years after they are granted, or two years after they have been assigned. These bills would so lessen the value of patents that the incentive to produce inventions would be so greatly decreased as to put our American patent system in the position of a second- or third-class system and deprive our country of that incentive to invent which has made us the foremost country in inventiveness, in manufacturing, and in agriculture.

The object of the bills is to throw German-owned American patents open to American use and prevent the Germans from manufacturing in Germany and importing here, while restraining the use of their invention here through their American patents.

The International Convention, to which most of the leading countries are parties, would prevent a working clause in our law which applied only to aliens. Therefore, the Stanley and Ladd Bills apply to all American patents.

The path which an inventor must travel before he can reap any return is already so difficult that many doubt that it is worth while to make inventions. The cost of "working" a patent is sufficiently large, so that if it had to be done merely to keep the patent alive, and whether commercial conditions would justify it or not, it could not ordinarily be undertaken, and most patents would lapse for that reason.

Few individuals or corporations would buy patents with a working clause hanging over them. Those patents which only become valuable and profitable during the last two or three years of their life would almost always have lapsed before that period would have been reached, to the embitterment of their inventors or owners and to the discouragement of all who knew of the experience. Where, as is usually the case, a development requires a number of years and the production of a series of patents, either for successive improvements or for auxiliary inventions, the expense of working a number of patents would be incurred, and the earlier patents would often have to be worked before the development had reached a successful conclusion and hence without any knowledge that any working would ever be justified.

---

[1] Manager, Switchboard Dept., Gen. Elec. Co., Schenectady, N. Y., and Chairman of the Standing Committee on Safety Codes.

Where it was necessary to patent several alternative inventions and no basic patent could be obtained to cover all the forms, each of the alternative forms would have to be worked to keep out competition. The expense of this possible multiple working would deter many manufacturers from entering at all upon a development. The working or compulsory license requirements would favor the rich inventor or corporation as against the poor inventor.

For these reasons, the market for patents would be largely decreased and hence the incentive to invent severely lessened to the defeat of the object of the patent system.

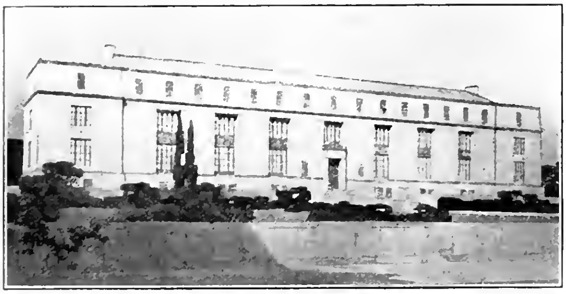
The Patents Committee of the American Engineering Council has been authorized to vigorously oppose the passage of the bills.

The Patents Committee of the Senate held a hearing on the Stanley Bill, S-3410, on April 6 and, because of protests at the shortness of the notice, the hearing was continued to May first and second. The Patents Committee of the Council arranged for a delegation to appear at the hearing, and a vigorous argument and protest against the passage of the bills were made.

Edwin J. Prindle, *Chairman*,
Patents Committee, American Engineering Council.

National Academy of Sciences and National Research Council to Have New Building

Plans for the erection in Washington of a $1,300,000 building as the home of the National Academy of Sciences and the National Research Council and a center for American science in all its fields have been announced by Dr. C. L. Walcott, President of the National Academy. The building, the completion of which is expected by a year from next fall, is the gift of the Carnegie Foundation of New York.



Artist's Drawing of the New Building for the National Academy of Sciences and the National Research Council

In addition to serving as a conference center for scientists, the institution will be designed as a "mutating museum" of the progress of scientific achievement. A large auditorium and a lecture room on the main floor will be surrounded by seven exhibition rooms, in which the newest scientific discoveries will be illustrated for the benefit of the public. One of the most interesting features of the building will be a coelostat telescope which will throw a large image of the sun on a white surface and demonstrate to the layman the natural phenomenon of sun spots.

Second Public Conference on Commercial Engineering

Engineers, business men, and educators from all parts of the country met at the public conference on Commercial Engineering held May 1 and 2 at Carnegie Institute of Technology, Pittsburgh. It was the second public forum on this subject, and was called by the U. S. Commissioner of Education on behalf of a national committee appointed to investigate business training of the engineering student, and engineering training of the business student.

The term "commercial engineering" is rather new; but the need for it is an old one. The primary cause of the investigations and the subsequent conferences was the realization among industrial executives that engineers were overtrained technically, and undertrained commercially. The necessity of a business training along with engineering development is felt by every engineering student soon after leaving college. To bring about a better coördination of college curricula as the means to make better business men of engineers, and conversely, better technically trained business students, was the basis of the conference discussions.

The convention provided the rare opportunity for industrial executives to tell educators where engineering students fell short as soon as they entered industrial life. Educator met educator and exchanged ideas on the best methods to coördinate business and engineering courses.

The first three sessions of the conference were group sessions where the following topics were discussed: Current practices in colleges and universities relating to business training for engineers and engineering training for business men; coördination of college training with the industrial demand; and civic and social training of the engineer and business man. The fourth session of the conference was a series of group conferences where the topics of the first three sessions were again the subjects of discussion and where the fourth group met to talk over the training of the engineer for management of overseas engineering projects.

Internationally known engineers, business men, and college executives spoke at the various sessions, and many prominent men took active part in discussing the various angles of the problem. Samuel Insull, President of the Commonwealth Edison Co., F. B. Jewett, Vice-President of the Western Electric Co., Eugene Meyer, Jr., Director of the War Finance Corporation, Dr. C. R. Mann, of the War Department, Dean Dexter S. Kimball, President of The American Society of Mechanical Engineers, and L. W. Wallace, Executive Secretary of the Federated American Engineering Societies were prominent speakers or group chairmen.

A Discussion of Draft-Tube Designs

To the Editor:

Referring to Mr. W. K. Ramsey's paper entitled A Discussion of Draft-Tube Designs, published on pages 171–176 of the March issue of Mechanical Engineering, I beg to take exception to the author's views upon the cause of the phenomenon of water being drawn up in the central region of a draft tube at lower gates.

Mr. Ramsey ascribes this phenomenon to the action of a "great centrifugal force of water whirling down a draft tube." According to his description "this column ascends to a point directly beneath the runner where it turns over and down and is discharged down the tube." Further down on the same page (171) we read that "when the runner is discharging water at best gate, the water is flowing down in practically straight stream lines" and "under this condition there is no centrifugal action to cause the water to be drawn up from the tail race."

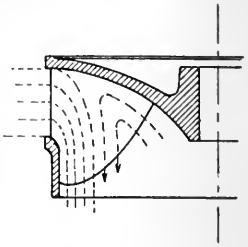


Fig. 1

I wish to remark that the phenomenon in question has been known for a long time and was long ago explained. Being due to the action of runner vanes, the inner parts of which run empty at lower gates, it has been named "pumping action." The ascending column of water goes further up than the point "directly beneath the runner;" it enters the runner, fills its empty space, and is discharged from it (see Fig. 1). This pumping action goes on at the expense of energy of a runner and is largely responsible for the decrease of efficiency of turbines at lower gates. It is to some extent controllable by suitable runner design. Of course there can be no pumping action in turbines at full gate, no matter what may be the direction of the velocity of discharge.

Those interested may find a full explanation of the matter in the works of R. Honold (Honold-Albrecht, Francis Turbinen, Mittweida 1907, pp. 56–57) and Professor Camerer (Vorlesungen über Wasserkraftmaschinen, Leipzig, Engelmann, 1914, p. 360).

Witold M. Aulich, M.E., Eng.D.
2533 Orchard St., Chicago Ill.

Engineering and Industrial Standardization

Machine-Tool Elements to be Standardized

As the result of a joint conference which was held in Atlantic City on April 26 it is more than probable that the standardization of certain machine-tool elements will be accomplished in the very near future. This joint conference between representatives of the National Machine Tool Builders' Association and The American Society of Mechanical Engineers was part of the regular program of the Association's Spring Meeting.

These two organizations, having sometime ago accepted joint sponsorship for a Sectional Committee which is to undertake this work under the Rules of the American Engineering Standards Committee, arranged for this conference to determine which of the machine-tool elements should be considered first. General Manager E. F. DuBrul who presided at the conference reported the results of an investigation which he has been making into the size, proportions and spacing of tee (T) slots as found on the various machines now on the market. This report opened up the subject completely and many of those present took part in the discussion. A few of the machine-tool parts and dimensions which in the opinion of the conference should receive the attention of the Sectional Committee are listed below under the heads of the machine tools to which they apply:

LATHE

1 Tee (T) slots
2 Standard rating (What is a 14 in. lathe?)
3 Nose piece
4 Bolt heads and nuts

DRILLS

1 Tee (T) slots
2 Spindle nose
3 Taper

MILLING MACHINES

1 Tee (T) slots
2 Spindle ends
3 Angle blocks
4 Bolt heads and nuts

PLANER

1 Tee (T) slots
2 Bolt heads and nuts
3 Distance between housing
4 Length of bed

BORING MILLS

1 Tee (T) slots
2 Ram and turret tool holders
3 Diameter of hole in table
4 Bolt heads and nuts

It will be seen that the majority of these elements can be classed as tool or work-holding elements. This brings us to mention the key-note of the conference, namely, "the purchaser should have something to say." The Sectional Committee which is being organized to carry on this work will consist of representatives of the manufacturers (producers), users (consumers), and general interests (neither one nor the other). All those who are or have been in touch with a machine shop in which are installed various kinds of machine tools and various makers of the same tool need not be told of the great saving in cost of parts of jigs and fittings and in time due to interchangeability, which would result from the standardization of certain of the elements common to a number of machines.

At the close of the discussion it was agreed that a Plan and Scope Committee be first organized to make a careful survey of the field which is to be covered by the work of the Sectional Committee and to assist in determining its personnel. It was suggested that this Committee consist of five representatives of the N.M.T.B.A. and five representatives of the A.S.M.E. and it was further decided that the representatives of the N.M.T.B.A. should be drawn one each from the manufacturers of the following five types of machine tools:

(1) Planing
(2) Work revolving
(3) Tool revolving
(4) Grinding
(5) Punching and forming.

The dealers also are to be asked to coöperate by making suggestions for the use of the Committee and by assisting in the promulgation of the standards when they are developed.

Standardization—Its Fundamental Importance to Prosperity

This is the subject which Mr. Charles le Maistre, Secretary of the British Engineering Standards Association, chose for his address before the General Meeting of the North-East Coast Institution of Engineers and Shipbuilders held at Newcastle-upon-Tyne the last week of March. While speaking of the general principles underlying standardization, he said in part:

> Standardization is not an easy term to define. There is nothing, however, new in the idea, for it has been practiced in one form or another for many centuries, and starting from the moral and social side with standards of conduct, standards in art and in literature and so forth, has in later years gradually developed as an economic movement in the production of the material necessities of life, a departure of interest to everyone, seeing that it implies both the study and the preparation, as well as the recognition of standard forms and qualities. In its broadest aspect it may be said to imply the introduction, through collective effort, of economical methods of manufacture, not so much with the idea of gaining dividends as of unifying the needs of industry and thus bringing about the greatest amount of good for the greatest number. But it is not so much a definition of standardization that is wanted as an understanding of its underlying principles, and perhaps the best way of arriving at this is through actual experience in the working out in practice of the standards.
>
> It is still sometimes urged against standardization that it retards invention and progress, and that once a standard has been adopted there is no possibility of modification or change even though new methods may have demonstrated their superiority over the old. Happily this is not the case so far as industrial standardization is concerned when carried on along right lines. Of course, crystallization which would tend to impede or hamper progress must be jealously guarded against so that the work may be of permanent value and the purchaser reap the benefit of competitive effort and inventive genius. Periodic review prevents crystallization and keeps the work abreast of progress. Nor is standardization coercion either by Government or by one section of the community over the other: indeed, there is nothing compulsory in it at all, its only authority being industrial public opinion.
>
> Industrial standardization does not necessarily involve the idea of actual perfection; it is rather the registering of what is best in present practice as against attempting to set up an ideal. It is quite easy to set up a standard, but it is altogether another thing to get that standard widely adopted, and a standard which is not in accordance with the fundamental needs of industry, that is, which does not fulfill a recognized want, is economically a bad one. It is a wasted effort and a pitfall for the unwary.
>
> In carrying out the work of industrial standardization, the aim should be to unify the requirements of industry to the best possible advantage without striving for an ideal which might involve an unnecessary sacrifice of capital. It is the buyer in the first instance to whom standardization is of the utmost value, for it enables him to know exactly what he can purchase and to be sure that he gets what he asks for in return for his money. But it is of equal value to the manufacturer for it simplifies his work, it enables him to produce what is required by the purchaser cheaply and expeditiously, as well as to avoid mistakes. It will thus be seen that the community of interest of the buyer and seller is one of the fundamental ideas underlying the work, for there cannot be the least doubt that the interests of both are really identical.
>
> Every problem of standardization may be divided into the technical and the human side, and in most cases the human side is well over 85 per cent of the total. The technical factors are usually so well known that the problem so far as this is concerned becomes one of basic facts rather than of opinion, but when we come to deal with the human side so very little is known of the reasons actuating us all that we deal largely with so-called human opinion, which sometimes is not too closely related to the facts.
>
> It must be remembered that standardization is really a science all of its own, and it is only gradually that its underlying principles have unfolded themselves and its great economic utility become recognized. Gradually, however, it has come to be seen and appreciated that standardization to be of lasting benefit must first of all be approached through the industrial side, the initial proposals coming from the manufacturers, the constructive criticism being supplied by the scientific and technical experts. That does not say that there are not isolated cases where the reverse is true, and rightly so.
>
> The full realization of the economical side will always result in producing standard specifications which, though perhaps not ideal, yet represent the best which can be devised at the moment, improvements being effected through the process of time.
>
> To be received with confidence by industry, standards must have a certain measure of permanency, and while crystallization must be avoided by periodical review as already mentioned, they must not be changed too often unless the changes are distinctly in the direction of improvements, and safeguards must be created so as to protect those standards from change merely for the sake of change. Standardization, based on these principles, can never result in fossilization or stultification of invention and progress. Indeed, they invite improvement and progress.
>
> Industrial standardization, then, has for its main objects the elimination

of waste of time and material involved in the production of a multiplicity of sizes and qualities for one and the same purpose, the fixing of the dimensions of component parts where interchangeability is necessary, the setting up of standards of performance whereby comparisons can be made with equity as well as the defining of attainable quality of material which involves unification of tests. Rapid and economical production may certainly be claimed as one of the leading benefits, and the securing of this is not only advantageous to the manufacturer but also to the consumer in the rapidity with which his orders can be filled from stock, the ready replacement of damaged and worn parts, and not infrequently the reduction in selling price. Notable examples of the increased business resulting from standardization can be seen in the well-known cases of the ordinary sewing machine and the bicycle. Interchangeability of component parts secured through standardization will give the purchaser the great advantage of an open market.

It should not be forgotten that the setting up of standards or the drafting of national purchasing specifications does not prevent a purchaser from obtaining anything which is not included in those specifications. He may possibly have to pay more for it and perhaps it is sometimes wise that he should. To be of the greatest benefit industrial standardization must be arrived at through the elimination of the unnecessary and the recognition that the recommendations are not unalterable, but rather subject to review, certainly not too frequently as I have already said, but whenever industry finds it economically desirable or necessary to do so.

The aim of those engaged in standardization must be to unify the needs and requirements of industry and that without hampering invention and design, and so encourage and direct progress along the best and most efficient lines.

Standardization, or unification as it might more appropriately be called, as signifying this great community of interest, goes so deep down and touches so closely on life's fundamentals, that to carry it out successfully requires much patience, caution, and evidences of vision, combined with optimism, good will and idealism. Fortunately these qualities are to be found increasingly among those who go to make up the great engineering industry of our country. All who are engaged in serving the public have a unity of purpose which is increasingly recognized, and as time moves on people are more and more willing to sink their individual differences with a view of benefiting the many.

When one considers the public-spirited manner in which so many freely give their valuable time and experience to this work, often at so much personal expense and inconvenience, one realizes indeed what a debt the nation owes to our engineers and business men for the part they are taking in this national work.

Florence M. Griswold Dies

Florence M. Griswold, who was often spoken of as the "Dean of Fire Insurance Engineers," and who was responsible for the standardization of fire-hose couplings, died on April 25, 1922. Mr. Griswold was born in Hoboken, New Jersey, in November, 1843, and received his education in the public schools there and at Wittenburg College, Springfield, Ohio. He served in the Union forces during the Civil War.

At the close of the war he entered the insurance business under the supervision of his father, Jeremiah Griswold, who was the author of many publications on various phases of the insurance business. Until 1875 he was connected with several of the principal fire-insurance companies in various responsible capacities, when he became general inspector of the Home Insurance Co. of New York. Since that time he had particular charge of the special hazards and technical work conducted by this company throughout the whole field of its operation.

When Mr. Griswold entered the insurance business the system was admitted to be one of guessing as to hazards and rates. He began to study the situation in an attempt to reach the scientific principles underlying it. He made himself familiar with the methods of all classes of manufacturing industries and the fire hazards incident to each. He assisted in the organization of many of the inspection bureaus and had an active hand in the formulation of a number of schedules for rating industrial plants.

His investigations naturally led him into the field of fire extinguishment. For many years he worked strenuously to secure universal standards for all classes of fire-fighting facilities and utilities. The National Fire Protection Association selected him to head a special committee to secure the adoption of a universal standard for hose and hydrant threads. Persistent efforts in this direction had failed many times in the past. Mr. Griswold was finally able to secure for his coupling the endorsement of many of the leading and most influential organizations of this country, and its use became general in all parts of the country. In 1917 it was approved and adopted by the United States Bureau of Standards as the "National Standard Hose Coupling and Hydrant Fitting" to be used for public fire service.

Mr. Griswold became a member of The American Society of Mechanical Engineers in 1914. He was also a member of the Grand Army of the Republic, the American and New England Water Works Associations, an associate member of the International Association of Fire Engineers, and an honorary life member of the National Fire Protection Association.

Louis E. Strothman, A.S.M.E. Vice-President, Dies in Milwaukee

Louis E. Strothman

Louis E. Strothman, Vice-President of the Society, died at his home in Milwaukee, Wisconsin, on May 8, 1922, after an illness of some months. Mr. Strothman was born in Milwaukee in 1879 and received his education in the public schools there and at St. John's Military Academy. From 1899 to 1902 he served as draftsman for several Milwaukee concerns, and then entered the employ of the Allis-Chalmers Manufacturing Co., with which he was associated in various capacities until August, 1919. At that time he became vice-president and general manager of the Richardson-Phenix Co., which position he held until his death.

Mr. Strothman had an extensive and varied engineering experience. He was a member of a number of engineering societies, including the American Society of Civil Engineers, the American Waterworks Association, the National Association of Stationary Engineers, and the Engineers Society of Milwaukee, of which latter he was president in 1916–17. In 1916 he was appointed a member of the board of directors of the Organization for National Preparedness for the state of Wisconsin, and was also appointed an associate member of the Naval Consulting Board.

He became a member of The American Society of Mechanical Engineers in 1909 and has taken an active interest in its affairs. In 1915–16 he was chairman of the Milwaukee Section. He served as chairman of the 1917 Nominating Committee and has since that time been a member of the Main Committee on Power Test Codes and chairman of the individual committee on Reciprocating Displacement Pumps. In 1919 he was appointed by President Cooley to represent the Society in company with himself on the National Industrial Conference Board. Later in the same year he was elected manager of the Society to fill a vacancy for a year. In 1921 he was elected Vice-President of the Society, which office he was holding at the time of his death.

The Council of the Society, at the Spring Meeting at Atlanta, Ga., received the news of Mr. Strothman's death with great regret, and voted to appoint a special committee to draw up resolutions to be entered upon the records of the Society and to be sent to his family.

From a close friend of Mr. Strothman's, Henry A. Allen, consulting engineer, Chicago, we have received the following appreciation: "Louis E. Strothman was a gentleman and an excellent engineer, always striving to increase his knowledge and to better the engineering profession. When manager of the pumping-engine department of the Allis-Chalmers Co. about twenty years ago, I had the opportunity of advancing him from the drawing board to the desk, where he handled the estimates and correspondence dealing with centrifugal pumps. He was very efficient and his rise from that time on to manager of the department was deserved and steady. His death was a distinct loss to the engineering profession, and to me and many others means the loss of another long-time dear friend."

Atlanta Papers Elicit Valuable Discussions

Contributions on Fuels, Power and Textile Machinery Prove to be Especially Noteworthy. Dr. Stumpf is Present. Atlanta Section Provides Enjoyable Entertainment Program

WITH a happily balanced technical and social program, preceded by an interesting trip to the University of Virginia at Charlottesville and followed by instructive trips to Greenville, S. C., Birmingham, Ala., and Muscle Shoals, the 1922 Spring Meeting of the American Society of Mechanical Engineers will go on record as the most interesting so far in the Society's history.

The meeting was essentially Southern and the Atlanta Section had carefully planned the entertainment program with hospitality achieved only by the open-hearted. Every detail for the comfort of the guests was amply safeguarded and the 350 who registered enjoyed every moment of their sojourn in Atlanta.

The social and entertainment features were described at length in the A.S.M.E. News for May 22, and a more complete account of the discussions presented at the Atlanta Technical Sessions will appear in later issues of MECHANICAL ENGINEERING.

On Tuesday, the first day of the professional sessions at the meeting, there were four simultaneous attractions. Three of the power test codes were presented for public hearing, and a small group of engineers entered earnestly into the discussion, although no fundamental changes were suggested. The codes presented were, Definitions and Values, Displacement Compressors and Blowers, Hydraulic Power Plants and their Equipment.

There was a large attendance at the first general session, which was presided over by Earl F. Scott, of Atlanta. The paper by Alfred Cotton of St. Louis, Mo., on the Accuracy of Boiler Tests attracted considerable attention and elicited a great many criticisms and comments on the subject matter of the paper. E. R. Fish of St. Louis made the presentation. The feature of the session, however, was the paper entitled Using Exhaust Energy In Reciprocating Engines which had been prepared by Dr. J. Stumpf of Charlottenberg, Germany and C. C. Trump of Syracuse, New York. Mr. Trump presented the paper and was followed in the discussion by Dr. Stumpf, who arrived from Germany in time to reach Atlanta for the meeting. This paper also drew out interesting discussion.

At the session on Materials Handling, which was presided over by R. M. Gates, chairman of the Materials Handling Division, F. L. Estep, Chief Engineer of the firm of Perin and Marshall of New York, presented a paper prepared by F. L. Leach, on the subject of Handling Equipment as Used in the Iron and Steel Industry. Mr. Leach is at present in India engaged in work for Perin and Marshall. This paper recorded the most important handling methods used in the iron and steel industry and brought out discussion as to the economies that may be obtained by the use of machinery in materials handling.

In the absence of Charles T. Plunkett, H. M. Latham, of Worcester, Mass. presided at the first session on Textile Machinery. The papers were those on Cotton-Ginning Machinery by S. E. Gillespie of Dallas, Texas and on the Maintenance Textile Machinery by E. H. Marble of Worcester, Mass.

On Tuesday afternoon a number of members and guests visited the plant of the Atlantic Steel Company, which is entirely equipped for the burning of pulverized coal.

On Wednesday there were three simultaneous sessions. A goodly crowd enjoyed the papers presented at the Fuels Session, which was presided over by F. R. Low of New York. The paper by F. G. Cutler of Birmingham, Ala., on the Reduction of Fuels Waste in the Steel Industry proved to be of great interest. E. A. Uehling of Milwaukee, Wis. was not present to give his paper on the Control of Boiler Operation, but the large number of discussions that were entered proved conclusively that the subject was one of great interest. Boiler Room Performance and Practice at Colfax Station of the Duquesne Light Company by C. W. E. Clarke, of New York, N. Y. brought forth a good round of comment from men engaged in boiler-plant operation.

The second session on Textile Machinery was presided over by H. M. Latham who because of the death of L. B. Jenckes of Worcester, Mass., also presented the paper on Weaving Machinery. The other papers at the session were Extraction of Oil from Vegetable Matter, by Joseph Davidson of Atlanta and Modern Shop Practice in the Building of Revolving Flat Cards, by F. E. Banfield, Jr. of Newton Upper Falls, Mass. All the papers were earnestly discussed by the crowd of textile engineers present.

The Management Session on Thursday, presided over by L. P. Alford was devoted to the discussion of two papers; Management Applied to Textile Plants by George S. Harris of Atlanta and The Southern Worker, His History and Character, by Frank H. Neely, also of Atlanta.

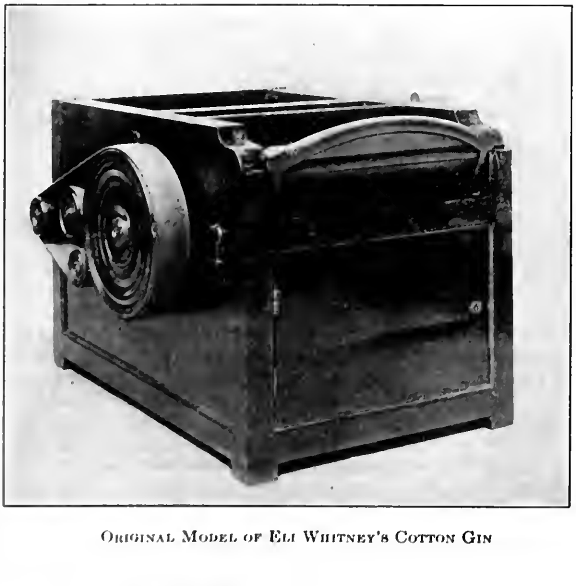
D. W. Mead of Madison, Wis. acted as chairman at the Power Session, which treated some phases of the development of hydroelectric power. Three papers on this subject were presented as follows: Power Development in the Southeast, by Chas. G. Adsit of Atlanta, Economics of Water-Power Development, by C. A. Mees, of Charlotte, N. C., Hydroelectric Power-Plant Design, by John A. Sirnit of Birmingham, Ala. The paper by Messrs. H. B. Reynolds and W. F. Hovey both of New York, which reported the Tests of a 60,000-KW., Cross-Compound, Triple-Cylinder Steam Turbine, was presented by title.

A host of engineers vitally interested in the problems of welding pressure vessels attended the session at which four papers on this subject were presented. Mr. E. R. Fish of St. Louis, presided over the presentation and discussion of these papers. The papers are as follows: Strength of Electrically Welded Pressure Containers, by R. J. Roark of Madison, Wis., Some Principles of the Construction of Unfired Pressure Vessels, by S. W. Miller of Rochester, N. Y., Steel for Forge Welding, by F. N. Speller of Pittsburg, Pa., Tests on Welded Cylinders, by E. A. Fessenden and E. J. Bradford, both of State College, Pa.

Whitney's First Model of His Cotton Gin

A unique feature of the A.S.M.E. Spring Meeting at Atlanta was the exhibition of Eli Whitney's first model of his cotton gin. This model is owned by his grandson, the present Mr. Eli Whitney of New Haven, Conn., who very generously loaned it for the benefit of those attending the Meeting.

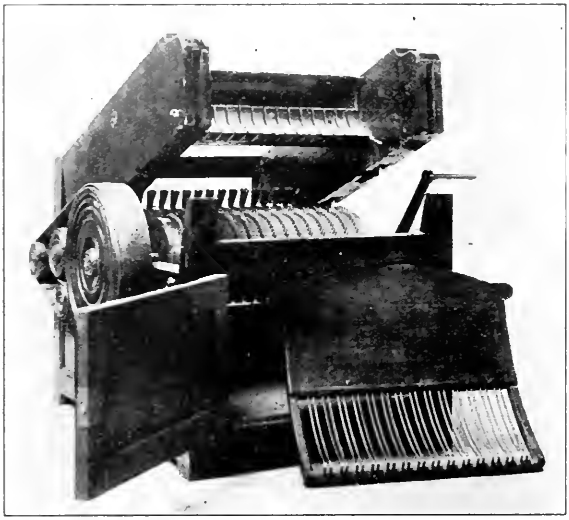
Eli Whitney was born in Westboro, Mass., in 1765 and was graduated from Yale College in 1792. In the fall of that year he was en-



ORIGINAL MODEL OF ELI WHITNEY'S COTTON GIN

gaged as a private tutor in a family in Georgia. On his way there he met Mrs. Greene, the widow of Gen. Nathaniel Greene, who was returning to Savannah from a visit north. On reaching Georgia he found that, despite his engagement, another had been given his place and he was stranded, practically penniless. Mrs. Greene invited the young man to her home until he could find something to do.

Shortly after Whitney's coming, a party of gentlemen from Augusta in the upper country, who had been officers in the Revolution under Gen. Greene, were visiting there. The conversation turned to the depressed state of agriculture in the South. Long-staple cotton had been introduced successfully in the sea islands, but could not be grown inland. Short-staple cotton would grow inland, but was unprofitable as there was no practical means of separating the cotton from the seed. The separation by hand of one pound of staple was a day's work for one woman. During the conversation Mrs. Greene told those present that Mr. Whitney could invent a machine for them that would do the work. This incident turned Whitney's attention to the subject. He went to Savannah, obtained a small parcel of raw cotton and set himself to work on the problem. With the resources the plantation afforded and such tools as he could contrive, he developed the invention in a few weeks and produced his first model, which is exhibited here. This model contains the three essential elements of all cotton gins: namely, the revolving cylinder with forward-pointing teeth; the comb through which the teeth pull the cotton; and the revolving brush to clear the cotton from the teeth.



Same Model Partly Disassembled to Show Mechanism

The cotton gin is justly rated as one of the major inventions in history. No other great invention is so clearly and unmistakably attributable to the work of one man. The modern cotton industry may be said to date from this invention.

For Wartime Government Work, F.A.E.S. Committee Recommends Cost-Plus Contract with Adjusted Compensation

During April the F.A.E.S. Committee on Types of Government Contracts submitted a report after giving careful consideration to a large number of suggestions invited from contractors and other interested individuals.

An abstract of the report is given below. The committee is made up of A. P. Davis, Chairman, Colonel Sherrill, D. Knickerbocker Boyd, Charles E. Ruffner, N. M. McFarland and P. Junkersfeld.

After due discussion the Committee reached the conclusion that all Government contracts should, in the interest of the Government, aim at certain definite objects:

1 The enlistment of the interest of the contractor on behalf of of economy and promptness of execution;

2 Elimination of uncertainties and of hazard to the contractor;

3 Elimination, so far as possible, of opportunities for friction or favortism.

For the purpose of the report it was deemed advisable to divide contracts into three general classes:

1 Contracts for purchase of material and supplies upon which specifications can be nearly exact and few uncertainties are involved;

2 Contracts for construction in which conditions are accurately known and specifications may be exact, such as war vessels, guns, public buildings, etc.;

3 Contracts for construction where many uncertainties are ininvolved, such as character of material, weather conditions, etc.

In the purchase of materials it is desirable that so far as possible, these be made on the basis of test, so that the material purchased will be paid for in accordance with its value. The same principles can be usefully applied to some forms of construction. An example may be cited in the case of ship construction, where it is always desirable to obtain the highest practicable speed within reasonable limits of cost.

The field of structural work is the one to which the Committee gave most attention and in which there is most controversy concerning proper policies.

Much has been said regarding the desirability of standardizing Government contracts and the general tendency of the times is very properly in many fields towards standardization, but it is the opinion of the committee that taking into consideration all of the conditions to be met in the various departments, the extent to which governmental contracts can be standardized is limited and in general can be applied only to certain important general provisions of those contracts, such as the method of determining and enforcing damages, the method of settling disputes as to questions of fact, and the method of determining the compensation of the contractors.

In order, however, to facilitate and encourage bidding by responsible persons in the interest of economy to the Government and fairness to the public, such standardization as is possible should be secured through coöperation between the governmental departments.

In summarizing its work, the committee made the following recommendations:

1. That Government work be normally carried out through unit price, or lump-sum contracts, or by the purchase-and-hire method. Where none of the above methods are applicable to conditions, that the cost-plus method be used in which the contractor is refunded the actual cost of the work plus an accorded compensation which increases if the work is done below the estimated cost of the work, and decreases if the work costs more than estimated, but never sinks below zero.

2. That the failure of any bider to demonstrate to the satisfaction of the Government that he has adequate capital, experience, organization and plant effectively to carry out the work to be done, shall be sufficient cause to justify the conclusion that he is not a responsible bidder, and the consequent refusal of the Government to award him the contract.

3. That there be appointed by the President an inter-Departmental Board on Standardization of Contracts, consisting of one representative of each Government deparment engaged in construction. That this board recommend policies to govern in the standardization of contracts within each department. Each department should have a small board representative of each bureau engaged in construction, and should seek to unify and standardize contract practices within the Department, and the Chairman of these Departmental Boards might preferably constitute the inter-Departmental Board, which should only be advisory in character. That when the contracts of each department shall have been by itself thus standardized, that the inter-Departmental Board consider these contracts and make necessary recommendations to harmonize and secure, so far as feasible, uniformity of practice in the different departments.

4. That it be recognized as the preferable practice that government contracts be so drawn as to place the burden of unforseen contingencies, as far as possible, on the government in the interest of economy to the government in the long run and fairness to the bidders.

5. That all government officials shall recognize the importance of exerting the utmost efforts to make prompt partial payments on government contracts at reasonable intervals as stated in the contracts, for all services rendered and materials delivered by the contractor on the work that has been accepted by the government inspector.

6. That payment shall in all cases, as far as possible, be made by the official or agency directing the work and not by an outside accounting or finance agency, in order to avoid the burden on the contractor of delays in payments when made by such an agency not directly concerned with, or responsible for, the efficiency, economy and dispatch of the work.

7. That boards of arbitration be not in general used to adjust disputes as to facts relating to the execution of government contracts; but that the contractor be given the right of appeal to each of the superiors and the official directing the work, up to the chief of the bureau who may in his dis-

cretion appoint a disinterested board of arbitration to determine the facts. In important cases, the contractor should have the right of appeal to the head of department.

8. That deductions for non-completion of contracts on time, so far as practicable, be in the form of liquidated damages and be limited as nearly as possible to the actual damages estimated in advance; that an interpretation of this clause should be made to insure substantial justice, both to the contractor and to the Government in a spirit of liberality. The decision as to the imposition of the liquidated damages should rest in all cases with the technical or professional official or agency directing the work, and not with the clerical or accounting agency.

9. That the Government should take no cognizance of subcontractors further than to see that the principal contractors make prompt payment for all services rendered and materials furnished by the subcontractors. That the disbursing officer may suspend payments to the principal contractor until this is done.

Engineers Are Requested to Provide Contracts Stipulating Abidance by Decisions of National Board of Jurisdictional Awards

In making public the report of Rudolph P. Miller, F.A.E.S. representative on the National Board of Jurisdictional Awards in the Building Industry, L. W. Wallace, Secretary of the American Engineering Council emphasizes the fact that Mr. Miller's report shows that the National Board of Jurisdictional Awards has been instrumental in reducing the number of jurisdictional strikes in the building industry in the United States. Mr. Wallace also asks that the F.A.E.S. use its influence towards securing greater recognition of the important decisions made by the Board.

The function of the Board is the settling of controversies between various labor organizations. Mr. Miller's account of the meeting of February 6 to 9, 1922 is of great interest and a résumé of the outstanding features are given here.

In two disputes before it, the Board made awards as follows: first, the erection of grain hoppers and spouts was conceded to the sheet-metal workers when the metal is ten gage or thinner and to the iron workers when thicker than ten gage; and second, elevator constructors were permitted to hoist, lower and place new elevator machinery, iron workers handling the transport of this machinery to the building in which it is to be erected. A third dispute between iron workers and bricklayers regarding the erection of derricks for setting stone was held over for a future meeting.

One troublesome situation created by the carpenters was given careful consideration by the Board for a day and a half. The carpenters do not abide by the Board's award to the sheet-metal workers of the work of setting hollow metal doors. This caused great embarrassment and a committee of the board was appointed to draw up a resolution regarding this situation. This resolution is given in part below as it makes a direct recommendation to the engineering profession:

Your committee appointed to outline a procedure to be followed in clearing up the situation created by the failure or refusal of the United Brotherhood of Carpenters and Joiners to conform to the decisions of your Board, as brought to your attention by a committee of the Associated General Contractors, has given careful consideration to the matter.

Some of the decisions in question were rendered more than a year ago. All parties to the plan of the Jurisdictional Board, with the exception noted have endeavored to comply with all its decisions. Of these seventeen International Unions that constituted the Building Trades Department at the inception of the Board sixteen have unqualifiedly endorsed its work and supported its decisions. The seventeenth, namely the Carpenters' Union, has been suspended from the Building Trades Department because of its refusal to abide by those decisions. Some more definite action on the part of those loyal to the plan of the Jurisdictional Board seems desirable and necessary. Your committee therefore recommends the adoption of the following resolution:

Whereas, the United Brotherhood of Carpenters and Joiners of America has not been observing or conforming to the decisions of the National Board for Jurisdictional Awards in the Building Industry; and

Whereas, the attitude of that organization in failing to observe those decisions is seriously embarrassing owners, architects, engineers, contractors and workmen engaged in the building industry, and such a condition tends to increase costs and to cause delay and is detrimental to the public interest and the building industry in general; and

Whereas, all parties signatory to the plan of the Jurisdictional Board have been actively supporting the decisions of that Board, including sixteen of the seventeen International Unions constituting the Building Trades Department at the inception of the Board;

Resolved, That in order to correct the above mentioned conditions, the several signatories to the plan of this Board be urged to instruct their constituent members, each in its respective field as follows:

That the members of the American Institute of Architects and of the Federated American Engineering Societies insert in all specifications and contracts for building operations a stipulation that the decisions of the Jurisdictional Board shall be observed:

That the members of the Associated General Contractors and of the National Association of Building Trades Employers incorporate in their agreements with their subcontractors a provision that will secure a compliance with all decisions of the Jurisdictional Board and that the members thereof shall refuse employment to any local union or members thereof neglecting or refusing to abide by decisions of the Jurisdictional Board;

That the Building Trades Department shall instruct local councils to unseat any local union refusing compliance with such decisions, and that associated International Unions shall instruct their respective locals to extend neither recognition nor support until such time as delinquent locals accept and abide by all decisions of the Jurisdictional Board;

Resolved further, That this resolution shall be enforced as expeditiously as possible beginning with those localities in which the trouble appears to be most acute and where action seems most urgent and that all these signatories make special and united efforts toward securing general and complete compliance with all the decisions of the Jurisdictional Board; and

Resolved also, That as and when trouble in any locality is brought to the attention of any of the signatories such organization shall take the initiative in forming a general committee of representatives from all the signatories for the purpose of dealing with the situation in that locality.

The resolution as will be noted, urges the Federated American Engineering Societies to instruct all firms or individuals who are members of any of its constituent societies and who are engaged in building work, to insert in all specifications and contracts for building operations, a stipulation that the decisions of the Jurisdictional Board shall be observed. The American Institute of Architects has also been requested to do this with its members. There is no doubt but that this will help to an enormous extent, if not in the elimination of trouble coming from jurisdictional disputes. It is not uncommon at the present time, for architects and engineers to incorporate in their specifications, that disputes as to the meanings of those specifications shall be submitted to arbitration, and even in many cases to certain individuals named in the specifications as arbitrators.

NEWS OF OTHER SOCIETIES

Society of Industrial Engineers

The Influence of Industrial Engineering upon the Earnings of Capitol and Labor was the major subject of the eighth national convention of the Society of Industrial Engineers held at Detroit April 26, 27 and 28. Sessions were held by groups devoted to production, education, industrial relations, executive management, sales management and accounting.

In his presidential address, Prof. Joseph W. Roe, head of the department of industrial engineering of New York University, cited the report of the Committee on Elimination of Waste in Industry as evidencing the need of some method of measuring the effectiveness of management. He declared that there was more need for measuring the effectiveness of management than for measuring any other element in industry, and discussed the phases of it that are measurable and those that may not be.

Some other topics discussed were: The Influence of Industrial Engineering upon Manufacturing Plants, by E. Karl Wennerlund; How Industrial Engineering Serves the Chief Administrator, by Col. Benjamin A. Franklin; How Industrial Engineering May Serve the Executive, by E. W. Hulet; Practical Tests of Employees, by Henry C. Link; The Conservation of Material, by L. Moorehouse and E. J. Schmidt; The Conservation of Plant and Equipment, by F. H. Lowe and A. S. Cunningham; The Conservation of Labor, by Frank B. Gilbreth; Developments in Waste Elimination in the Field of Fatigue; by Norval A. Hawkins; Sales Management and Industrial Engineering, by Daniel B. Gauchet; and How Industrial Engineering Increases the Productivity of Each Industrial Unit at Reasonable Cost, by Parker A. Sowden.

The industrial relations' group discussed Experience with Employees' Representation Plans during the Periods of Business Depression; the managing executives' group discussed Managerial Red Tape; the accountants' group discussed With the Establishment of an Effective Budget Control, What Non-Essentials Can be Eliminated from Present Industrial Accounting, and the sales managers' group, Educating the Distributor.

A feature of the convention was the inspection of the big industrial plants of Detroit. An informal banquet was held on the evening of April 27 at which Matthew Woll, vice-president of the

American Federation of Labor spoke on How Industrial Engineering Can Serve Labor. President Roe presided at the banquet and other speakers included Robert B. Locke of the Federal Reserve Bank, Detroit, and Howard E. Coffin, vice-president of the Hudson Motor Co.

National Metal Trades Association

The program at the twenty-fourth annual convention of the National Metal Trades Association, held at the Hotel Astor, New York City, April 19 and 20, covered a wide range of subjects that dealt in a realistic way with many industrial problems of national and international importance.

Among the questions discussed were the stabilization of Europe and its bearing on domestic business; the relation between the railroads and their patrons; dealings between employers and employees; and coöperation between the farmer and the manufacturer. The report of a recent survey among plants of the members of the Association, which compared conditions as they exist at the present time, a year ago, and in 1914, was one of the most interesting features of the program. It revealed the fact that during the past year no strikes occurred at any of the plants of the members of the Association. The belief was expressed by the president, however, that the coming year, with its necessary further readjustment in wages, may not be so free from disturbances in the metal industry. It was predicted that normal wages will be considerably above the prewar plane. Additional information on this subject was brought out in an address on Facts and Fancies about Wages in Basic American Industries, by N. W. Alexander, of the National Industry Conference Board.

American Society of Civil Engineers

The Spring Meeting of the American Society of Civil Engineers was a three-day meeting devoted to Flood Problems. The meeting was held at Dayton, Ohio, on April 5, 6, and 7, with the technical sessions at the Engineers' Club, and was the first Spring Meeting which the Society has held.

The technical program was given at the three sessions held on the first day of the meeting. The remaining two days were devoted to excursions to nearby points of particular interest to those who were in attendance. The papers presented were: Flood Conditions in Canada, by J. G. Sullivan, President of the Engineering Institute of Canada; Floods on Small Streams Caused by Rainfalls of the Cloudburst Type, by Gerard H. Matthes; Standing Waves in Rivers, by N. C. Grover, chief hydraulic engineer, U. S. Geological Survey; Flood Problems in China, by John R. Freeman, President, A.S.C.E.; Methods in Flood Prevention in the Mississippi Valley, by J. A. Ockerson, member Mississippi River Commission; Relation of Flood Problems to Power and Irrigation Development in the Rocky Mountain States, by A. P. Davis, director U. S. Reclamation Service; Flood Prevention Methods on the Pacific Slope, by C. E. Grunsky, Vice-President A.S.C.E.; and Flood Problems of the Miami Valley and Their Solution, by Arthur E. Morgan and Charles H. Paul, former chief engineer and chief engineer, Miami Conservancy District.

On Thursday and Friday excursions were made to Englewood Dam, Huffman Dam, McCook Aviation Field, the National Cash Register Company's plant, which was the center of relief activities during the flood of 1913, and the American Rolling Mill plant at Middletown. Inspection was also made of the Dayton Channel Improvement work. The Englewood and Huffman Dams are two of the five hydraulic-fill dams that have been built for flood control in the Miami Valley. McCook Aviation Field is the center of research and engineering work in aeronautics for the U. S. Government.

At the dinner and smoker at the Miami Hotel on Thursday evening, Col. E. A. Deeds, president of the Dayton Engineers' Club and chairman of the Board of Directors of the Miami Conservancy District, spoke on Human Phases of the Miami Conservancy Project.

American Gear Manufacturers' Association

A three-day program devoted largely to the technical phases of gearmaking was carried out at the sixth annual convention of the American Gear Manufacturers Association held at the Lafayette Hotel, Buffalo, N. Y., April 20-22. Among the papers of a technical nature that were presented and discussed were: The Use of the Projection Comparator in Testing Gear Teeth (illustrated), by Ralph E. Flanders; Proportions of Industrial Gears, by G. E. Katzenmeyer; The Grinding of Gear Teeth and its Future, by R. S. Drummond; Good Hob Practice, by H. E. Harris; and Bevel Gears, by F. E. McMullen and T. M. Durkon.

Reports were delivered from the standardization committees but no definite action was taken on this phase of the work of the Association. George L. Markland, Jr., of the Philadelphia Gear Works, and R. P. Johnson, of the Worm Gear Co., Muncie, Ind., were the leaders of a general discussion on business conditions. The conditions of the automobile industry, particularly as they affect the gear-making trade, was one of the main topics discussed at this session. Although it was agreed that nothing approaching a business "boom" was to be expected, the general tone of the meeting was optimistic.

Book Notes

Abriss der Lehre von den Erzlagerstatten. By Richard Beck; prepared by Georg Berg. Gebruder Borntraeger, Berlin, 1922. Paper, 7×10 in., 408 pp., illus., $3.60.

During his latter years Dr. Beck had in mind the preparation of an abridgment of his well-known treatise on ore deposits which would be suitable as a college textbook and a survey of the principal information on the subject for use by geologists whose chief interests lie along other lines. With this in view, he had corrected and annotated a copy of the third edition of the treatise, when his death in 1919 made it necessary to entrust the preparation of the present work to Mr. Berg, one of his earliest assistants.

This outline is approximately one-third the size of the original work, which it follows in plan and arrangement. Condensation has been effected in the different chapters by bringing together the less important occurrences, that are interesting for geological or other reasons, as examples in a general description of the corresponding groups of deposits. The number of ore formations has been reduced by combining certain groups, and the chapter on epigenetic deposits has been shortened.

Analysis of Fuel, Gas, Water and Lubricants. By S. W. Parr. Third edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×8 in., 250 pp., illus., diagrams, tables, $2.50.

This book was originally published for use by students of mechanical engineering, and provided a course intended to help the engineer to a better understanding of the literature of the topics treated, and also to an appreciation and more intelligent use of data supplied by the chemist. The present edition has been expanded to meet the needs of students of chemistry as well. It contains a synopsis of the author's lectures on fuel, gas, water and lubricants, and a course in laboratory methods for their analysis.

Automatic Telephone Systems. By William Aitken. Vol. 1. Circuits and apparatus as used in the public services. Benn Brothers, Ltd., London, 1921. Cloth, 8×10 in., 282 pp., diagrams, 25s.

The great mass of detail and the complicated circuit diagrams required to present this subject make special treatment necessary, if a treatise is to be suited to the needs of students. This book attempts to present the subject in intelligible form by rearranging the diagrams, eliminating unnecessary crossing lines, simplifying the form and presenting them in such a way as to show the relationship of the system as a whole. To accomplish these ends a large page and a new system of describing the diagrams, which consists in numbering a circuit from end to end with the same system, have been used. The book covers the whole subject. The principal commercial systems and other less known systems of promise are described.

Continuous Wave Wireless Telegraphy. By B. E. G. Mittell. (Pitman's technical primers.) Sir Isaac Pitman & Sons, Ltd., London and New York, 1922. Cloth, 4×7 in., 110 pp., illus., $0.85.

This little book is offered as an introduction to radiotelegraphy from the engineer's point of view. It avoids the use of mathematics and plunges directly into the subject without a preliminary discourse upon electricity or the development of mechanical analogies. Special attention, so far as space permits, is given to the Poulsen arc and to the construction of tall aerial structures, and useful references to important papers are given throughout the book.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Methods and Limitations. Limitations and New Methods of Accident Prevention (Grenzen und neue Wege der Unfallverhutung), Karl Hartmann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 8, Feb. 25, 1922, pp 186–188 Conditional and unconditional protection Technical and economic limitations Development of protective regulations. Necessity of coöperation between machine constructor, manager and workman.

AERIAL PHOTOGRAPHY

Fairchild Camera. Aerial Photography, W. L. Hamilton. Aerial Age, vol 15, nos 1 and 2, Mar. 13 and 20, 1922, pp 6-7 and 36-38, 7 figs. Mar. 13: Discusses a map of New York taken from an airplane, and the Fairchild camera with which it was made Mar. 20: Discusses several examples of successful aerial photography.

AERONAUTICAL INSTRUMENTS

Telecompass. A Solution of the Problem of Determining Position in an Airplane (Une solution du problème de l'orientation en avion), Industrie Électrique, vol. 31, no. 710, Jan. 25, 1922, pp. 25–27, 4 figs. Mechanical and electrical description of the telecompass, and its use.

AIR COMPRESSORS

Modern. Modern Compressors (Les compresseurs modernes), A. Lambrette. Technique Moderne, vol. 13, nos. 11 and 12, Nov and Dec 1921, and vol. 14, no. 2, Feb. 1922, pp. 468–474, 502–510 and 59–63, 48 figs. Discusses single-acting, double-acting, monocylindric-two-phase, two-stage, and multiple-stage compressors; inlet and outlet valves; lubrication; play in bearings and connecting rod; etc.

Portable Oil-Engine-Driven. A Portable Air Compressor for Industrial Use (Groupe motocompresseur transportable pour usages industriels), J.-A. Calmettes. Génie Civil, vol. 80, no 4, Jan. 28, 1922, pp. 87–88, 2 figs. Describes the Diatto compressor driven by an oil engine, for drilling, boring, etc.

AIR CONDITIONING

Gas-Absorption Device. A New Device for Gas Absorption, H. E. Robertson Chem. Age (N. Y.), vol. 30, no. 2, Feb. 1922, pp. 59–60, 2 figs. Construction and operation of new air conditioner and purifier adapted to many industrial processes involving handling of gases.

AIRCRAFT

Designing Parts. Improved Method for Designing Aircraft Parts, Roy G. Miller and F. E. Seiler, Jr. Aviation, vol. 12, no 13, Mar. 27, 1922, pp. 366–367, 2 figs. Practical method for determination of elements of irregular structural sections.

Fuels. See GASOLINE.

Research. Research from the Designers', Constructors' and Users' Points of View, Fred M. Green. Flight, vol. 14, no. 8, Feb. 23, 1922, pp. 121–122. Discusses problems of wing surface, power required, metal construction, calculations of stresses, engine design, fuels, navigation, etc. (Abstract.) Paper read before Air Conference, 1922. See also Aerial Age, vol. 15, nos. 1 and 3, Mar 13 and 27, 1922, pp. 8–9 and 61–62.

Specialized. Specialized Aircraft, W. D. Beatty. Aeronautical Jl., vol. 26, no 135, Mar. 1922, pp. 92–101 and (discussion) 101–107. How heavier-than-air aircraft has been developed in England on specialized lines, with special reference to comfort of passenger.

AIRCRAFT CONSTRUCTION MATERIALS

Fabric Coverings. Deterioration of Aeroplane Fabrics, Fr. Wendt. Aerial Age, vol. 14, no. 25, Feb. 27, 1922, p. 593. 32nd report of German Experimental Inst. for Aviation at Berlin-Adlershof. Series of experiments were carried out on effect of weathering on cloth covering of airplane wings and fuselages. From Zeit. für Flugtechnik u. Motorluftschiffahrt, Nov. 30, 1921, p. 325.

AIRPLANE ENGINES

Developments. Recent Aircraft Engine Developments, C. Fayette Taylor. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 204–206, 5 figs. Outlines most important advances in aircraft engines since signing of armistice. Use of anti-knock compounds; aircraft-engine size and cooling; aircraft powerplant refinement.

Maybach. Performance of Maybach 300-Horsepower Airplane Engine. Nat. Advisory Committee for Aeronautics, report no. 134, 1922, 11 pp., 24 figs. Deals with results of test made in altitude chamber of Bur. of Standards. From standpoint of thermal efficiency, full-load performance is excellent at densities corresponding to altitudes up to 15,000 ft.; at part load thermal efficiency is low.

AIRPLANE PROPELLERS

Performance. Graphic Calculation of Performances of Air Propellers According to Model Tests (Zeichnerische Berechnung der Leistungen von Luftschrauben nach Modellversuchen), Adolf Rohrbach. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 13, no. 5, Mar. 15, 1922, pp. 61–63, 2 figs. New nomogram is developed to supplement graphic calculations of Durand and Lesley in U. S. Nat. Advisory Committee for Aeronautics Reports nos. 14, 30, 64 and 109.

AIRPLANES

Aerofoils. Properties of Two Aeromarine Aerofoils, B. V. Korvin-Kroukovsky. Aviation, vol. 12, no. 11, Mar. 13, 1922, pp. 314–315, 2 figs. Development of two high-lift wings for use on large aircraft, particularly adapted for performance at large incidence.

Center of Pressure Coefficients for Aerofoils at High Speeds, W. S. Diehl. Nat. Advisory Committee for Aeronautics Technical Notes, no. 25, Apr. 1922 2 pp., 3 figs. It has been customary to calculate strength of rear wing beam for "high-speed" condition on assumption that center of pressure was at 0.50 of wing chord. It is shown that this assumption is not justified.

Altimeter and Air Speed Indicator. The Dugit Altimeter and Air Speed Indicator, J. H. Blakely. Aviation, vol. 12, no. 13, Mar. 27, 1922, pp. 371–372, 3 figs. Discusses instruments based on application of Archimedean spiral which give increased precision and uniform sensitiveness. Translated from Génie Civil.

Commercial. A Gloucestershire Goods Type Commercial Aeroplane. Flight, vol. 14, no. 6, Feb. 9, 1922, pp. 87–88, 1 fig. Tractor biplane, fitted with Rolls-Royce Eagle engine; 360 hp.; 1,600 lb. goods-carrying capacity.

Electric Cables, Directing by. Directing Airplanes by Electric Cables (Le guidage des avions par cables électriques), P. Franck and A. Volmerange. Aeronautique, vol. 4, no. 33, Feb. 1922, pp. 39–47, 17 figs. Describes method by Loth, based on method of directing ships by electric cable, by which landing in fog and "taking of position" are made possible.

Fuel Level Indicator. The Smith Petrol Level Indicator. Flight, vol. 14, no. 8 Feb. 23, 1922, p. 124, 2 figs. Describes new device by S. Smith & Sons, Ltd., Lond., special features of which are simplicity both in construction and operation. Adaptable also for use on reservoirs, storage tanks, etc.

German Commercial. The L. F. G. Commercial Airplane Type V 13 (Das L. F. G.-Verkehrsflugzeug Type V 13). Motorwagen, vol. 25, no. 6, Feb. 28, 1922, pp. 119–120, 2 figs. Characteristics of the Strela, for 2 or 4 passengers: Weight empty, 1460 kg.; total weight, 2128 kg.; max. span, 17.5 mm.; max. length, 10.9 m.; max. height, 3.88 m.; engine, 185-hp. Benz or Bavarian Motor Works engine, or 220-hp. Benz or Mercedes.

1000-Hp. Napier Cub. Harnessing 1,000 Horse Power. Flight, vol. 14, no. 8, Feb. 23, 1922, pp. 118–119, 7 figs. Describes the 1000-hp. Napier "Cub."

Parachutes. See PARACHUTES.

Research. Research With Full Sized Airplanes, F. H. Norton. Tech. Eng. News, vol. 2, no. 9, Mar. 1922, pp. 240–241, 3 figs. Describes some free flight problems recently investigated by Nat. Advisory Committee for Aeronautics, at Langley Field.

Seaplanes. See SEAPLANES.

Speed Calculation in Flight. Graphic Calculation of Airplane Speeds in Straight and Circling Flight (Zeichnerische Berechnung der Geschwindigkeiten von Flugzeugen im Geradeaus- und Kurvenflug), Adolf Rohrbach. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 13, no. 5, Mar. 15, 1922, pp. 59–61, 2 figs. Presents charts and describes method of calculation.

Waco Model 4. The Waco Model 4. Aerial Age Weekly, vol. 15, no. 2, Mar. 20, 1922, pp. 32–34, 2 figs. Describes four-place biplane of Weaver Aircraft Co. of Lorain, Ohio; Curtiss Ox-5 motor; 84 m.p.h. at 1050 r.p.m.

AIRSHIPS

Development and Possibilities. Airships, G. H. Scott. Aerial Age, vol. 14, no. 25, Feb. 27, 1922, pp. 590–593. Airship activities in various countries; technical position of modern British airship, including hull, fabric, engines, safety, weather conditions, and mooring mast; value of airships for defense. Paper read before British Air Conference.

Drag of Hull. The Drag of C Class Airship Hull with Varying Length of Cylindric Midships, A. F. Zahm, H. R. Smith and G. C. Hill. Nat. Advisory Committee for Aeronautics, Report no. 138, 1921, 10 pp., 6 figs. A model of C class airship hull, when severed at its major section and provided with cylindric mid-body of variable length, had its air resistance increased about in proportion to length of mid-body up to 3 diameters, and in about manner to be expected from increase of skin friction on this variable length. For greater length drag increased less and less rapidly.

Model Tests. Hydrostatic Test of an Airship Model. Nat. Advisory Committee for Aeronautics Technical Notes, no. 87, Mar. 1922, 15 pp., 8 figs. on supp. plates. Airship model made by Goodyear Rubber Co. was filled with water and suspended from beam and deformations of envelope studied under following conditions: both ballonets empty; forward ballonet filled with air; rear ballonet filled with air; and both ballonets filled with air.

R 38 Accident. British Report on the Loss of Airship R38. Aviation, vol. 12, no. 11, Mar. 13, 1922, pp. 311–312. Findings of Aernautical Research

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Committee attribute accident to inaccurate calculations, faulty design and structural weakness.

Speed. The Choice of the Speed of an Airship, Max M. Munk. Nat. Advisory Committee for Aeronautics Technical Notes, no. 89, Mar. 1922, 8 pp., 2 figs. Presents fairly simple rules which it is claimed may be of advantage if reasonably applied.

ALCOHOL

Dilute Solutions. The Vapour Pressures of Dilute Alcohol Solutions, R. Thomas. Soc. Chem. Industry Jl., vol. 41, no 4, Feb. 28, 1922, pp. 33T–34T, 2 figs. Describes rapid method of determining partial pressures of alcohol and water in an aqueous solution of former.

ALLOY STEELS

Vibrac. Vibrac Steel. Motor Transport, vol. 34, no. 888, Mar. 6, 1922, p. 287, 1 fig. Describes properties and tests of new steel produced by Armstrong, Whitworth & Co., which is proof against temper-brittleness.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Copper. See COPPER ALLOYS.

Ternary and Quaternary. The Graphic Presentation of Ternary and Quaternary Alloys (Die graphische Darstellung von Dreistoff- und Vierstoff-Legierungen), W. Hommel. Zeit. fur Metallkunde, vol. 13, nos. 13, 14 and 15, Oct. Nov. and Dec. 1921, pp. 456–465, 511–518 and 565–569, 22 figs. Development of new method for diagrammatic presentation of such alloys. The concentration and melting temperature for each alloy can be read immediately in diagram. Construction of diagrams for different systems.

Treatment. Modern Metal Alloys and Their Treatment (Neuere Metallegierungen und ihre Verarbeitung), Willy Hacker. Elektrotechnischer Anzeiger, vol. 39, nos. 2, 3 and 5, Jan. 4, 5 and 10, 1922, pp. 8–10, 14–16 and 35–37. Review of modern German processes for preparation and treatment of alloys.

ALUMINUM ALLOYS

Failures. Some Cases of Failure in "Aluminium" Alloys, W. Rosenhain. Inst. of Metals Advance Paper for meeting Mar. 9, 1922, 4 pp., 2 figs.; also Engineering, vol. 113, no. 2932, Mar. 10, 1922, p. 308, 2 figs. Discusses two examples of failures showing that materials which undergo serious growth, distortion, and disintegration in course of service, are not aluminum alloys in ordinary sense of that term, but materials of essentially different type.

Research. On Some Alloys of Aluminum, Walter Rosenhain and Sydney L. Archbutt. Instn. Mech. Engrs. Proc., no. 7, 1921, pp. 699–725 and (discussion) pp. 727–771. Report to Alloys Research Committee representing result of organized work of practically whole staff of Metallurgical Dept. of Nat. Physical Laboratory. Deals with cast and wrought alloys, permanence and constitution of alloys.

Zinc and Aluminum. A Further Study of the Alloys of Aluminum and Zinc, D. Hanson and Marie L. V. Gayler. Inst. of Metals Advance Paper for meeting Mar. 9, 1922, 28 pp., 29 figs. Account of investigation. Deals with determination of the solidus; constitution of solid alloys; the constituent beta; age-hardening of constituent beta and gamma. Photomicrographs.

AMMONIA COMPRESSORS

Losses. Losses in Ammonia Compressors, S. F. Smith. Refrig. World, vol. 57, no. 3, Mar. 1922, pp. 25–26. The five ways in which losses occur in compression machine and conditions which control same. The two-stage compressor and its field. Paper read before Mountain States Ice Manufacturers Assn.

Starterless Induction Motors for. Starterless Induction Motors for Ammonia Compressors, J. Lebovici. A.S.R.E. Jl., vol. 8, no. 5, Mar. 1922, pp. 398–402 and (discussion) 402–404, 7 figs. Combines favorable characteristic of squirrel cage and slip ring types, and makes ideal drive for ammonia compressors using up to 150 hp.

APPRENTICES, TRAINING OF

System, Rock Island Arsenal. Apprenticeship System at Rock Island Arsenal, William Baumbeck. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 512–514, 6 figs. Devices for teaching. Use of slide rule. Action of gear teeth and selection of proper views for drawings. Outline of courses.

ASH HANDLING

Hydraulic Disposal System. Handling Ashes by Sluicing, C. C. Lance. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 503–504, 1 fig. Calumet and Hecla Mining Co. power plant at Lake Linden, Mich., reduces ash handling costs by hydraulic system of ash disposal.

AUTOMOBILE ENGINES

Air Cooling. Air-Cooling Progress in U. S. A., Harold F. Blanchard. Autocar, vol 48, no. 1376, Mar. 4, 1922, pp. 355–359, 8 figs. Economy in operation important feature. Discusses air cooling as applied to Franklin, Holmes, 6-cylinder Fox, and twin-three D.A.C. cars, and explains how cooling draught is induced

Buda. A Good Example of Modern Engine Design, J. Edward Schipper Automotive Industries, vol. 46, no. 13, Mar. 30, 1922, pp. 699–700, 1 fig. New model of Buda engine designed for light commercial trucks and similar applications, but of heavy-duty type and similar in general design to other engines of same make. Compression ratio, 4.35 to 1.

Carburetors. See CARBURETORS.

Crankshafts. See CRANKSHAFST.

Cylinders. Some Aspects of Air-Cooled Cylinder Design and Development, S. D. Heron. Soc. Automotive Engrs. Jl., vol. 10, no. 4, Apr. 1922, pp. 231–260, 35 figs. Design and development of modern high-output air-cooled cylinder. Deals primarily with problems of aircraft cylinder of approximately 40 b.hp.

Development. Aircraft Engine Experience as a Basis for Automobile Engine Development, H. Dechamps. Automotive Industries, vol. 46, no. 11, Mar. 16, 1922, pp. 611–613. Super-compression and over-dimensioning of engines as an aid to fuel economy.

Fuel Economy. Relation Between Fluid Friction and Transmission Efficiency, Neil MacCoull. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 193–199, 16 figs. Experiments to determine mechanical losses, including data from E. H. Lockwood's experiments at Yale. Possibilities for increasing fuel economy of a motor vehicle. See also Lubrication, vol. 8, no. 1, Jan. 1922, pp. 1–8, 15 figs.

Ignition, Automatic. Automatic Ignition Advance. Autocar, vol. 48, no. 1376, Mar. 4, 1922, pp. 362–363, 1 fig. Describes mechanism to provide automatic spark advance by depression in inlet pipe, which is very great when throttle is almost closed, but grows less with increase of engine speed, and mechanical compensation moving with throttle mechanism.

Increasing Power Obtainable. The Super-Power Engine, G. Funck. Autocar, vol. 48, no. 1377, Mar. 11, 1922, pp. 395–400, 13 figs. Deals with means of increasing power obtainable from engine of given cubical capacity other than those ordinarily employed.

Manifold Design. Manifold Vaporization and Exhaust-Gas Temperatures, O. C. Berry and C. S. Kegerreis. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 171–176, 10 figs. Discusses low volatility of fuel for internal-combustion engines as cause of uneconomical utilization of fuel and of engine maintenance troubles. Tests carried out.

Stutz. Powerplant in New Stutz Model Incorporates Many Changes, J. Edward Schipper. Automotive Industries, vol. 46, no. 14, Apr. 6, 1922, pp. 750–751, 6 figs. Lighter pistons, redesign of jackets and cylinder head, better fuel vaporizing means, heavier crankshaft, machined combustion chambers, etc.

Two-Stroke. An Investigation of Certain Aspects of the Two-Stroke Engine for Automobile Vehicles, F. W. Lanchester and R. H. Pearsall. Automobile Engr., vol. 12, no. 160, Feb. 1922, pp. 55–62, 16 figs. Investigation of principal factors controlling performance of internal-combustion engines functioning on two-stroke cycle, especially small size engines of simplest forms adapted to work at comparatively high revolution-speeds. Paper before Instn. Automobile Engrs.

AUTOMOBILE FUELS

Alcohol. The Use of Alcohol as Fuel in Exported Vehicles, Herbert Chase. Automotive Industries, vol. 46, no. 14, Apr. 6, 1922, pp. 771–773, 1 fig. Use of alcohol in Spanish-American countries because of less cost, and adaptation of vehicles for use of alcohol. Discusses problems met in its use and suggests remedies.

[See also GASOLINE.]

AUTOMOBILES

Austro-Daimler. The 17/60-Hp. Anstro-Daimler Six-Cylinder Car Type AD 617 (Der 17/60 PS-Anstro-Daimler-Sechszylinder-Wagen, Type AD 617). Allgemeine Automobil-Zeitung, vol. 23, no. 4, Jan. 28, 1922, pp. 28–30, 7 figs. Dimensions: Max. length, 4.625 m.; max. width, 1.685 m.; max. height, 1.56 m.; wheelbase, 3.45 m.; gage, 1.36 m.; weight of chassis, 1240 kg. Details of engine.

Bianchi 12–20 Hp. The 12–20 Hp. Bianchi Chassis. Automobile Engr., vol. 12, no. 161, Mar. 1922, pp. 66–71, 12 figs. Describes engine, clutch, gearbox, etc., of small car made by Bianchi Motors, Ltd., Milan.

Bodies, Manufacture of. The Efficient Production Automobile Bodies, G. W. Eastwood. Eng. Production, vol. 4, nos. 74 and 75, Mar. 2 and 9, 1922, pp. 200–202 and 221–224, 18 figs. Construction methods. Paper presented before Instn. Production Engrs. See also discussion of paper in same journal, vol. 4, no. 76, Mar. 16, 1922, pp. 218–250.

Brakes. Developing a Method for Testing Brake-Linings, S. von Ammon. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 153–162, 23 figs. Describes equipment developed and methods used for tests; coefficient of friction; endurance tests with cooled drum; severe-service test with uncooled drum; etc.

Passenger-Car Brakes, J. Edward Schipper. Soc. Automotive Engrs. Jl., vol. 10, no. 4, Apr. 1922, pp. 273–289, 29 figs. Comprehensive survey of present braking practice and outline of future requirements and possibilities; design factors; future of brakes.

The Perrot-Hallot Brake (Die Perrot-Hallot-Bremse), Claus Syrlin. Allgemeine Automobil Zeitung, vol. 23, no. 1, Jan. 7, 1922, pp. 33–34, 2 figs. Details and principle of automobile brake developed by Hallot and Perrot, tests with which recently carried out under auspices of Royal English Automobile Club showed excellent results.

Gear Boxes. Improvements in Gear-box Design, H. F. L. Orcutt. Automotive Industries, vol. 46, nos. 9, 10 and 11, Mar. 2, 9 and 16, 1922, pp. 511–514, 563–565 and 617–621, 5 figs. Mar. 2: Points out some of usual defects and outlines methods of improvement. Mar. 9: Methods employed to carry on special gear-box gear tests. Describes new gear-tooth grinding process. Mar. 16: Factors in production of gear boxes, and suggestions for improvements in design. Condensed from paper read before Instn. Automobile Engrs.

German Szawe. German Car of Novel Design Employs Many Aluminum Parts, Benno R. Dierfeld. Automotive Industries, vol. 46, no. 13, Mar. 30, 1922, pp. 701–706, 20 figs. Uses six-cylinder, 2.44 by 5.51-in. aluminum alloy engine with thin steel liners cast in block. Outstanding features are an automatic gearshift, and rear axle housing casting and pistons of silumin. Built by Szabo & Wechselmann, Berlin, principally for export trade.

Hubs and Pistons. Tooling Equipment for Automobile Hubs and Pistons, Ralph E. Flanders. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 640–644, 16 figs. Describes tools and operations.

Miniature Four-Cylinder. Miniature "Fours." Autocar, vol. 48, no. 1378, Mar. 18, 1922, pp. 431–435, 9 figs. Description of some of best known of modern four-cylinder engines having piston displacements of less than 1,000 cc.

Modern Plant Design. Designing a Modern Automobile Plant, Paul L. Battey. Iron Age, vol. 109, nos. 10 and 11, Mar. 9 and 16, 1922, pp. 652–656 and 713, 14 figs. What is involved in relations of departments and in many services now demanded. View of future in industrial developments. Providing power, heating, water supply and other services. Details of plant and manufacturing procedure of the Willys Corp., Elizabeth, N. J. Based on paper presented before Am.Soc.Mech.Engrs.

Repair Shops. Service in a "White" Station, Fred. H. Colvin. Am. Mach., vol. 56, no. 12, Mar. 23, 1922, pp. 429–432, 9 figs. Layout of Newark, N. J., service station of White Motor Co. Eliminating time waste. Layout of stockroom. Exchange of worn or damaged parts. Facilities for handling motors and other parts.

16–20 Hp. Cubitt. The 16–20–Hp. Cubitt Chassis. Automobile Engr., vol. 12, no. 160, Feb. 1922, pp. 34–40, 15 figs. Low-priced vehicle built on quantity production lines. Described engine, clutch, gearbox, transmission brake, transmission and rear axle, suspension, etc.

Star. New Durant Product Makes Good Impression, Herbert Chase. Automotive Industries, vol. 46, no. 11, Mar. 16, 1922, pp. 601–604, 7 figs. Describes new car built for Star Company. Has 102-in. wheelbase; pump circulation; long, semi-eleptic springs; storage battery; etc.; 35 hp. at 2,500 r.p.m.

Steam. A Steam Car That Is Different. Sci. Am., vol. 126, no. 4, Apr. 1922, p. 262, 4 figs. Details of new Coats steam car having gas-car control and finish with steam-car smoothness.

Suspension. A New Suspension System. Auto, vol. 27, no. 7, Feb. 16, 1922, p. 136, 1 fig. Some details of the Gattie device in which helical springs are utilized.

240-Hp. Racing. A 240-Hp. Car For Brooklands. Autocar, vol. 48, no. 1376, Mar. 4, 1922, p. 351, 2 figs. Fitted with Benz aero engine, Hartford shock absorbers and Rudge-Whitworth wire wheels.

AVIATION

Aerial Transportation. Aerial Transport Today and Tomorrow, W. A. Bristow. Aerial Age, vol. 14, no. 26, Mar. 6, 1922, pp. 616–618 and 627 and vol. 15, no. 2, Mar. 20, 1922, pp. 35 and 38. Also abstract in Flight, Feb. 16, 1922, p. 99. Discusses present situation depending on subsidies of some sort, the building up of merchant air fleets as main reliance for military air fleets, and increased passenger traffic required.

Civil. The Air Conference. Flight, vol. 14, no. 6, Feb. 9, 1922, pp. 83–86, 2 figs. Summary of Lord Gorell's paper on Civil Aviation, discussing factors of successful development, service and civil sides, progress, necessity for more research work, cross-channel services, imperial air services, air mails, policy of subsidization, etc.

Marking Aerodromes. Marking Aerodromes, P. James. Aerial Age, vol. 14, no. 25, Feb. 27, 1922, pp. 586 and 588. Necessity of adopting system of markers for giving direction for starting and landing and of indicating good part of field. Methods hitherto employed and methods now proposed. From Premier Congrès Internationale de la Navigation Aérienne, Paris, Nov. 1921, vol. 2, pp. 115–118.

AXLES

Milling Eccentric Keyways In. Device for Milling Eccentric Keyways in Axles of Locomotives After the Axles are Pressed Into the Wheels. Ry. & Locomotive Eng., vol. 35, no. 3, Mar. 1922, pp. 58–59, 3 figs. Details of construction and application.

B

BALANCING

Rotating Masses. Notes on Balancing Rotating Masses, J. W. Rogers. Mech. World, vol. 71, nos. 1832 and 1833, Feb. 10 and 17, 1922, pp. 106–107 and 124–125, 6 figs. Feb. 10: Statical and dynamical balancing. Feb. 17: Describes Martin rotor balancing machine, whose application affords quick, safe and inexpensive method of balancing all types of rotary bodies and gives very accurate results.

BEARINGS, ROLLER

Street Cars. Roller Bearings in the Municipal Street-Railway Cars of Hagen (Germany) (Rollenlager im Betriebe der Hagener Strassenbahn), K. Pforte. Verkehrstechnik, vol. 29, no. 7, Feb. 17, 1922, pp. 80–83, 4 figs. Describes Jaeger type of roller bearings adopted by municipal street railway as substitute for uneconomic journal bearing for motors and axle bearings, and points out their value in reducing cost and increasing safety. Advantages over ball bearings.

BEARINGS, THRUST

Michell. The Michell Bearing Machy (Lond), vol. 19, no 495, Mar 23, 1922, pp 765-766, 4 figs Application.

BELTING

Power Transmission by. Power Transmission by Belting, W G Dunkley Eng & Indus Management, vol 7, no. 10, Mar 23 1922 pp 280-281, 2 figs. Describes common faults which are met with in works, and suggests methods by which they may be satisfactorily overcome Notes on belt design, stresses and tension

BENDING MACHINES

Boiler-Plate. A New Boiler-Plate Bending Machine of Vertical Type with Electric Drive (Eine neue Kesselblechbiegemaschine stehender Anordnung mit elektrischem Antrieb), Hugo Becker Schiffbau, vol 23, no 22-23, Mar 1-8, 1922, pp. 690-693, 6 figs. Describes new type of bending press for boiler plate which is claimed to show marked improvements and advantages over older types

BOILER FEEDWATER

Treatment. Advantages of Treating Locomotive Feed Water. Boiler Maker, vol 22, no. 3, Mar 1922, pp. 66-68 Quality of boiler water, treatment to prevent scale and plants designed for the purpose; gives questionnaire on water treatment. To be presented at 1922 meeting Master Boiler Makers' Assn.

Treated Water Improves Locomotive Performance, W. A. Powanall. Ry Mech. Engr , vol. 96, no. 4, Apr. 1922, pp. 191-192 Systematic methods of boiler water treatment by soda ash process.

BOILER OPERATION

Efficient. The Expectation of Efficiency of Steam Boiler Operation, Hugh R. Carr Power Plant Eng , vol 26, no 7, Apr. 1, 1922, pp 357-360, 2 figs Discusses variables entering into the question, viz : type of draft, combustion rate, coal, ratio of heating to grate surface, point of maximum heat intensity. Proposes empirical curves for determining efficiency with fair degree of accuracy

Rating Percentage. Percentage of Boiler Rating. Power, vol. 55, no. 14, Apr. 4 1922, pp 531-532. What it means and how it is figured Presents table for simplifying computations

BOILERS

Adaptation to Low-Grade Fuel. Reconstruction of Coke Sectional Boilers for the Burning of Substitute Fuels (Umstellung von Koksgliederkesseln auf Ersatsbrennstoffe), H. Pradel. Braunkohle, vol. 20, no. 45, Feb. 11, 1922 pp. 705-711, 12 figs. Details of improvements in boilers by German boilermakers designed for use of low-grade fuel.

Ambitubular. Ambitubular Boiler (Chaudière ambitubulaire), C. Anguenot Arts et Metiers, vol. 74, no. 15, Dec. 1921, pp. 357-360 2 figs Describes boiler combining water tubes and fire tubes and advantages of both.

Design and Operation. Steam Boilers, F. W Dean. N. E. Water Works Assn Jl , vol 36, no. 1, Mar. 1922, pp. 115-139 and (discussion) pp. 139-140, 5 figs. Notes on internally and externally fired boilers, fire-tube and water-tube boilers, workmanship; baffles; method of taking steam from boilers, height of boilers above floor, height of bridge walls, locomotive-type boilers, feedwater regulators, temperature of escaping gases mechanical and hand stokers, pulverized coal, oil fuel, feeding boilers, etc.

Electrically Heated. Electrically Heated Boilers (Elektrodampfkessel), H. Schneider Archiv. fur Wärmewirtschaft, vol. 3, no 2, Feb 1922, pp 27-28, 5 figs. Comparison with steam generation with coal firing. Types of electrically heated boilers

Heat-Loss Determination. A New Method of Determining Heat Losses by Means of the Combustible Gas in the Exhaust Gases of Boilers (Ein neues Verfahren zur Bestimmung der Wärmeverluste durch brennbares Gas in den Abgasen der Kesselfeuer), O. I. Hansen. Zeit. des Bayerischen Revisions-Vereins, vol. 26, nos. 1, 2 and 3, Jan. 15, 31 and Feb. 15, 1922, pp. 3-5, 13 15 and 21 22, 4 figs. Describes method and apparatus with which it is possible to determine heat loss with sufficient accuracy. Account of tests carried out by K. E. Nielsen in Copenhagen (Denmark) gas works.

High-Pressure. The Thermo-Dynamics of Extra High Pressure Steam in Connection with Power and Heat Economics, O. H. Hartmann. Eng. Progress, vol. 3, no. 3, Mar 1922, pp. 45 48, 7 figs. Describes vertical-tube boiler for pressure of 60 atmos. developed by Wilhelm Schmidt, which can generate steam at this atmosphere and up to temperature of 450 deg. cent. Tests with extra-high-pressure steam engines, and importance of these engines for heat economics. Possibilities of application of extra-high-pressure steam in connection with combined power and heating installations.

Locomotive. See LOCOMOTIVE BOILERS

Low-Pressure Gas in Oil-Field. Use of Low-Pressure Gas Burners in Oil-Field Boilers, M. P. Youker. U. S. Bur. of Mines Reports of Investigations, serial no. 2329, Feb. 1922, 8 pp. Résumé of report on possibilities of using low-pressure gas to generate steam for drilling purposes and on types of gas burners which would be best for this purpose.

Welding. Commercial Welding on High Pressure Boilers, Edward H. Heidel. Can Machy , vol. 27, no. 12, Mar. 23, 1922, pp. 27-28, 5 figs. Procedure and rules to be followed in welding boilers, autogenous welding of locomotives, etc. Paper read before Am. Welding Soc.

BOILERS, WATER-TUBE

Design. Standard Rules Governing The Construction of Water Tube Boilers Shipbldg & Shipg Rec , vol. 19, no 11, Mar 16, 1922, p. 345. Deals with Part V of Standard Conditions for Design and Construction of Marine Boilers and Shafting, prepared by British Marine Engineering Design and Construction Committee.

Reliability. The Reliability of Water-Tube Boilers Shipbldg & Shipg. Rec , vol. 19, no 10 Mar 9, 1922 p 299 Editorial dealing with explosion which occurred in one of the water-tube boilers of the Berengaria

BOLTS

Tightening by Use of Liquid Air. Experimental Use of Liquid Air and Explosives for Tightening Body-Bound Bolts, H. L. Whittemore. Am. Mach , vol 56, no 14, Apr. 6, 1922, pp. 524 526 Cylindrical and taper bolts contracted by liquid air and allowed to expand after insertion. Cylindrical bolts expanded in place by explosives.

BORING TOOLS

Chart for Determining Pressure. Chart for Determining the Pressure Exerted by Boring Tools, J. B. Conway. Am. Mach., vol. 56, no. 13, Mar. 30, 1922, pp. 476-478, 1 fig. Describes construction and operation of chart. Determination of end thrust and pressure due to cutting. Table for values of feed to 0 7 power.

BRAKES

Freight-Train. Continuous Brake for Long Freight Trains (Le freinage continu des longs trains de marchandises), J. Netter. Le Génie Civil, vol. 79, nos 26 and 27, Dec. 24 and 31, 1921, pp. 557 561 and 585-590, 28 figs. Dec. 24: Discusses tests in progress by Commission of French Public Works. Describes situation before and after war, also the Westinghouse triple-valve brake. Dec. 31. The Kunze-Knorr and Lipkowski compressed-air brakes and the Clayton-Hardy vacuum brake. Results of tests carried out.

BRASS

Forgings, Manufacture of. The Manufacture of Brass Forgings, C. T. Roder. Iron Age, vol. 109, no. 13, Mar. 30, 1922, pp. 857-858, 2 figs. Called also die pressing or hot forging. Details of process developed in United States during war. Physical and other properties.

Plasticity Under Compression. Plasticity of Brass Rods Under Percussive Compression, Fr. Doerinckel and Julius Trockels. Raw Material, vol. 5, no. 2, Mar. 1922, pp. 58-62, 16 figs. Discusses occurrence of flow in compressed brass by hydraulic compression of bars, showing that at red-heat vortex motions ensue by pressure in brass block. From Zeit. für Metallkunde.

Season Cracking. Further Studies in Season-Cracking and Its Prevention. Condenser Tubes, H. Moore and S. Beckinsale. Inst. of Metals Advance Paper for meeting Mar. 8, 1922, 22 pp., 11 figs. Record of work done in consequence of suggestion made by George Goodwin, of application to Admiralty condenser tubes of low-temperature annealing recommended for removal of internal stress in brass. See also (abstract) in Engineering vol. 113, no. 2933, Mar. 17, 1922, pp. 337-340, 11 figs.; and Metal Industry (Lond.), vol. 20, no. 13, Mar. 31, 1922, pp. 298-302, 6 figs.

BROACHES

Design. The Design of Pull Broaches, J. Labensky and Palmer Hutchinson. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 615-617, 4 figs. Depth of cut, pitch, length, shape of teeth. Methods of attaching broaches to machines.

BUSES

Trolley. The Operation of a Self-Contained Trolley Omnibus System, J. B. Parker. Tramway & Ry. World, vol. 51, no. 13, Mar. 16, 1922, pp. 117-123, 13 figs. Describes operation of system controlled by Tees-side Railless Traction Board, and gives operating costs of new trolley buses.

C

CABLEWAYS

Aerial. Aerial Cableways (Les transporteurs aériens à cables), Cretin. Génie Civil, vol. 80, nos. 4 and 5, Jan. 28 and Feb. 4, 1922, pp. 75-79 and 103-105, 15 figs. Jan. 28: Discusses analytical calculations with examples. Feb. 4: Tension of cableways and calculation of loads.

CAMS

Design. Design of Cams (Einiges uber die Nockenscheiben der Motoren), Arthur Balog. Wirtschaftsmotor, no. 12, Dec. 25, 1921, pp. 19-21, 5 figs. It is shown how, for different types of engines (for example, Diesel engines), a uniform basis can be developed for design of uniform, easily made cams.

CAR WHEELS

Chilled-Iron, Manufacture. Car Wheel Manufacture Revolutionized, Gilbert L. Lacher. Iron Age, vol. 109, nos. 13 and 14, Mar. 30 and Apr. 6, 1922, pp. 847-852 and 939-943, 8 figs. Describes practice at plant of Griffin Wheel Co. at Council Bluffs, Iowa. Notes on mechanical molding; charging and handling of cupolas; sand preparation; core making and baking.

Flange Welding. Getting Wheel Mileage Without a Lathe. Elec. Traction, vol. 18, no. 3, Mar. 1922, pp. 214-215, 6 figs. Utilization of welding and cutting torch instead of wheel-turning lathe by Terre Haute, Indianapolis and Eastern Traction Co.

Machining. Machining and Mounting Wheels and Axles, Charles Petrain Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 148 150, 1 fig. Gaging-worn axles and rolled-steel wheels; welding cast steel wheels (Abstract.) Paper read before Car Foremen's Assn of Chicago.

CARBURETORS

German Types. Carburetors Exhibited at the German Automobile Show 1921 (Die Vergaser auf der Deutschen Automobil-Ausstellung 1921), Joh Menzel Allgemeine Automobil Zeitung, vol 22, nos. 43, 44, 45, 46, 47 and 49 Oct 22, 29, Nov 5, 12, 19 and Dec. 3, 1921, pp 24 25, 28 30, 33 35, 34 35, 28 29 and 32 34, 29 figs. Details, advantages and disadvantages of types exhibited.

Problems and Design. The Relation of Carburetion to Fuel Economy, J. N. Golten. Automotive Industries, vol. 46, nos. 12 and 13, Mar. 23 and 30, 1922, pp. 666 669 and 711 717, 14 figs. Mar. 23 Functions of carbureting system; metering characteristics of ideal carburetor; pulsating air flow; carburetor problems and design. Mar. 30 Vaporization from theoretical and practical standpoint.

CARS

British Works. The Nottingham Works of Cammel Laird and Co , Limited. Engineer, vol. 133, no 3451, Mar. 10, 1922, pp. 268 270, 12 figs. partly on p 272. Describes shops, equipment and practice of works for production of railway rolling stock. See also Engineering, vol. 113, no. 2932, Mar. 10, 1922, pp. 292 294, 4 figs.

Hose Connector, Automatic. Recent Changes in American Hose Connectors. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 141-143, 4 figs. Manufactured by Am. Automatic Connector Co., Cleveland, Ohio. Passenger heads interlocked under pressure; permanently attached freight interchange adapter.

CARS, COAL

Gondola. C. M. and St. P. Ry. Sets An Example in Good Car Design. Ry. Rev., vol. 70, no. 12, Mar. 25, 1922, pp. 415-420, 5 figs. Particulars of design of new gondola cars of Chicago Milwaukee & St. Paul; 50 tons capacity; weight, 40,400 lb.

CARS, FREIGHT

Interchange. On the Question of Interchange of Rolling Stock (all countries except America), M. Charron. Int. Ry. Assn. Bul., vol. 4, no. 3, Mar. 1922, pp. 479 535. Report on interchange of goods rolling stock (freight cars), and penalty charges in case of delay in return of that stock; rules to be adopted in relations between railways themselves; rules to be adopted in relations between railways and consignors and consignees.

CASE-HARDENING

Chemical Energizers. More About Chemical Energizers, H. B. Knowlton. Forging & Heat Treating, vol. 8, no. 3, Mar. 1922, pp. 141-145, 2 figs. Action of chemical energizers during carburizing process; tests to prove relative efficiency of certain chemicals and methods of manufacture of compounds.

CAST IRON

Welding. The Dependability of Cast Iron Welding, G. O. Carter. Iron Age, vol. 109, no. 14, Apr. 6, 1922, pp. 928-930, 8 figs. Preheating and annealing essential; correct preparation of casting. Some results attained commercially. (Abstract.) Paper read before Cleveland section, Am. Welding Soc.

CASTING

Centrifugal. Producing Centrifugal Castings, H. Cole Estep. Iron Trade Rev., vol. 70, no. 13, Mar. 30, 1922, pp. 887-892, 19 figs. Process employed in England for making gray iron and nonferrous castings. Micrographs show effect of centrifugal force. See also Foundry, vol. 50, no. 6, Mar. 15, 1922, pp. 217-222, 19 figs.

Chilled. Inversed Chill Casting and Related Phenomena (Umgekehrter Hartguss und verwandte Erscheinungen), W. Heike. Stahl u. Eisen, vol. 42, no. 9, Mar. 2, 1922, pp. 325-332, 24 figs. Examples of occurrences. So-called black fracture. Inversed chill casting attributed to differences in pressure.

CASTINGS

Ingot Mold. How Ingot Mold Castings Are Made. Foundry, vol. 50, no. 6, Mar. 15, 1922, pp. 229-235, 11 figs. Practice at plant of Hanna Furnace Co. at Dover, Ohio, having capacity of 500 tons a day.

Internal-Combustion Engines. British Motor Castings Methods—I-VI, Ben Shaw and James Edgar. Foundry, vol. 50, nos. 1, 2, 3, 4, 5 and 6, Jan. 1, 15, Feb. 1, 15, Mar. 1 and 15, 1922, pp. 11-16, 57-62, 102-107, 149-152, 198-202 and 236-239, 129 figs. Jan. 1: Making of a wooden pattern of a water-jacketed cylinder block for an internal-combustion engine. Jan. 15: Preparation of mold; core problems; valve faces molded down; artificially bonded sand strengthened with rods and vented with wax. Feb. 1: Making of patterns and core-boxes for a typical crankcase casting. Feb. 15: Molding procedure dependent on whether machine is to be used or not. Patterns gated to cause aluminum to flow quietly. Mar. 1: Types of smaller castings for internal-combustion engines. Mar. 15: Methods for molding water-inlet, front-cover and oil-pan castings.

Looms. Loom Castings Tax Molder's Skill, H. R. Simonds. Foundry, vol. 50, no. 6, Mar. 15, 1922, pp. 223-224, 2 figs. Two core prints were attached to strengthen pattern as well as to form seat for longitudinal core at one side and pocket core at other end of intricate casting shown.

CENTRAL STATIONS

Modern Construction. Modern Tendencies in Central Station Construction (Les tendances moderns dans la construction des centrales), F. Sconmanne. Société Belge des Électriciens, vol. 35, Sept.-Oct. and Nov.-Dec. 1921, pp. 211–224 and 252–257, and vol. 36, Jan.-Feb. 1922, pp. 19–25. Sept.-Oct.: Discusses choice in the power of units, boilers and economizers, steam piping, coal and ash handling, automatic stoking, forced draft, etc. Nov.-Dec.: Deals with machinery room, including turbines, alternators, condensers. Jan.-Feb.: Switchboard arrangements, including bus-bars and distribution of current.

Montreal Street Railway. The Main Plant of the Montreal Street Railway, T. H. Fenner. Power House, vol. 15, no. 6, Mar. 20, 1922, pp. 15–21, 10 figs. Describes Hochelaga power house and its equipment, including 22 water-tube boilers, turbo generators, direct connected reciprocating units of large size, etc.

Superpower. The Superpower System. Am. Inst. Elec. Engrs., vol. 42, no. 4, Apr. 1922, pp. 287–297. Two articles dealing with essential elements of superpower plant. The first, by Henry Flood, Jr., deals with steam-electric plants proposed by system; and second, by L. E. Imlay, deals with hydroelectric plants, transmission system and superpower system as a whole.

CHAIN DRIVE

Inverted- and Roller-Tooth Type. Chain Drives, A. Bayliss. Eng. & Indus. Management, vol. 7, no. 10, Mar. 23, 1922, pp. 282–286, 3 figs. Practical notes concerning two main types, viz. (1) inverted tooth and (2) roller tooth type. Describes rocker-joint chain.

CHROME STEEL

Etching Medium for Tungsten and. New Etching Medium for Chromium and Tungsten Steels. Iron Age, vol. 109, no. 11, Mar. 23, 1922, p. 790, 1 fig. Special solution for detecting presence of carbides. Valuable as applied to high-speed steels. Translated from article by K. Daeves in Stahl u. Eisen, Sept. 8, 1921.

Nickel-Molybdenum and. Chrome and Nickel-Molybdenum Steels, C. N. Dawe. Iron Age, vol. 109, no. 11, Mar. 16, 1922, pp. 725–728, 2 figs. Comparison with other alloy steels for automobile use. Nickel molybdenum for case-hardening. (Abstract.) Paper presented at Soc. of Automotive Industries.

CHUCKING MACHINES

Automatic, for Railway Shops. An Improved Automatic Machine For Railway Shops. Ry. Gaz., vol. 36, no. 9, Mar. 3, 1922, pp. 351–352, 2 figs. Describes the Victor automatic chucking machine, made by W. G. Armstrong, Whitworth & Co., Ltd.

CLUTCHES

Friction. A New Friction Clutch of Radical Design Developed in France. Automotive Industries, vol. 46, no. 11, Mar. 16, 1922, pp. 609–610, 1 fig. Clutch is engaged by increasing foot pressure.

COAL HANDLING

Automatic. Automatic Coal and Ash Handling Plant, E. W. L. Nicol. Chem. Age (Lond.), vol. 6, no. 141, Feb. 25, 1922, pp. 234–236, 7 figs. Describes rotary truck tippler, the U link conveyor, and the "sandwich" system of feeding coke and coal.

COMBUSTION

Air Required for. Air Required for Combustion of Gases in Steel Plants, R. T. Haslam and A. F. Spiehler. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 174–175, 1 fig. Determination of amount of air required for combustion of various gases from B.t.u. content of gas.

Control Apparatus. Combustion Regulators (Verbrennungsregler). Elektrotechnischer Anzeiger, vol. 39, nos. 35 and 37, Mar. 2 and 7, 1922, pp. 268–270 and 293–294, 13 figs. Describes new governors patented by G. Ph. Haass, Obrigheim, Germany, consisting of undergrate-blast and swivel-damper regulators which are attached to furnace and boiler.

Modern Apparatus for Control of Cumbustion and Evaporation (Les appareils modernes destinés au controle de la combustion et de la vaporisation), Lucien Maugé. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 10, Dec. 1921, pp 1237–1321, 84 figs. Describes apparatus at international exposition of Office Central de Chauffe Rationelle, including gas-analysis apparatus, thermometers and pyrometers, pressure gages, steam meters, etc.

CONDENSERS, STEAM

Low-Level Multi-Jet. New Condensers for an Old Turbine. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 492–493. Baltimore plant makes unique application of low-level, multi-jet condensers.

CONVEYORS

Chemical Industry. Conveying Machinery in the Chemcial Industry, George Frederick Zimmer. Chem. Age (Lond.), vol. 6, no. 141, Feb. 25, 1922, pp. 230–233, 12 figs. Fundamental principles which should underlie economical employment of labor-saving devices; review of most suitable mechanical handling devices for specific purposes of chemical industry.

Portable. Handling with Portable Conveyors, E. J. Tournier. Gas Age-Rec., vol. 49, no. 11, Mar. 18, 1922, pp. 317–323, 18 figs. Discusses development of machinery for moving material, up to most recent designs of apparatus for the purpose.

Types. Conveying and Elevating Machinery, Gardner Mitchell. Instn. Mech. Engrs. Proc., vol. 2, no. 8, Dec. 1921, pp. 895–916 and (discussion) pp. 931–969, 16 figs. Deals with different types of conveyors and elevators.

COPPER ALLOYS

Cupro-Nickel, Cold Work in. The Internal Mechanism of Cold-Work and Recrystallization in Cupro-Nickel, Frank Adcock. Inst. of Metals Advance Paper for meeting Mar. 8, 1922, 20 pp., 45 figs. Results of experiments on commercial cupro-nickel (copper 80 per cent, nickel 20 per cent). See also Engineering, vol. 113, nos. 2932 and 2933, Mar. 10 and 17, 1922, pp. 305–308 and 340–342, 45 figs.

COST ACCOUNTING

Drop-Forge Plants. Forge Shop Burden and Estimating, George H. Koskey. Forging & Heat Treating, vol. 8, no. 3, Mar. 1922, pp. 136–140, 2 figs. Advocates machine-hour basis for burden system in place of flat burden rate over whole shop.

Paper-Mill Power Plant. Power Costs in Paper Mill Accounting, B. C. Gause. Paper, vol. 29, no. 26, Mar. 1, 1922, pp. 7–8. Classification of power expenses; apportionment of costs; overhead charges; elements of cost.

Predetermination of Costs. The Predetermination of Costs, J. McD. Cronin. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 221–224. Writer points out some of more glaring defects in commonly accepted methods of cost accounting and advantages derived from installation of modern methods. Notes on predetermination of burden factor, labor and material factor.

Sewage Works. Keeping Records and Accounts for a Small Sewage Works, Percy Lamb. Eng. & Contracting, vol. 57, no. 13, Mar. 29, 1922, pp. 294–295, 1 fig. Importance of accounting methods; meteorological records; method of recording results; working costs, fuel, repairs, etc. (Abstract.) From 1921 Proc. of Assn. of Mgrs. of Sewage Disposal Works.

COTTON GINS

Machinery. Cotton-Ginning Machinery, Solomon E. Gillespie. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 231–236 and 242, 15 figs. Describes apparatus developed for mechanically handling raw seed cotton, removing lint therefrom, and forming it into shape suitable for delivery to baling press. Cotton-ginning process, and latest developments of various devices employed.

COTTON MILLS

Electric Drive. Electric Drive in Cotton Mills, George Wrigley. Gen. Elec. Rev., vol. 25, no. 2, Feb. 1922, pp. 102–110, 9 figs. Discusses electrical and individual drive and control of machines and explains operation performed by each type of machine.

COUPLINGS

Machining Large Flexible. Machining Large Flexible Couplings. Machy. (Lond.), vol. 19, no. 491, Feb. 23, 1922, pp. 632–634, 6 figs. Describes practice of Wm. Beardmore & Co., Ltd., Dalmuir, in machining large flexible couplings of a type extensively used in marine propulsion work.

CRANES

Electric Controllers. Electric Crane Controllers, J. F. Schnable. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 4, Apr. 1922, pp. 313–319, 5 figs. Deals with problems concerning selection of ohmic values for resistors, and connection arrangements and resistance values involved in dynamic braking control of lowering loads.

Motor-Operated. Auxiliary Electrical Equipment for Motor-Operated Cranes, H. W. Eastwood. Am. Inst. Elec. Engrs., Jl. vol. 41, no. 4, Apr. 1922, pp. 319–328. Deals with brakes, overload protective panels and limit switches. Discusses various service requirements and describes several available types of magnet brakes and their particular fields of application.

Shipyard. Shipyard Cranes (Krananlagen für Schiffbau und Schiffsmaschinenbau), H. Kessner and Karl Böttcher. Schiffbau, vol. 23, no. 22–23, Mar. 1–8, 1922, pp. 645–669, 42 figs. Review of development in Germany in past 20 years in crane installations for construction of ships and ship machinery.

Shipyard Cableway Cranes (Hellingkabelkrane), Martin Bruckmann. Schiffbau, vol. 23, no. 22–23, Mar. 1–8, 1922, pp. 669–675, 10 figs. Describes Bleichert system and its installation in Hamburg shipyards. Economic advantages.

CRANKSHAFTS

Machining Automobile. Machining Automobile Crankshafts, Fred H. Colvin. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 504–507, 11 figs. Approved methods of machining and balancing crankshafts. Data as to wheels for various grades of steels. Wheel speed and wear.

CUPOLAS

Center-Blast Tuyere. The Bottom or Center-Blast Cupola Tuyere, Geo O. Vair. Can. Foundryman, vol. 13, no 3, Mar. 1922, p. 25, 1 fig. Advantages and disadvantages compared with side-blast.

Flameless. Flameless Cupolas with Overgrate Blast (Flammenloser Kupolofen mit Oberwind). Zeit. für die gesamte Giessereipraxis, vol. 43, no. 5, Feb. 4, 1922, pp. 62–64. Suggestions for design and proper care of cupolas.

D

DIES

Forming and Assembling. Forming and Assembling Dies for Roll Cam, W. B. Greenleaf. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 618–619, 5 figs. Describes dies used in making parts for roll cam, including combination blanking and forming die; blanking, piercing, and flanging die; and assembling die.

DIESEL ENGINES

American Marine. Building American Diesel-Engines. Motorship, vol. 8, no. 4, Apr. 1922, pp. 259–263, 8 figs. Details of McIntosh & Seymour plant at Auburn, N. Y., where oil engines for 25 successful merchant ships have been turned out.

German Marine. Demonstration of the Deutsche Werke Engine. Motorship, vol. 8, no. 4, Apr. 1922, pp. 264–266, 10 figs. New 950-shaft hp. Diesel marine engine exhibited shortly after completing 7-day non-stop run. Four-cycle, crosshead, single-acting type, direct reversible.

1900-Hp. High-Speed. Investigation of a 1900-Hp. High-Speed Diesel Engine in a Cotton Spinning Plant in Augsburg (Germany) (Untersuchung einer 1900 PSe-Schnelläufer-Dieselmaschine in der Baumwollspinnerei am Stadtbach in Augsburg), H. Deinlein. Zeit. des Bayerischen Revisions-Vereins, vol. 26, no. 4, Feb. 28, 1922, pp. 25–27, 2 figs. Results of investigation carried out by Bavarian Revisions-Verein confirmed guaranteed efficiency of engine.

Nobel 1600-Hp. Tests on a 1600-Hp. Nobel Diesel Engine (Untersuchung eines 1600 PSe-Nobel-Dieselmotors). A. Rosburg. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 6, Feb. 11, 1922, pp. 137–139, 15 figs. Investigation of two-cycle Diesel engine described in same journal (no. 3, 1922) with regard to efficiency, fuel consumption, relation of indicated work to useful work, compressor, scavenging-pump and friction work at different speeds and load conditions. Test results.

DRILLING MACHINES

Multiple-Spindle Drill Heads. Multiple-spindle Drill Heads, George Hey. Machy. (Lond.), vol. 19, nos. 491 and 493, Feb. 23 and Mar. 9, 1922, pp. 621–627 and 702–705, 21 figs. Feb. 23: Discusses shortcomings of multiple-spindle drill heads, and describes design of multiple-spindle adjustable type, for drilling of high tensile steels. Mar. 9: Fixed center type of drill head.

DROP FORGING

Practice. Drop-Forging Practice, J. H. Nelson. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 207–211. Discusses practice from standpoint of materials used; advocates more rigid inspection and testing of raw products to determine their fitness for use in making automatic forgings. Tabular data of chemical analyses and physical tests made on a 0.40 to 0.50 per cent carbon steel.

Perfecting. Perfecting a Drop Forging, J. H. G. Williams. Forging & Heat Treating, vol. 8, no. 3, Mar. 1922, pp. 152–155, 14 figs. Discusses various defects in drop forging and how to remedy them.

E

ELECTRIC DRIVE

Woolen Mills. Electric Driving in Scottish Woolen Mills, A. W. Stevenson. Electrician, vol. 88, no. 2284, Feb. 24, 1922, pp. 217–219, 4 figs. Discusses electric and steam drive, and describes the various processes to produce finished wool product.

ELECTRIC FURNACES

Basic-Hearth. Basic Hearth Electric Furnace for Cast Iron, George K. Elliott. Can. Foundryman, vol. 12, nos. 10 and 11, Oct. and Nov. 1921, pp. 41–42 and 44 and pp. 32–34. Advantages of electricity over other fuel, from the standpoint of clean, sound metal and uniform chemical analysis. Paper read before Instn. British Foundrymen.

Brass. Brass Melting in Electric Furnaces (Messingschmelzen im elektrischen Ofen) Herbert Hein. Metall-Technik, vol. 48, no. 2, Jan. 7, 1922, pp. 9–11, 4 figs. Describes Röchling-Rodenhauser system of two-phase induction furnace with auxiliary heating rings.

Fiat. The Fiat Electric Furnace (Il forno elettrico "Fiat"). Electtrotecnica, vol. 9, no. 4, Feb. 5, 1922, pp. 74–79, 16 figs. Describes furnace invented by Masera, of Acciaierie Fiat, which can be used advantageously for special steels in small quantities and for ordinary steel in large quantities.

Smelting. Smelting Iron Ore Electrically, R. Durrer. Iron Trade Rev., vol. 70, no. 12, Mar. 23, 1922, pp. 827–828, 1 fig. Comparison of operating conditions in standard and electric blast furnaces. Causes of hot and cold working. Relation of direct and indirect reduction in electric furnaces. Translated from Stahl u. Eisen, June 2, 1921.

Tool-Steel Melting. Electric Tool Steel Melting Practice, W. J. and S. Stuart Green. Three important factors: Acid or basic bottoms; liquid or cold charges and double or single voltage. Electric furnace in other roles.

ELECTRIC LOCOMOTIVES

Monophase. Monophase Locomotive for Swiss Federal Railway. Ry. Elec. Engr., vol. 13, no. 2, Feb. 1922, pp. 45–50, 8 figs. Detailed description of locomotive designed for both freight and passenger service. (Abstract.) From Bulletin of Brown, Boveri & Co.

Passenger, Chile. Electric Passenger Locomotives for Chilean State Rys. Ry. Rev., vol. 70, no. 9, Mar. 4, 1922, pp. 291–293, 2 figs. Describes the two types of locomotives for new electrified line between Valparaiso and Santiago.

Regeneration Characteristic Curves. Regeneration Characteristic Curves of Direct-Current Locomotives, C. A. Atwell Elec Jl., vol 19, no 3, Mar. 1922, pp. 113–116, 7 figs Explains plotting of curves and regeneration characteristics

ELECTRIC RAILWAYS

Braking, Regenerative Regenerative Braking and Single-Phase Commutator Motors. R Nordefeldt. Electrician, vol 88, nos 2287 and 2288, Mar 17 and 24, 1922, pp. 312–314 and 340 341, 10 figs. Discusses regenerative braking on electric railways, especially problems arising in single-phase traction, and distinguishes between regenerative braking as a speed check on long down grades, and as required for bringing train to a standstill Describes methods of single-phase that have been used or suggested and advantages and disadvantages of each. Abstract from Teknisk Tidskrift

Development and Equipment. Electric Traction for Steam Railroads Ry Elec Engr, vol. 13, no. 2, Feb. 1922 pp. 57 61, 1 fig Tendencies of practice in United States. Limitations and advantages of equipment used

Italy. Electric Traction (La questione della trazione elettrica), Alfredo Donati. Elettrotecnica, vol. 9, nos 4 and 5, Feb 5 and 15, 1922, pp. 81 91 and 104–112, 23 figs. Feb. 5 Discusses Italian developments since 1899 and gives details of three-phase system adopted for state railways. Feb. 15. Technical data of Valtellina, Monza-Lecco, Milano-Varese-Porto Ceresio, Torino-Modane and other lines, and technical and financial results of Italian electrification. Translated from Bul de l'Association Internationale des Chemins de Fer, Sept. 1921, pp. 1199.

Mountain Districts. Electrical Operation in Mountain Districts, Frank Rusch. Ry. Age, vol. 72, no. 13, Apr. 1, 1922, pp. 833 834 Outline of operations on Chicago, Milwaukee & St. Paul. (Abstract) From Milwaukee Employees' Mag, Mar. 1922.

Trackless Transportation vs. Trackless Transportation and the Electric Railway. Elec. Ry. Jl, vol. 59, no. 9, Mar. 4, 1922, pp. 355–362. Abstracts of papers read at Midyear Meeting of Am Elec Ry. Assn. How the Maryland Commission Acts, E H. Whitman; City Service and British Conditions, C. D. Emmons; Auto Bus and Truck Good as Interurban Feeders, Harry Reid; and California Situation Regarding Rail and Trackless Transporation, Paul Shoup.

ELECTRIC WELDING

Boiler Tubes. Electrically Safe Ending Boiler Tubes, J. J. Sullivan. Ry. Elec. Engr., vol 13, no. 3, Mar. 1922, pp. 102–103, 2 figs. Describes practice on Nashville, Chattanooga & St. Louis, at Nashville shops, cost of electric welding.

Steel Construction. Electric Welding Applied to Steel Construction, With Special Reference to Ships, A. T. Wall. Shipbldg. & Shipg. Rec., vol. 19, nos. 8 and 9, Feb. 23 and Mar. 2, 1922, pp. 239–242 and 271–272, 14 figs. Discusses various ways in which electric welding is being applied to ship construction and indicates further possibilities in this connection for steel structures; reasonable precautions to be taken in carrying out work. Paper read before Instn. Mech. Engrs.

ELECTRIC WELDING, ARC

Applications. Applications of Electric Arc Welding E. Wanamaker. Ry. Elec. Engr, vol. 12, no. 10, Oct. 1921, pp. 376–382. Successful welding calls for three prime requisites: Proper equipment, proper materials, and necessary skill.

Cast Iron. Arc Welding of Cast Iron, A. R. Allard. Welding Engr., vol. 7, no. 3, Mar. 1922, pp. 19–22 and 40–41, 8 figs. Characteristics of cast iron which influence its weldability and general procedure for welding it. Paper read before Am Welding Soc.

Cyc-Arc Process. The Cyc-Arc Process of Automatic Electric Welding, L. J. Steele and H. Martin. Instn. Elec. Engrs. Jl., vol. 60, no 306, Feb. 1922, pp. 236–244. Discussion of paper which appeared in same journal in Jan. 1922 number, pp. 136–162.

Railway Shops. Arc Welding in Railway Shops, S. E. Mason. Elec. Ry. Jl., vol. 59, no. 11, Mar. 18, 1922, pp. 446–448, 5 figs Repairs to rolling stock equipment can be made without removal from cars so that large savings in labor and material result.

Shipbuilding, Application to. On the Application of Electric Arc Welding to Two Vessels, M. Harmiishi. Am. Welding Soc. Jl., vol. 1, no. 2, Feb 1922, pp. 31–41, 5 figs Account of author's experience with arc welding in converting a steam trawler into an oil lighter, and work on a steel self-floating caisson for drydock in Japanese dockyard. (Abstract.) Paper read before Japanese Soc. of Shipbuilders.

EMPLOYEES, TRAINING OF

Extension Work in Factory. Taking University Training to the Factory, Paul M. Atkins. Indus. Management, vol. 63, no 4, Apr 1922, pp. 239–242. Describes plan consisting of university extension work in individual plant.

Manufacture. The Training of Workers in Manufacture, J. V. L. Morris. Am. Mach., vol. 56, no. 11, Mar. 16, 1922, pp. 400–402 Coöperative employment of engineering students Length of shop period. Courses on technical subjects. Advanced shop and school instruction.

ENGINEERING

Human Activity. Engineering as a Human Activity, H. E. Riggs. Eng. News-Rec., vol. 86, no. 11, Mar. 16, 1922, p. 435. Deals with some of non-technical sides of engineering. Jobs and how to get them; fees and how to maintain them; etc. (Abstract.) Paper before Mech. Eng. Soc.

ENGINEERS

Code of Ethics. A Code of Ethics for Engineers Min & Metallurgy, no. 183, Mar 1922 p 46 Presents code and method of interpreting and administering it, recommended by Joint Committee on Code of Ethics

Licensing Advantages and Disadvantages of Licensing Engineers, B. R. Gottsberger. Min. & Metallurgy, no 183, Mar. 1922, pp 47–50. Arguments for and against licensing.

Practicing. How Practicing Engineers May Sell Their Services. Eng. News-Rec., vol. 88, no. 13, Mar. 30, 1922, pp. 523–524. Methods of securing clientele and increasing business. Abstract of two papers at Conference of Practising Engrs under auspices of Am. Assn. Engrs.

ENGINEHOUSES

Cold Climate. Novel Engine Facilities for a Cold Climate. Ry. Mech. Engr., vol. 96, no 3, Mar. 1922, pp. 163–164, 2 figs. Describes rectangular enginehouse with radial tracks and enclosed turntable of Canadian National Railways.

F

FACTORIES

Size and Efficiency. Considerations on Factory Size and Efficiency, Henry Baker. Engineer, vol. 133, no. 3455, Mar. 17, 1922, pp. 292–294, 2 figs. Writer concludes that factory just large enough to be well under control of one man probably represents most efficient size at present time. Future of large factory depends on overcoming difficulties of management.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FATIGUE

Industrial. Fatigue in Industry, Eugene Lyman Fisk Am. Jl. Public Health, vol. 12, no. 3, Mar. 1922, pp. 212–217. Reviews literature discussing kinds of fatigue and how to measure fatigue

FIREPROOFING

Wood and Textures. Protection Against Fire By Fireproofing Textures and Woods (La protection contre l'incendie par l'ignifugation des tissus et des bois), André Kling and Daniel Florentin. Génie Civil, vol. 80, nos. 8 and 9, Feb. 25 and Mar. 4, 1922, pp. 180–183 and 202–204. Feb. 25: Discusses especially fireproofing of stage decoration materials and describes two processes for the purpose. Mar. 4: Fireproofing of woods and methods employed; tests made to show their efficiency.

FLIGHT

Controls Locked. Airplane Flight With Locked Controls (Vol de l'avion à commandes bloquees), Alavrac. Aerophile, vol. 30, no. 1–2, Jan. 1–15, 1921, pp. 9–11, 1 fig. Mathematical treatment of movement of center of gravity of a solid in a resisting medium.

Human Physical Sensations. The Human Machine in Aviation, Edward C. Schneider. Aerial Age, vol. 15, no. 4, Apr. 3, 1922, pp. 82–83, 86 and 95. Discusses human physical sensations in flying, including those caused by high altitude, insufficient oxygen, etc. Reprinted from Yale Rev.

Optical Delusions. Perception of Space and Location in Flight (Die Raumempfindung im Fluge), Friedrich Noltenius. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 13, no. 3, Feb. 15, 1922, pp. 31–33. Discusses frequently occurring optical delusions of airmen in flight that earth or horizon is out of place.

Soaring. Engineless Flight (Le vol des avions sans moteur), Dorand. Aeronautique, vol. 4, no. 32, Jan. 1922, pp. 11–16, 4 figs. Discusses and calculates behavior of machines at various wind conditions and summarizes results.

FLOW OF GASES

Cylinders. The Flow of Gas Into a Cylinder, A. Johnson. Automobile Engr., vol. 12, no. 160, Feb. 1922, pp. 4143, 7 figs Discusses flow of atmospheric air into cylinder of an internal-combustion engine, assuming that temperature of air does not alter. Works out calculations applicable to its flow.

Liquids and Gases. Determination from the Pressure Reduction in Pipes of Quantity of Gas and Liquid Flowing Therefrom (Bestimmung von strömenden Gas- und Flüssigkeitsmengen aus dem Druckabfall in Rohren), Max Jakob. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 8, Feb. 25, 1922, pp. 177–182. Simple calculation according to law of similarity of Reynolds and Blasius. The two constants of this law are newly determined by means of tests with air; tests with water show that with same constants, water quantities can be accurately calculated. Recommends use of smooth pipes instead of gasometers as standard measuring tool for nozzle calibrations.

FLUE GASES

Testing Apparatus. Apparatus for Testing Flue Gas, John B. C. Kershaw. Combustion, vol. 6, no. 3, Mar. 1922, pp. 125–128, 8 figs. Describes Duplex-Mono automatic, Foxboro-Heath CO_2, Hays automatic CO_2 and draft recorders.

The Unograph (Der "Unograph"), Kurt Müller. Archiv für Wärmewirtschaft, vol. 3, no. 2, Feb. 1922, p. 33, 1 fig. Describes apparatus for determination of carbonic acid which functions without use of absorption media.

FOREMEN

Teaching Ability, Developing. Building Up Teaching Ability in Foremen, D. J. MacDonald. Am. Mach., vol 56, nos. 10 and 11, Mar. 9 and 16, 1922, pp. 360–361 and 406 408. Explains why average foreman is not a good teacher, and points out importance of planning teaching work, and what constitutes good teaching.

Training. As Foreman Is, So Is the Plant, C. R. Hook, E. A Holbrook and Arthur Notman. Iron Trade Rev., vol. 70, no. 12, Mar. 23, 1922, pp 820–822. Deals with training of foremen. Report of subcommittee on education of Am.Inst.Min. & Met. Engrs.

Foremanship Training, E. T. Terce Indus. Management, vol 63, no. 4, Apr 1922, pp 216–217. Notes on questions to be answered. Suggested outline of preliminary course.

FOUNDRIES

Cupolas. See CUPOLAS.

Desulphurization Process. The Walther Desulphurization Process (Das Walthersche Entschwefelungsverfahren). Zeit. für die gesamte Giessereipraxis, vol. 43, no. 8, Feb. 25, 1922, pp. 101–103. Account of tests carried out with this process at the A. Borsig foundry at Berlin-Tegel, demonstrating that it is possible, with comparatively simple means and without interference with operation or workers, to successfully combat the disagreeable sulphur enrichment. Abstract of paper by H. Scharlibbe and discussion before Assn. German Foundrymen.

Railway Iron and Steel. Control in a Railway Iron and Steel Foundry, G. N. Shawcross. Foundry Trade Jl., vol. 25, no. 281, Jan. 5, 1922, pp. 3 8, 7 figs. Discusses coöperation of chemist and molder, pre-war and post-war output, air compressors, cupolas, annealing and pyrometry, etc. Read before Cambridge Univ. Eng. Soc.

Space and Equipment, Utilization of. Volumetric Efficiency as a Measure of Foundry Costs, Douglas T. Sterling. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 201–205, 3 figs. Relations between floor space, flask volume and weight of castings.

FREIGHT HANDLING

Package. Organization and Modern Handling of Package Freight through Freight Houses, G. Marks. N. E. R. R. Club, Feb. 14, 1922, pp. 278–289 and (discussion) pp. 289–314. Author outlines facts and methods, based on results of personal observation and operation, in handling large volumes of freight in all sorts of places under varying conditions.

FUELS

See OIL FUELS; PULVERIZED COAL.

FURNACES, BOILER

German Bamag. The New Bamag Furnaces for High- and Low-Grade Fuels (Die neuen Bamagfeuerungen für gute und geringe Brennstoffe), H. Pradel. Wärme- u. Kälte-Technik, vol. 24, no. 5, Mar. 1, 1922, pp. 56–59, 6 figs. Describes new nozzle grate of the Berlin-Anhalt Machine Constr. Corp., and its application to their forced-draft horizontal grates, traveling grates and underfeed furnaces.

Semi-Producer-Type. The Bergmans Semi-Producer-Type Furnace (Bergmans-Halbgasfeuerung), H. Nettmann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 6, Feb. 11, 1922, pp. 131–132, 2 figs. Details of furnace and basic principles on which design is based. Results of tests.

FURNACES, FORGING

Types. Discussion of Forge Furnaces, Charles Longenecker. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 194–196. Discusses soaking pits, regenerative and non-regenerative types, and furnaces of small hearth area, pointing out possibilities for saving and increased efficiency with various classes of fuel.

FURNACES, HEAT-TREATING

Lead Hardening. Lead Hardening Furnaces for Heating Hammers and Hatchets, G. T. Straub. Forging & Heat Treating, vol. 8, no. 3, Mar. 1922, pp. 160–161, 1 fig. Describes hardening furnaces used in Evansville Tool Works which have proved very satisfactory.

G

GAGES

Hand- and Machine-Lapped Surfaces of Precision. Hand- and Machine-Lapped Surfaces as Seen Through a Microscope. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 638–639, 6 figs. Includes examples of photomicrographs made by Pratt & Whitney Co., Hartford, Conn., in connection with study of characteristics of different surfaces, as obtained by various methods.

Machining Dial. Tooling Equipment and Methods Used in Making Dial Gages, Robert Mawson. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 627–630, 13 figs. Describes operations performed in Stickney & Randall plant, Waltham, Mass.

GAS ENGINES

Working Fluids, Properties of. Some Properties of the Working Fluid of Gas Engines, W. T. David. Engineering, vol. 113, no. 2932, Mar. 10, 1922, pp. 281–284, 2 figs. Notes on pressures developed on explosion; after-burning in gas engines; internal energy of working fluid; factors governing heat loss during explosion-expansion stroke. Results of experiments made by author.

GASES

Discharge Through Orifices or Nozzles. The Effect of Variable Specific Heat on the Discharge of

Gases Through Orifices or Nozzles, William J. Walker. Lond., Edinburgh, & Dublin Philosophical Mag. & Jl. Sci., vol. 43, no. 255, Mar. 1922, pp. 589–593. Discusses the question whether or not it is desirable to account for abnormal orifice or nozzle discharges by consideration of changes in value of γ, index in equation pv^γ=constant, for adiabatic changes of state.

GASOLINE

Anti-Knock Compounds for Aircraft. Effect of Doped Fuels on the Fuel System. Automotive Industries, vol. 46, no. 12, Mar. 23, 1922, p. 661, 1 fig. Use of anti-knock compounds in aircraft.

GEAR CUTTING

Machines. Commercial Gear-cutting Practice, Franklin D. Jones. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 437–446, 20 figs. Cutting of spur gears on automatic machines of formed-cutter type. See also Machy. (Lond.), vol. 19, no. 495, Mar. 23, 1922, pp. 749–757, 20 figs.

Shapers. Cutting Spur Gears on Gear Shapers. Machy (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 645–650, 14 figs. Use of machines operating with planing or shaping action and forming gear teeth by generating and formed-cutter processes.

GEARS

Automobile, Wear in. Wear on Various Automobile Gear Steels, E. R. Ross. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 515–519, 6 figs. Results of tests showing various factors which affect wear in driving gears. A tooth-profile indicator.

Auto-Pitch. A New Form of Gear, W Rees Darling. Machy. (Lond.), vol. 19, no. 492, Mar. 2, 1922, pp. 664–667, 17 figs. Describes auto-pitch gear obtained by roller flow, resulting from studies of requirements of a perfect gear. (Abstract.) Read before Instn. Engrs. & Shipbuilders in Scotland.

Hotchkiss-Taylor Tangent. The Hotchkiss-Taylor System of Gearing. Engineering, vol. 113, no. 2935, Mar. 31, 1922, p. 401, 10 figs. partly on p. 400. Describes system in which rack is arranged in plane tangential to cylinder. Basic gear form is a crown wheel, teeth of which are involute curves in plane normal to axis of crown wheel.

Spiral Bevel. The Spiral Bevel Gear. Machy. (Lond.), vol. 19, no. 492, Mar. 2, 1922, pp. 653–654, 2 figs. Comparison between arcs of action of spiral and helical teeth and straight teeth.

Tooth-Rolling Machine. Rolling the Teeth in Hot Gear Blanks, Frederick E. Walker, Jr. Am. Mach., vol. 56, no. 11, Mar. 16, 1922, pp. 409–412, 6 figs. Process eliminates cutting gear teeth. Rolling bevel gears in 15 seconds, and saving 20 to 40 per cent of metal.

Production by Rolling Process. Production of Gears by the Rolling Process. Can. Machy., vol. 27, no. 9, Mar. 2, 1922, pp. 46–47, 7 figs. Pressure required; forming of teeth; redressing die rolls; etc.

GLUES

Water-Resistant. Water Resistant Glues: Casein and Blood Albumin, Robert Herman Bogue. Chem. Age (N. Y.), vol. 30, no. 3, Mar. 1922, pp. 103–106. Manufacture of casein by lactic acid, acid coagulation grain-curd, and other methods; influence of method of manufacture; casein glue and cements; preparation of blood albumin glue.

GOVERNORS

Steam Haulage Engines. The Governing of Steam Haulage Engines (Die Fahrtregler der Dampfördermaschinen), H. Hoffmann. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 8, 9 and 10, Feb. 25, Mar. 4 and 11, 1922, pp. 173–177, 207–210 and 226–229, 29 figs. Uses and development of governors, and regulation of speed obtainable therewith. Astatic and static regulation. Nature and strength of static centrifugal governors; changing from one direction to the other; regulation of start. Examples of modern governors.

GRAIN ELEVATORS

Automatic Box-Car Unloader. Automatic Box-Car Unloading in Grain Elevators, C. D. Howe. Can. Ry. & Mar. World, no. 290, Apr. 1922, pp. 169–172, 6 figs. partly on p. 173. Describes automatic box-car unloader developed for use in reconstruction of Can. Nat. Rys. elevator at Port Arthur, Ont. which has storage capacity of over 8,500,000 bush. of grain.

Pneumatic. Discharge of Grain Cargoes in the Port of London by Pneumatic Elevators, R. E. Knight. Instn. Mech. Engrs. Proc., vol. 2, no. 8, Dec. 1921, pp. 917–931 and (discussion) pp. 931–969, 10 figs. Deals with pneumatic discharge of grain from ships.

GRINDING

Printing-Press Parts. Grinding Printing-Press Parts, B. K. Price. Abrasive Industry, vol. 3, no. 2, Feb. 1922, pp. 45–46, 2 figs. Cylinders and rolls are finished accurately on large grinders at plant of an eastern printing press manufacturer.

Shears. Grinding Shears in New England Plant, Herbert R. Simonds. Iron Trade Rev., vol. 70, no. 11, Mar. 16, 1922, pp. 751–756, 5 figs. Describes grinding problems involved in shear manufacture and practice at the Acme Shear Co., Bridgeport, Conn., producers of cast-steel shears and scissors complete from raw material to finished product.

GRINDING MACHINES

Centerless. Centerless Grinding Efficiency, H. J. Swanson. Abrasive Industry, vol. 3, no. 3, Mar. 1922, pp. 75–76, 1 fig. Rapid production is possible as wheel cuts continuously; results of practical tests are given and inspection methods are described.

Chilled Iron Rolls. Large Grinding Machine for Chilled Iron Rolls. Engineer, vol. 133, no. 3455, Mar. 17, 1922, p. 306, 2 figs. on p. 307. Describes heavy roll machine with capacity for work up to 36 in. diam. by 18 ft. between centers.

Oil Feed Control. Grinding Machine With Oil Feed Control. Can. Machy., vol. 27, no. 9, Mar. 2, 1922, p. 48, 2 figs. Design based upon principle of high traverse speeds.

Tool and Cutter. An Improved Tool and Cutter Grinder. Eng. Production, vol. 4, no. 75, Mar. 9, 1922, pp. 225–226, 5 figs. Details of improved pattern of universal machine by Alfred Herbert, Ltd., Coventry, one of distinctive features of which is provision made for wet grinding.

H

HAMMERS

Electric. The Electric Hammer, P. Trombetta. Am. Inst. Elec. Engrs., vol. 42, no. 4, Apr. 1922, pp. 297–305, 9 figs. Electric hammer has been studied and developed by writer to point where it seems to show superiority to present used hammers, in simplicity, safety, running expenses, cost of installation and upkeep, and in many cases in original cost. Development shown is of induction motor type.

HARDNESS

Scleroscope for Testing. Uses Scelroscope on Thin Sections, Fred S. Triton. Foundry, vol. 50, no. 6, Mar. 15, 1922, pp. 225–227, 2 figs. Samples a quarter-inch thick give accurate results when mounted by new methods. Low readings are obtained when samples are supported in ordinary ways. Paper presented before British Inst. of Metals.

HEALTH

Factory Dental Clinic. What a Dental Clinic Can Do in Your Factory, Linwood G. Grace. Factory, vol. 28, no. 4, Apr. 1922, pp. 405–407, 3 figs. Why dental clinic pays and how to operate one.

HEAT PUMPS

Evaporators and. Experiences on Evaporators with Heat Pumps (Erfahrungen an Eindampfanlagen mit Wärmepumpe), E. Wirth. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 7, Feb. 16, 1922, pp. 160–164, 13 figs. Reports on installations with evaporators for slowly boiling liquids and with vacuum evaporators for low-boiling temperatures show to what extent vapor compression has been realized after overcoming practical difficulties and as result of laboratory tests.

HEAT TRANSMISSION

Building Materials. A Study in Heat Transmission with Special Reference to Building Materials, F. C. Houghten. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 2, Mar. 1922, pp. 151–172, 13 figs. Notes on theory of heat flow; methods of determining heat transmission. Discussion of research work on heat transmission through building and allied materials by various investigators. Work of research laboratory.

Conduction and Convection. Heat Transfer by Conduction and Convection, W. K. Lewis, W. H. McAdams and T. H. Frost. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 2, Mar. 1922, pp. 97–106, 2 figs. Points out that mass velocity, viscosity and thermal conductivity are major factors in determining coefficient of heat transfer from gases or liquids to solids, and that, for accuracy, heat transfers must be calculated by use of film coefficients, one on each side of heating surface.

HEATING, ELECTRIC

Houses. Limits of Electric House Heating, E. A. Loew. Elec. World, vol. 79, no. 13, Apr. 1, 1922, pp. 623–625, 6 figs. Large-scale heating of residences, stores and other establishments in Tacoma shows limits within which electric heating may compete with other heat in mild climates. (Abstract.) University of Wash. Eng. Experiment Station, Bul. no. 15.

HEATING, STEAM

Central Stations. Mechanical Use of Power in Low-Pressure Steam to Improve the Position of Central Heating Stations (Utilization mécanique de l'énergie contenue dans la vapeur a très basse pression pour l'amélioration des installations de chauffage central), André Nessi. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 10, Dec. 1921, pp. 1322–1366, 31 figs. Use of steam for improving circulation of hot water and hot air, for fans, pumps, etc.

HOISTS

Electric, Connections for. Hoisting-Machine Connections for Direct Current (Hebezeug-Schaltungen für Gleichstrom), L. Weiler. Siemens-Zeit., vol. 2, nos. 2 and 3, Feb. and Mar. 1922, pp. 76–81 and 108–114, 14 figs. Different types of connections by the Siemens-Schuckert Works, special connections, safety devices.

HYDRAULIC TURBINES

Efficiency Tests. Efficiency Tests of a New Turbine at the Boise Works (Note sur les essais de rendement d'une des nouvelles turbines de l'usine du Bois Noir), A. de Montmollin. Bul. Technique de la Suisse Romande, vol. 48, no. 4, Feb. 18, 1922, pp. 37–40, 2 figs. Results of tests of horizontal axis Francis turbines for Lausanne Electricity Works, showing nearly 90 per cent efficiency at full charge as against 81 per cent guaranteed.

Ejector, Moody. The Moody Ejector Turbine, S. Logan Kerr. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 243–247, 15 figs. Particulars of a turbine for low-head installations which delivers rated horsepower at maximum efficiency when head is a maximum, and also maintains output when head is reduced at flood periods.

HYDROELECTRIC DEVELOPMENTS

Niagara Falls. Increasing Niagara Falls Power Development By 200,000 Hp., G. W. Morrison. Compressed Air Mag., vol. 27, no. 3, Mar. 1922, pp. 65–69, 12 figs. New project under construction by Niagara Falls Power Co., requiring driving of a 32-ft. tunnel, a distance of 4,500 ft.

HYDROELECTRIC PLANTS

Caribou, California. High Head Impulse Wheels at New Feather River Plant. Eng. News-Rec., vol. 88, no. 12, Mar. 23, 1922, pp. 472–477, 7 figs. Caribou hydro-electric plant in California has two 30,000-hp. impulse turbines under 1008-ft. head. Water is brought from headwater reservoir by tunnel, river and pipe. Includes article entitled General Features of Design of the Caribou Plant, by Albert A. Northrop; and article on transportation problem in plant construction.

Kern River, California. Hydroelectric Installation on the Kern River, Ely C. Hutchinson. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 239–241, 7 figs. Two turbo-generators arranged for dual operation at either 50 or 60 cycles. Unique equipment for efficient use of water supply.

Modern Structures. The Construction of Modern Hydroelectric Plants (Die Bauausführung neuzeitlicher Wasserkraftanlagen), M. Enzweiler. Siemens-Zeit., vol. 2, no. 3, Mar. 1922, pp. 93–102, 27 figs. Deals with construction of dams, headwater canals, power stations, etc.

Sand Box. Design of Sand Box for Kern River Hydro-Electric Plant, H. L. Doolittle. Eng. News-Rec., vol. 88, no. 15, Apr. 13, 1922, pp. 616–617, 4 figs. Operation of high-head reaction turbines demands clear water. Test shows 400-ft. tank settles particles passing 200-mesh sieve.

Shawinigan Falls, Canada. Extension to Shawinigan Hydro-Electric Plant, Julian C. Smith. Can. Engr., vol. 42, no. 11, Mar. 14, 1922, pp. 299–306, 15 figs. New 41,000-hp. unit has world's largest steel casing and biggest valve ever built. Foundation slab is 12-ft. thick, 52-ft. space. Paper read before Eng. Inst. Can.

Test Code, A.S.M.E. Test Code for Hydraulic Power Plants and Their Equipment. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 248–258, 13 figs. Preliminary draft of the sixth in series of 19 test codes being formulated by A.S.M.E. committee on power test codes.

I

ICE MANUFACTURE

Center-Freeze System. Ice Making by the Center-Freeze System, A. G. Solomon. Power Plant Eng., vol. 26, no. 5, Mar. 1, 1922, pp. 279–281. Five-ton blocks are produced in 30 hr. from raw water.

Uniflow Engines, in. Ice-Making With the Unaflow Engine, Sterling H. Bunnell. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 505–506, 1 fig. Comparison of electric-motor and steam-engine operation shows greater possibilities of economy for latter.

IMPACT TESTING

Mild Steel. New Tests With Repeated Impact (Nouvelles expériences de chocs répétés), Léon Guillet. Révue de Métallurgie, vol. 18, no. 12, Dec. 1921, pp. 755–757, 1 fig. Describes experiments with various mild steel test bars, showing especially effect of cold working.

INDICATORS

Steam-Engine, Diagram. Why Complete Compression Is Not Economical. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 496–499, 11 figs. Discusses compression line on indicator diagram, showing that compression to inital pressure is not efficient. Describes graphical method of finding proper compression for any given cutoff.

INDUSTRIAL MANAGEMENT

Brass and Copper Industry. Management in the Brass and Copper Industry, James E. Morrison. Management Eng., vol. 2, nos. 1, 2, 3 and 4, Jan., Feb., Mar. and Apr. 1922, pp. 3–6, 4 figs.; 103–108, 8 figs.; 173–178, 6 figs. and 237–242, 4 figs. Account of author's experience during eight years in development of management methods in some of largest brass and copper mills in United States and Canada. Jan.: Possibilities in better utilization of existing resources. Feb.: Setting and using standards of accomplishment. Mar.: Problem of brass mill standards. Apr.: Planning for production in brass mill.

Overhead Distribution. Distributing Overhead to Allow Lower Sales Prices, Walter N. Polakov. Factory, vol. 28, no. 4, Apr. 1922, pp. 400–402, 4 figs. Outlines plan for decreasing costly item of idle machines and men until business comes back.

Production Control. Watching Production from the Office, A. W. Hinkel. Factory, vol. 28, no. 4, Apr. 1922, pp. 416–418, 5 figs. Describes planning department that actually controls production and makes it possible to guarantee date of completion.

Production Costs, Cutting. Cutting Production Costs by Combining Manufacturing Operations, C. B. Bartlett. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 198–200. Account of experience of large company which found that combining manufacturing operations helped materially to eliminate wasted production time.

Production Methods. Modern Production Methods W. R. Basset. Am Mach vol 56, no. 12, Mar 23, 1922, pp. 443–445. Administrative methods Advantages of functional organization, periodical reports save conference time

Production Planning and Control. The Planning and Control of Production R O Herford Indus Administration Jl vol 1, no 9, Jan 1922 pp 259–261 (includes discussion) Discusses date maximum output from a given plant, maximum output from limited capital, maximum output at minimum cost, as factors in control of production, etc

Ratio Chart for Inventory Control The Ratio Chart Applied to Inventory Control Bert E Holmes Indus. Management vol 63, no 4 Apr 1922, pp 243–245, 1 fig. Author shows facility with which ratio chart may be used for ascertaining rapidly and accurately various factors of inventory

Routing. How to Study the Routing of Work Edward H Tingley Management Eng, vol 2 no 4, Apr. 1922, pp. 209–214 9 figs Such analysis is said to be particularly helpful in older plants and those which have expanded rapidly

Sales Records. Keeping Track of Sales and Distributors, A H. Tuechter Am Mach., vol. 56, no. 15, Apr. 13, 1922, pp 541–543, 9 figs Cards and forms for recording sales and shipping data in shop and office. Records to show activities of agents

Tool Crib Service. Stabilizing and Standardizing Tool Crib Service, James H. Delany Indus. Management, vol. 63, no. 4, Apr 1922 pp 209–216, 2 figs. How to eliminate time and tool losses

Tool-Division Organization. Organization of a Large Tool Division, H. P. Losely Machy (N Y), vol. 28, no. 8, Apr. 1922 pp 632–637, 10 figs Duties of various members and units of organization responsible for development of quantity production tools.

INDUSTRIAL ORGANIZATION

Knitting Mill. The Organization of Knitting Mills, Carle M. Bigelow. Management Eng, vol. 2, no. 4. Apr. 1922, pp. 221–226, 6 figs. Standardizing control of manufacturing.

INDUSTRIAL PLANTS

British. Famous British Works Eng Production, vol. 4, no. 75, Mar. 9, 1922, pp. 218–220, 6 figs. Layout of works of John I. Thornycroft & Co, Ltd. Basingstoke for manufacture of commercial motor vehicles, covering 18 acres.

INDUSTRIAL RELATIONS

Antagonism of Capital and Labor. The Inevitable Antagonism Between Employers and Employees. Management Eng., vol. 2, no. 4, Apr. 1922, pp 233–236. Discussion of C. E. Knoeppel's article in March issue of same journal.

INJECTORS

Principle and Application. Practical Information About Injectors, Terrell Croft. Power, vol 55, no. 12, Mar. 21, 1922, pp. 460–463, 11 figs. How different types work; advantages and disadvantages, applications; testing; selection; how to overcome operating troubles.

INTERNAL-COMBUSTION ENGINES

Castings for. Castings for Internal-Combustion Engines, Ben Shaw and James Edgar Foundry Trade Jl., vol. 25, no. 290, Mar 9, 1922, pp 174–176, 28 figs. Considers pattern-shop and foundry work of smaller castings.

Combined Compressed-Air and. Possibilities of Combined Internal-Combustion and Compressed Air Engines, R. W. Robinson. Practical Engr., vol. 65, no. 1828, Mar. 9, 1922, pp. 118–119 Describes design of prime mover which will combine outstanding advantages of steam engine with those of internal-combustion engine and, as far as possible, eliminate disadvantages of both, to produce engine of greater thermal efficiency than present internal-combustion engine From paper read before Inst. Mar Engrs.

Efficiency. Efficiency of Internal-Combustion Engines (Rendement organique des moteurs à combustion interne), André Planiol. Comptes Rendus des Séances de l'Académie des Sciences, vol. 174, no. 10, Mar. 6, 1922, pp. 663–666. Discusses losses by friction as a criterion by which to judge mechanical quality of engine and describes new method of measuring friction losses.

Elastic. Elastic Internal-Combustion Engines (Elastische Verbrennungsmotoren), Aurel Persu. Motorwagen, vol. 25, no 8, Mar 20, 1922, pp. 153–158, 8 figs. Deals with increasing limit of elasticity of engines without changing volume of cylinder that is, for ordinary engines with constant stroke.

[See also AIRPLANE ENGINES, AUTOMOBILE ENGINES, DIESEL ENGINES; GAS ENGINES, MARINE ENGINES, Still; OIL ENGINES.]

IRON AND STEEL

Packing for Export. Exporting Iron and Steel, V. G. Iden. Iron Trade Rev, vol 70, no. 12, Mar. 23, 1922, pp. 823–826, 5 figs Containers for certain classes of goods have been generally standardized for shipments intended for foreign markets. Deals with packing.

IRON CASTINGS

Gray. The Problem of Grey Iron Castings, H. J. Young. Foundry Trade Jl, vol. 24, nos. 279 and 280, Dec. 22 and 29, 1921, pp. 497–501 and 511–514, 19 figs. Composition of pig iron; possibilities of standard castings; turbine castings; duplexing; importance of graphite, test-bars, influence of phosphorus; sulphur-manganese balance versus silicon control; absence of standard composition in internal-combustion engines. Paper read before Inst Min. Engrs.

J

JIGS

Standardisation of Fixtures and. Standardization of Jig and Fixture Design Machy. (N Y.), vol. 28, no 8, Apr 1922, pp 610–613, 5 figs. Discusses use of standardized parts, such as shoulder screws fixture keys, shoulder drill bushings, binder handles, etc

L

LABORATORIES

Missouri School of Mines. Mining Laboratory of the Missouri School of Mines, C. R. Forbes. Min. & Sci. Press, vol 124, no. 11, Mar. 18, 1922, pp. 359–360, 2 figs. Describes small experimental mine for purpose of supplementing classroom study of mining operations with laboratory where practical demonstrations might be given.

LATHES

Turret. The Herbert No. 11 Bar Turret Lathe. Machy. (Lond.), vol. 19, no. 491, Feb. 23, 1922, pp. 637–638, 3 figs. Describes lathe by Alfred Herbert, Ltd., Coventry, in which possibilities of danger, damage and wear have been reduced to a minimum.

LIGHTING

Committee Report. Illumination Items. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 4, Apr. 1922, pp. 278–280, 3 figs. Report of Lighting and Illumination Committee on highway lighting, textile-mill lighting standards, elixit devices, and color temperature and its relation to quality of light.

Industrial Plants, Code for. Tentative Lighting Code. Textile World, vol. 41, no. 13, Apr. 1, 1922, pp. 79, 115 and 117. Rules and regulations made by Mass. Dept. of Labor and Industries for lighting industrial establishments.

LIQUID-MEASURING DEVICES

Tests. Testing of Liquid-Measuring Devices, Ralph W. Smith. U. S. Bur. of Standards, Weights and Measures, Miscellaneous Publications no. 48, 1922, pp. 64–72. Necessity for accuracy of mechanically operated liquid-measuring devices, and possibility of fraudulent use.

LOCOMOTIVE BOILERS

Seams, Calculating Efficiency of. Calculating the Efficiency of Boiler Seams, R. J. Finch. Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 193–196, 5 figs. Explains use of two tables which facilitate work and reduce chance for error; places where failure is likely to occur.

Tubes. Installing and Maintaining Charcoal Iron Locomotive Boiler Tubes, G. H. Woodroffe and C. E. Lester. Boiler Maker, vol. 22, no. 3, Mar. 1922, pp. 61–65, 20 figs. Makes recommendations regarding application of body tubes, superheater flues, and arch tubes. See also Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 221–225, 20 figs.

Welding. Expert Report on Locomotive Boiler Welding—Details of Approved Methods of Selecting Material and Perfecting Repairs. Ry. & Locomotive Eng., vol. 35, no. 3, Mar. 1922, pp. 62–64, 19 figs.

LOCOMOTIVES

British and American Design. British and American Locomotive Design and Practice, P. C. Dewhurst. Engineering, vol. 113, nos. 2934 and 2935, Mar. 24 and 31, 1922, pp. 373–377 and 405–408, 11 figs Some comparative comments thereon from practical experience. Paper read before British Instn. Mech. Engrs.

British Works. The Works of the South Eastern and Chatham Rly. Co. Eng. Production, vol. 4, nos. 77 and 78, Mar. 23 and 30, 1922, pp. 271–275 and 298–302, 21 figs. Description of organization and shop practice in locomotive and car works.

Cab Signals. On the Question of Locomotive Cab Signals (France), Jules Verdeyen. Inst. Ry. Assn. Bul., vol. 4, no. 3, Mar. 1922, pp. 537–552, 8 figs. Report on repeating and recording track signals on locomotive; different systems already used or tried, results obtained; recording running speed of locomotives.

Counterbalancing Reciprocating Masses. The Development of Counterbalancing in British Locomotive Practice, F. W. Brewer. Engineer, vol. 133, no. 3455, Mar. 17, 1922, pp. 298 and 300. History of development down to present-day practice.

Diesel-Engined. Possibilities of the Diesel Locomotive. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 120–121. Editorial note. Disadvantages of Diesel engine for locomotive service.

Electric. See ELECTRIC LOCOMOTIVES.

Electric Camshaft Control. The English Electric Camshaft Control. English Elec. Jl., vol. 2, no. 1, Jan. 1922, pp. 27–35, 12 figs. Describes master controller for heavy locomotives and multiple-unit stock, designed to give reliability with lowest possible maintenance cost.

4-8-2 and 2-10-2 Types. New Mountain Type and Santa Fe Type Locomotives for the Manila Railroad. Ry. & Locomotive Eng., vol. 35, no. 3, Mar. 1922, pp. 65–66, 2 figs. Describes 4-8-2 type, with tractive effort of 28,600 lb., for passenger service, and 2-10-2 type, with tractive effort of 35,700 lb., for freight service.

Handling on Descending Grades. Handling Locomotives on Descending Grades, A. G. Newell. Ry. Mech Engr, vol 96, no 3, Mar 1922, pp 132–135, 6 figs Drifting and by-pass valves important; effect of reverse lever position and use of throttle.

New Russian 0 10 0 Type. Construction, Manufacture and Transport of the Locomotives for Russia Ordered From Nydqvist and Holm A. B. (Konstruktion, tillverkning och transport av de hos Nydqvist & Holm a.-b. beställda ryska lokomotiven), Bengt Sjölin Teknisk Tidskrift (Utgiven av svenska teknologföreningen), vol. 52, no 8, Feb. 25, 1922, pp 119–131, 12 figs. Reviews development of Trollhättan work shops and describes new Russian 0 10 0-type locomotive building.

Tire-Roughing Mill. Tire-Roughing Mill Engineering, vol. 113, no. 2931, Mar. 21, 1922, pp. 351–356, 4 figs. Describes powerful tire roughing mill, which is capable of rough-rolling from slabbed blanks, ready for finishing mill, locomotive tires of largest diameter and can also produce broad rings up to 12 in. in width.

Trailer Wheels. Rolled Steel Trailer Wheels for Locomotives. Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 189–190, 3 figs. Also Ry. Age, Mar. 11, 1922, pp. 571–572, 3 figs. Method of manufacture of Edgewater Steel Co.

Valve Gear. Walschaert Valve Gear Variable Lead. Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 187–188, 4 figs. Modifications discusses secure ample lead while running combined with no lead when starting.

LUBRICANTS

Paraffin Series. Boundary Lubrication—The Paraffin Series, W. B. Hardy and Ida Doubleday. Royal Soc. Proc., vol. 100, no. A 707, Mar. 1, 1922, pp. 550–574, 5 figs. Results of experiments, and theory. Lubricating qualities of normal paraffins and their related acids and alcohols; influence of quantity of lubricant; solid lubricants; influence of chemical constitution.

Testing Apparatus. A Proposed Method for Solving Some Problems in Lubrication, William Stone. Commonwealth Engr., vol. 9, nos. 4 and 5, Nov. 1 and Dec. 1, 1921, pp. 115–122 and 139–149, 13 figs. Describes method of testing and construction of apparatus employed to determine conditions of formation and stability of lubricating film and effect of variations of viscosity in different parts of film due to varying temperatures. Results of tests carried out.

Viscosity and Friction. Viscosity and Friction, Winslow H. Herschel. Sci. Lubrication, vol. 2, no. 1, Jan. 1922, pp. 10–21, 2 figs. Viscosity effect in complete-film-lubrication regeme; viscosity estimation at one temperature from observed viscosity at another temperature; friction testing of bearing metals; transition point; oiliness of different lubricants; service tests; desirable features of oil-friction testing machines. Paper read before S.A.E.

LUBRICATING OILS

Automotive-Engine, Dilution of. The Dilution of Lubricating Oil in the Present Automotive Engine, William F. Parish. Sci. Lubrication, vol. 2, no. 1, Jan. 1922, pp. 5–7 and 21. Dilution through decomposition of oil; leakages of raw gasoline; leakages during compression stroke; extent to which dilution exists; results of dilution; wear; etc. Paper read before combined meeting of Am. Petroleum Inst., Soc. Automotive Engrs., and Nat. Automobile Chamber of Commerce.

Compounding. Compounding of Lubricating Oils, W. F. Osborne. Power, vol. 55, no. 14, Apr. 4, 1922, pp. 535–536. Points out that for steam-engine cylinders and marine-engine lubrication compounding is essential. On the other hand, a pure mineral oil should be used where there is any danger of water causing emulsion.

Emulsions. The Cause of Emulsions in Lubricating Oils, W. F. Osborne. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 502–503. Notes on separation of water and oil; impurities in oil; effect of compounding.

Pour Test. The Meaning of Cloud and Pour Points in Lubricating Oil, W. F. Osborne. Power, vol. 55, no. 12, Mar. 21, 1922, pp. 458–459, 2 figs. Describes method of making pour test.

Steam Cylinders. Compounded Cylinder Oil for Superheated Steam Conditions. Lubrication, vol. 8, no. 1, Jan. 1922, p. 9. Recommends use of medium-heavy viscosity cylinder oil, having about 4 or 5 per cent of animal oil.

Steam-Turbine. Keeping Steam Turbine Lubricating Oil in Good Condition, Charles H. Bromley. Sci. Lubrication, vol. 1, no. 12, Dec. 1921, pp. 5–11, 7 figs. Lubrication trend in turbine practice; turbine-oil circulating systems; formation of emulsion and sludge; acidity; continuous by-pass system; requirements of efficient oil filter for purifying steam turbine oil; etc. Reprinted from Gen. Elec. Rev.

Substitutes. Lubricants and Their Substitutes (Ueber Schmiermittel und deren Ersatzstoffe), Bruno Simmersbach. Wärme- u. Kälte-Technik, vol. 24, no. 5, Mar. 1, 1922, pp. 53–56. Experience in Germany with substitute oils.

LUBRICATION

Lubricants and. Lubrication and Lubricants. Sibley Jl. of Eng., vol. 36, no. 2, Feb. 1922, pp. 18–29 and 37, 7 figs. Discusses loss of friction, viscosity of lubricants, laws of lubrication, etc.

Theory. Theory of Lubrication, William F. Parish. Sci. Lubrication, vol. 1, no. 11, Nov. 1921, pp. 15–19. Discusses the two functions of a lubricant, keeping

surfaces apart, and conveying heat from surfaces that is caused by friction.

M

MACHINE SHOPS

High-Speed Production. Examples of Modern High Speed Production, H. A Wilson. Can. Machy., vol. 27, no. 7, Feb. 16, 1922, pp. 27–30, 11 figs. Methods adopted at Ford motor plant.

Modern Design. An Eastern Shop of Modern Design, C. E. Clewell. Am. Mach., vol. 56, nos. 14 and 56, Apr. 6 and 13, 1922, pp. 508-511 and 558-559, 7 figs. Machine-tool plant of Gould & Eberhard, Irvington, N. J., has saw-tooth roof and reinforced-concrete frame. Mercury-vapor lamps for shop. Railroad and power facilities. Crane service and sanitary arrangements.

MACHINE TOOLS

Bearings, Adjustments of. The Adjustment of Machine Tool Bearings, Fred Horner. Machinery (Lond.), vol. 19, no. 482 and 483, Dec. 22 and 29, 1921, pp. 342–347, 385–387, 53 figs. Discusses divided, solid, and tapered bearings, and gives a number of examples of their adjustments; contraction of parallel bushings; capped bearings; end adjustments.

Economical. Economical Machine Tools (Wirtschaftliche Werkzeugmaschinen), H. Vossmann. Betrieb, vol. 4, no. 11, Mar. 4, 1922, pp. 345–349, 8 figs. Main features of a single-disc high-speed lathe and a new turret lathe. Results of tests on a four-spindle automatic machine. Relations between cutting speed and width of cutting and between efficiency and sharpness of tools. A logarithmic alignment chart is presented, with help of which, number of pieces machined per hr. on automatic machines, and working time for given length on lathes can be determined.

Progress. Machine Tool Progress. Engineering, vol. 113, no. 2933, Mar. 17, 1922, pp. 424–426, 9 figs. Describes machining methods and appliances developed in recent years at works of Alfred Herbert, Ltd., Coventry, England.

MALLEABLE IRON

Manufacture. Progress in Manufacture of Malleable Iron, Enrique Touxeda. Can. Foundryman, vol. 13, no. 3, Mar. 1922, pp. 32–34. Air-furnace thermal efficiency; proportioning air supply; use of waste-heat boilers; design of double-hearth furnace; use of coke-oven gas; etc.

MARINE ENGINES

Still. The Still Engine for Marine Propulsion, Archibald Rennie. Engineering, vol. 113, nos. 2931 and 2932, Mar. 3, and 10, 1922, pp. 275–278, 14 figs. partly on supp. plate and pp. 309–312, 8 figs. Also Mar. Engr. & Naval Architect, Mar. 1922, pp. 107–110, 4 figs. (Abstract.) Discusses engine of single-piston type which works on its combustion (or top) side upon two-stroke port scavenging principle, and employs airless (solid) injection for fuel oil; on its steam (or bottom) side it operates upon single-acting principle.

MEASURING INSTRUMENTS

Accuracy. The Accuracy of Measuring Instruments (Genauigkeiten der Messzeuge), R. P. Schröder. Betrieb, vol. 4, no. 9, Feb. 11, 1922, pp. 269–274. Notes on gage blocks, initial comparative, trial and working gages. Measurement of workpieces.

Optical Equipment. Optical Auxiliary Equipment for Measuring Instruments (Optische Hilfsmittel an Messgeräten), Walter Block. Betrieb, vol. 4, no. 9, Feb. 11, 1922, pp. 285–289, 6 figs. Discusses optical media for measuring instruments of all kinds, but especially those used in machine construction, for purpose of manipulating them with greater ease and accuracy.

METALS

Grain Growth and Recrystallization. Grain Growth and Recrystallization in Metals, Zay Jeffries and R. S. Archer. Chem. & Met Eng., vol. 26, nos. 8, 9 and 10, Feb. 22, Mar. 1 and 8, 1922, pp. 343–345, 402–410 and 449-457, 39 figs. Feb. 22: Technical definition of recrystallization, and list of recrystallization temperatures for common metals. Methods for measuring grain size, shape and volume. Mar. 1: Effect of time and temperature of heating, degree of cold-work, original grain size and obstructing impurities on grain growth of metals and solid solution alloys. Mar. 8: Possible causes of grain growth; recrystallization is grain growth of fragmented crystals; germination; formation of nuclei.

Mechanical Properties of. Variation of Mechanical Properties in Metals and Alloys at Low Temperatures (Sur la variation des propriétés mécaniques des métaux et alliages aux basses températures), Léon Guillet and Jean Cournot. Comptes Rendus des Séances de l'Académie des Sciences, vol. 174, no. 6, Feb. 6, 1922, pp. 381-386. Experiments with a number of metals; table of Brinell hardness and resiliency of these at +20 deg., —20 deg., —80 deg. and liquid air temperatures.

Strength and Fatigue. Calculation of a Non-Circular Cylindrical Envelope (Méthode générale de calcul des enveloppes cylindriques a section non circulaire), P. Cayere. Houille Blanche, vol. 20, no. 59-60, Nov.-Dec. 1921, pp. 213-216, 5 figs. Discusses interior pressure, fatigue of metals, etc.

Tensile Strength of Plastic. Tensile Strength (Verfestigung und Zugfestigkeit), Friedrich Körber. Stahl u. Eisen, vol. 42, no. 10, Mar. 9, 1922, pp. 365–370, 8 figs. The mechanics of tensile test of plastic metals. Notes on calculation of tensile strength from curve of true stresses. Theory that slip and rotation of crystal elements takes place is confirmed.

METEOROLOGY

Wind, Velocity of. Variation of Velocity of Wind With Altitude (La variation de la vitesse du vent avec l'altitude), Ch. Maurain. Révue Générale des Sciences, vol. 33, no. 3, Feb. 15, 1922, pp. 76–80, 5 figs. Discusses results obtained by means of recording balloons and gives comparative curves.

MICROMETERS

Lever Gages and. Accuracy Requirements of Micrometers and Lever Gages (Genauigkeitsansprüche an Mikrometer und Fühlhebel), G. Berndt. Betrieb, vol. 4, no. 9, Feb. 11, 1922, pp. 280–284. Relation between measuring and reading accuracy of screw micrometers. Suggestions for increasing accuracy of lever gages.

MILLING MACHINES

Universal. Economical Use of High-Power Universal Milling Machines (Wirtschaftliche Verwendung von Hochleistungs-Universal-Fräsmaschine), H. Pohlmann. Betrieb, vol. 4, no. 11, Mar. 4, 1922, pp. 360–363, 9 figs. Describes machine constructed by Mammutwerke, Nuremberg, Germany.

Vertical. The "Relmil" Vertical Milling Attachment. Machinery (Lond.), vol. 19, no. 493, Mar. 9, 1922, p. 699, 2 figs. Distinguishing feature is that it does not clamp or fix on lathe saddle. Is secured to back of lathe bed and also to chip tray by means of two substantial cast-iron brackets.

MOLDING

Plastic and Powdered Substances. Moulding Plastic and Powdered Substances (including Casting Substances other than Metals and Presses, Mechanical). Abridgments of Specifications, class 87(ii), 1922, 379 pp. Patents for inventions for period 1909–15.

MOLDING METHODS

Boxes. A New System in Molding-Boxes. Mech. World, vol. 71, no. 1835, Mar. 3, 1922, p. 161. Describes box having separate ends and sides, secured by a pin and two wedges, of opposed bevel, at each joint. System has proved very satisfactory in sizes from 16 in. sq. to 80 in. sq. Translated from Giesserei-Zeitung.

MONEL METAL

Water Works, Suitability for. Monel Metal and Its Suitability for Water-Works Use, H. S. Arnold. N. E. Water Works Assn. Jl., vol. 36, no. 1, Mar. 1922, pp. 86–93 and (discussion) pp. 93–94. Describes source of supply and method of manufacture. Physical properties and uses.

MOTOR-TRUCK TRANSPORTATION

Graphical Control. A Graphical Control of Motor Truck Transportation, Howell B. May. Factory, vol. 28, no. 4, Apr. 1922, pp. 410–412, 3 figs. Describes graphical planning and recording system which it is claimed, makes it possible to realize greatest number of productive minutes out of total 480 that truck is out of garage.

MOTOR TRUCKS

German Types. Motor Trucks with Special Regard to Types Exhibited at the German Automobile Show (Der Lastkraftwagen und seine vielseitige Verwendung unter besonderer Berücksichtigung der auf der D.A.A. ausgestellt gewesenen Bauarten), Karl Redtmann. Fördertechnik u. Frachtverkehr, vol. 15, nos. 1 and 2, Jan. 6 and 20, 1922, pp. 8–13 and 27–33, 39 figs. Details of various German types.

Tipping Gear. Gravity-Type Tipping Gear for Motor Wagons. Engineering, vol. 113, no. 2934, Mar. 24, 1922, p. 358, 3 figs. With described gear center of gravity of load during tipping operation moves along a straight line, with slight downward slope towards rear end of wagon.

O

OIL ENGINES

Combustion. Combustion Process in Oil Engines (Der Verbrennungsvorgang im Oelmotor), Constantin Redzich. Wärme- u. Kälte-Technik, vol. 24, no. 2, Jan. 15, 1922, pp. 17–18. Review and discussion of scientific investigations.

Doxford. Doxford's Engine and Boiler-Oil, J. L. Chaloner. Motorship, vol. 7, no. 3, Mar. 1922, pp. 187-188. Improvements made in Doxford engine and economics effected by use of boiler-oil.

Fishing Boats. Engines for Fishing Boats (Les moteurs des bateaux de pêche), Edmond Marcotte. Technique Moderne, vol 13, nos. 11 and 12, Nov. and Dec. 1921, pp. 449-457 and 518-521, and vol. 14, no. 1, Jan. 1922, pp. 21-26, 33 figs. Nov.: Discusses those of French manufacture, including kerosene and semi-Diesel engines; their operation and control. Dec.: The Tuxham-Delaunay-Belleville engine, and the Atlas Semi-Diesel. Jan.: The Bellenger and Renault Semi-Diesels, and the Chaleassière Diesel engines.

Hot-Bulb Marine. New Hot-Bulb Marine Engines of the German General Electric Co. (Neue AEG-Glühkopf-Schiffsmotoren). Motor u. Auto (formerly Oel- u. Gasmaschine and Kraftwagen), vol. 19, no. 3, Feb. 15, 1922, pp. 33-36, 2 figs. Development and present status of construction.

OIL FUELS

Boilers for. Liquid Fuel For Steam Boilers (L'Emploi des combustibles liquides pour le chauffage des foyers industriels et particulièrement des chaudières à vapeur), Louis Cauchois. Bul. des Associations Françaises de Propriétaires d'Appareils à Vapeur, no. 2, Oct. 1920, pp. 37–68, 6 figs. Properties of combustible liquids and precautions necessary in handling, including petroleum and its derivations, shale oil, alcohol, etc. Burners of various types.

Heavy, in Carburetor. The Use of Heavy Oil Fuels in Carburetors (Zur Frage der Verwendung schwerer Brennstoffe in der Vergasermaschine), J. Plünzke. Motorwagen, vol. 25, no. 7, Mar. 10, 1922, pp. 125–127, 5 figs. Determination of boiling curve for two fuels, naphthalene and anthracene, during suction and compression.

Injection and Combustion. Injection and Combustion of Fuel-Oil—VII, C. J. Hawkes. Motorship, vol. 7, no. 3, Mar. 1922, pp. 195–196, 1 fig. Experiments with solid-injection and air-blast in marine Diesel engines. (Continuation of serial.)

Internal-Combustion-Engine. Internal-Combustion Engine Fuels, C. A. Norman. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 187–192 and (discussion) 192 and 203. Discusses use of kerosene and gasoline, and substitute fuels, including shale oils.

Steam Power. Fuel Oil For Steam Power, A. D. White. Combustion, vol. 6, no. 4, Apr. 1922, pp. 175–176, 1 fig. Advantages of fuel oil over coal; conditions for efficiency; controlling steam supply; preheating of oil.

OPEN-HEARTH FURNACES

Design. Design of Open-Hearth Furnaces, A. D. Williams. Iron Age, vol. 109, nos. 13 and 17, Mar. 16 and 30, 1922, pp. 717–719, 1 fig. and 853–855, 2 figs. Mar. 16: Regenerator computations for volume and weight of checker work required. Temperature changes based on time reversals. Mar. 30: Regenerator and flue calculations for frictional resistance to passage of air and gases. Summation of losses.

Fluorspar, Use of. Fluorspar in Open-Hearth Practice. Iron Age, vol. 109, no. 11, Mar. 23, 1922, pp. 783–784. Effective agent in removing sulphur from steel. Action on slag and furnace lining. Old ideas altered. Translated from article by S. Schleicher in Stahl u. Eisen, Mar. 17, 1921.

German. Arrangement of Open Hearths in Germany, Hubert Hermanns. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 192–194, 3 figs. Steelmakers of Germany have not adopted water-cooled parts, but use detachable posts; arrangement of gas and air chambers is of special interest.

OXY-ACETYLENE CUTTING

Cast Iron. Cutting Cast Iron With the Oxyacetylene Torch, Alfred S. Kinsey. Stevens Indicator, vol. 38, no. 4, Oct. 1921, pp. 287–296, 5 figs. Reviews progress made with oxyacetylene torch; how to cut cast iron; effects of oxyacetylene cutting on cast iron advantages; theory of cutting of metals by gas.

OXY-ACETYLENE WELDING

Cutting and. Modern Iron Welding and Cutting Devices with Dissolved Acetylene and Oxygen (Neuzeitliche Eisen-Schweiss- und -Schneideinrichtungen mit gelöstem Azetylen und Sauerstoff), H. Kropf. Metall-Technik, vol. 48, no. 1, Jan. 1, 1922, pp. 3–4. Describes installations for workshops which are entirely fire- and explosion-proof, and can be used for various welding and cutting operations with great amount of economy and efficiency.

Instruction Sheet. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter), Betrieb, vol. 3, no. 11, Mar. 4, 1922, pp. 39–40. Proposal of Works Dept of German Federation of Technical and Scientific Societies for care and manipulation of gas-welding equipment.

Rods for. Choosing Rods for Welding Work, J. R. Dawson. Iron Trade Rev., vol. 70, no. 15, Apr. 13, 1922, pp. 1033–1036 and 1043, 10 figs. Selection of welding rod for oxy-acetylene process depends on service requirements of finished weld. Inspection of rods and tests of welds aid in determining choice of materials. (Abstract.) Paper delivered before Int. Acetylene Assn.

Safety in. Safety Engineering as Applied to Oxy-Acetylene Cutting and Welding Apparatus, F. J. Napolitan. Am. Welding Soc. Jl., vol. 1, no. 2, Feb. 1922, pp. 13-30, 3 figs. Writer emphasizes safety of modern acetylene generators. Discusses acetylene and its generation; explosive mixtures; portable acetylene cylinders and oxygen cylinders; high-pressure gages; torches and tips; flashbacks; etc.

P

PAPER MANUFACTURE

Tar Paper. Tar Paper (Le carton bitumé), J. Tricard. Arts et Métiers, vol. 74, no. 10, July 1921, pp. 216–218, 7 figs. Discusses manufacture which has been developed during war, to supply quick and cheap protection in inclement weather.

PARACHUTES

Calthrop "H" Type. The Calthrop "H" Type Parachute and Frontal Suspension Harness. Flight, vol. 14, no. 12, Mar. 23, 1922, pp. 170–177, 5 figs. Describes latest model, "Guardian Angel" and its method of operation.

PLANERS

Open-Side. A Large Open-side Planing Machine, C. S. Pettit. Machinery (Lond.), vol. 19, no. 493,

Mar 9, 1922, pp. 689–690, 1 fig. Describes machine in which peak load is of negative character, produced by use of fly-wheels in special positions which absorb reversal effort and actually take load off motor for the time being.

PLASTIC MATERIALS

Plastic Wood. Plastic Wood. Engineer, vol. 133, no 3453, Mar. 3, 1922, pp. 230–231. Describes material like soft wood, but without grain having cellulose nitrate as a base, chief raw material being cotton. It has consistency of dough used in pastry making and can be molded into any conceivable form, it can be used for patching up patterns and rounding off fillets and in molding process for making small articles. Process of manufacture.

PLATES

Steel, Manufacture and Properties of. Manufacture and Properties of Steel Plates Containing Zirconium and Other Elements, George K. Burgess and Raymond W. Woodward. U. S. Bur. of Standards Technologic Papers, no. 207, Feb. 2, 1922, pp. 123–176, 16 figs. Describes manufacture and certain physical properties obtained from steel plates produced from about 193 heats of steel containing in various combinations following principal variable elements. Carbon, silicon, nickel, aluminum, titanium, zirconium, cerium, boron, copper, cobalt, uranium, molybdenum, chromium and tungsten.

POWER PLANTS

British Practice. Notes on British Power Plant Practice, C. H. S. Tupholme. Power Plant Eng., vol. 26, no. 6, Mar. 15, 1922, pp. 315–319. Efforts directed by engineers toward securing higher fuel economy, due to continued high prices of fuel.

Design. Developments in Power Station Design. Engineer, vol. 133, no. 3455, Mar. 17, 1922, pp. 290–292, 10 figs. partly on p. 302. Describes cooling towers of Powell Duffryn Steam Coal Co. built by Davenport Engineering Co., each designed to reduce temperature of 216,000 gal. of water per hr. from 100 deg. Fahr. under average atmospheric conditions, turbine-driven feed pump; coal and ash-handling plant, etc.

Rubber-Tire Factory. A Modern Power Plant in the Rubber-Tire Industry. Power, vol. 55, no. 12, Mar. 21, 1922, pp. 448–454, 15 figs. Details of coal-handling equipment, water-tube boilers, superheaters, steam turbines, air compressors and hydraulic pumps of the Cumberland (Md.) Plant of Kelly-Springfield Tire Co.

POWER TRANSMISSION

Oil Variable Gear. Power Transmission by Oil (Elaulic Gear), H. S. Hele-Shaw. Instn. Mech. Engrs. Proc., no. 7, 1921, pp. 843–873, 16 figs. Author discusses power transmission when it is accompanied with its transformation, and where oil is employed as working agent. Design and applications of oil variable gear, or elaulic gear.

PRESSES

Forging, Steam-Hydraulic. Steam-Hydraulic Forging Presses (Les presses vapo-hydrauliques a forger). Outillage. vol. 249, no. 9, Mar. 4, 1922, pp. 271–273, 6 figs. Describes hydraulic presses in which high-water pressure is produced by steam compressor.

Safety Devices. Making a Punch Press Department Safe, C. B. Auel. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 501–503, 9 figs. How manufacturing company has greatly reduced accidents. Methods and devices that helped make for safety.

PRESSURE VESSELS

Mechanically Welded. The Strength of Mechanically Welded Pressure Containers, R. J. Roark. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 225–230, 18 figs. Describes pressure tests made on electrically welded, gas-welded, and riveted pressure containers, and tension and shear tests made on specimens of welded metal, carried out for purpose of demonstrating strength and uniformity of construction in which electric weld is employed.

PRESSWORK

Tools for Aluminum Ware. Press Tools for Aluminum Ware, Frank A. Stanley. Am. Mach., vol. 56, no. 12, Mar. 23, 1922, pp. 437–438, 5 figs. Press tools for blanking, bending and perforating; how body is drawn; spouts attached by use of welding torch.

PRODUCER GAS

Cleaning Without Washing. Cleaning Producer Gas Without Washing, James H. Matheson. Iron Age, vol. 109, no. 14, Apr. 6, 1922, pp. 916–917, 4 figs. Gas equalizer and soot collector developed to treat gas from bituminous coal.

Furnace Work, Producer Gas for Furnace Work. Engineering, vol. 113, no. 2934, Mar. 24, 1922, pp. 347–351, 34 figs. partly on supp. plate. Describes low-temperature rotary carbonization plant devised by Harold Nielsen, consisting essentially of combination of ordinary producer with low-temperature carbonizing retort, in which partial distillation of raw coal is effected by sensible heat of producer gas. Designed to improve efficiency of manufacture of producer gas, and permit recovery of valuable by-products.

PULVERIZED COAL

Systems of Burning. Burning Pulverized Fuel—V, F. P. Coffin. Combustion, vol. 6, no. 4, Apr. 1922, pp. 181–184, 2 figs. Discusses conditions of efficient combustion, tube slag, effect of furnace temperature on ash, baffling of horizontal water-tube boilers, and describes some recent installations. Excerpts from author's contribution on "The Utilization of Coal on a Multiple-Product Basis" to Bacon and Hamor's "American Fuels."

PUMPING PLANTS

Diesel-Driven. Diesel-Driven Pumping Plant for Trinidad. Engineer, vol. 133, no. 3453, Mar. 3, 1922, p. 248, 3 figs. partly on p. 242. Describes treble-ram pump for Trinidad, with capacity of 76,000 gal. per hr. when running at 44 r.p.m. and with head of 350 ft. Pump is driven by means of 200-hp. Diesel engine of four-cylinder, four-cycle pattern.

PUMPS

High-Lift Turbine. High Lift Turbine Pumps A. M. Attack. So African Instn. Engrs. Jl., vol. 20, no. 7, Feb. 1922, pp. 130–145 and (discussion) 145–146, 19 figs. Discusses some of the more important features upon which a successful design will depend, including multi-stage and centrifugal pumps, pumps in series, axial thrust, pumps driven by synchronous motors, sinking pumps, impellers, diffuser, etc.

Jets, Impact Losses of. Impact Losses of Jets, J. B. Burnell. Engineering, vol. 113, no. 2935, Mar. 31, 1922, pp. 404–405, 4 figs. Account of experiments made by author to determine loss of kinetic energy in jet due to varying deviation, and friction losses in bends. (Abstract.) Paper read before Melbourne Division of Instn. Engrs., Australia.

Pipe Efficiency. Pipe Friction and Pump Efficiency, William Brasenall. Colliery Guardian, vol. 123, no 3191, Feb. 24, 1922, pp. 472–473. Results of experiments carried out with turbine, three-throw ram, and differential ram pumps. (Abstract.) Paper read before Min. Inst. of Scotland.

PUMPS, CENTRIFUGAL

Types and Operation. Centrifugal Pumps, J. W. Rogers. Eng. Rev., vol. 35, nos. 8 and 9, Feb. and Mar. 1922, pp. 259–262 and 296–301, 12 figs. Feb.: Advantages, principles, operating characteristics, efficiency and regulation, power requirement, electric motors. Mar.: Describes some modern types.

PYROMETERS

Ardometer and Holborn-Kurlbaum. The Measurement of High Temperatures with the Ardometer and the Holborn-Kurlbaum Pyrometer (Die Messung hoher Temperaturen mit Ardometer und Holborn-Kurlbaum-Pyrometer), Georg Keinath. Metall-Technik, vol. 47, no. 20, Dec. 15, 1921, pp. 161–164 and vol. 48, no. 1, Jan. 1, 1922, pp. 1–3, 9 figs. Describes the Holborn-Kurlbaum optical pyrometer, and the ardometer which is based on the Féry total-radiation pyrometer and said to possess excellent resistive qualities and great reliability.

R

RAILS

Head, Conditions Affecting. Conditions Affecting the Head of a Rail, James E. Howard. Eng. & Contracting, vol. 57, no. 11, Mar. 15, 1922, pp. 252–253. Review of destructive influences. Paper presented before N. Y. R. R. Club.

RAILWAY CONSTRUCTION

Specifications. American Railway Engineering Convention. Eng. News-Rec., vol. 88, no. 12, Mar. 23, 1922, pp. 498–501, 1 fig. Rail committee presents experimental rail specification based on quiet -seeting steel. Engineers and labor economics. Analysis of warehouse and freighthouse design. Specifications for movable bridges adopted.

RAILWAY ELECTRIFICATION

Economies Due to. The Future of Railroading is Electrification, W. R. Steinmetz. Can. Ry. Club Official Proc., vol. 20, no. 8, Nov. 8, 1921, pp. 16–39 (includes discussion). Discusses electrification generally in various countries, and enumerates economies due to it.

Holland. Electrification of Railways in Holland (Electrificatie van de spoorwegen in Nederland), J. J. W. Van Loenen Martinet. Ingenieur, vol. 37, no. 9, Mar. 4, 1922, pp. 151–162, 8 figs. Discusses report of commission appointed to study the question, which is review of electrification practice in various countries; also Amsterdam-Rotterdam electrification.

Induction Interference and Electrolysis. Effects of Electric Power Used for Traction, Chas. F. Scott. Ry. Age, vol. 72, no. 11, Mar. 18, 1922, pp. 727–729, 1 fig. Inductive interference and electrolysis as related to railroad electrification.

Superpower Survey. Superpower Survey, Gen. Elec. Rev., vol. 25, no. 2, Feb. 1922, pp. 72–91, 15 figs. Articles on The Superpower System as an Answer to a National Power Policy, by W. S. Murray; What the Superpower Survey Means to the United States, by H. Goodwin, Jr.; and Abstract of "Appendix C" of Superpower Report on the Electrification of Railroads, by W. D. Bearce.

RAILWAY MOTOR CARS

Gasoline. Gasoline Motor Cars for Railways (Motor-Benzol-Triebwagen für Eisenbahnen). Verkehrstechnik, vol. 39, no. 11, Mar. 17, 1922, pp. 130–131, 1 fig. Describes new cars with four-cycle engine built by the Kiel Dockyards of the German Works Corp., with 2 or 4 axles, weighing 9 and 15 tons, and having accommodation for 42 and 95 passengers, respectively.

Gasoline Motor Cars with Four-Wheel Drive. Ry. Age, vol. 72, no. 11, Mar. 18, 1922, 749–750, 4 figs. For passenger, freight and light switching; manufactured by Four-Wheel Drive Auto Co., Clintonville, Wis.; has three speeds; four-cylinder engine; 42 hp. by S.A.E. rules, but develops 68 hp. on a brake test.

New Haven Branch Lines. Motor Cars Used on New Haven Branch Lines. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 139–141, 3 figs. Describes the Mack rail car used in local passenger service. Important advantages are flexibility and low-operating cost.

RAILWAY OPERATION

Automatic Train Control. American Train Control System. Ry. Signal Engr., vol. 15, no. 3, Mar. 1922, pp. 101–104, 6 figs. Detailed description of intermittent contact or ramp type system, developed by Am. Train Control Co. On right side of track ramps are arranged to apply brakes, on left side ramps are arranged to give only cautionary indication in cab.

Automatic Train Control System of General Railway Signal Co. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 330–337, 11 figs. Describes operation and advantages claimed.

G. R. S. Company's Auto-Manual Train Control. Ry. Elec. Engr., vol. 13, no. 3, Mar. 1922, pp. 95–97, 6 figs. Recent improvements by General Ry. Signal Co. of Rochester, in their automatic train-control system. Essential element of this system is arrangement for permitting engineman to cut out automatic brake-setting machinery and keep in his own hands full control of train; hence the name auto-manual train control.

Recent Tests of Train Stops and Control. Ry. Elec. Engr., vol. 13, no. 2, Feb. 1922, pp. 67–70, 5 figs. Describes Webb automatic train stop, and the M-V. All Weather train control, and tests carried out with them.

The Bourdette-Brookins Train Control System. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 353–355, 7 figs. System featuring three-position mechanically held plunger, to provide clear, caution and stop indications.

The Hearing on Train Control. Ry. Rev., vol. 70, nos. 12 and 13, Mar. 25 and Apr. 1, 1922, pp. 421–424 and 455–460. Gives summary of argument of 40 American railroads represented by Am. Ry. Assn. against recent order of Interstate Commerce Commission requiring installation of automatic train control.

The Regan Automatic Train Control Systems. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 337–344 9 figs. Intermittent contact type, consisting of two elements, one comprising locomotive and tender equipment and other, apparatus located on roadside. See also Ry. Signal Engr., vol. 15, no. 3, Mar. 1922, pp. 116–120, 8 figs.

The Simplex Train Control System. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 351–353, 3 figs. Works on principle of telegraphing track conditions to engine which is automatically controlled by device that applies air brakes.

The Union Switch & Signal Company's Automatic Train Control System. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 348–350, 6 figs. Describes company's complete speed-control system used as automatic-stop system.

Motive-Power Maintenance. Notes on the Maintenance and Supply of Motive Power in a Railway District, W. Land and H. B. Buckle. Ry. Gaz., vol. 36, nos. 2, 3, 4, 5 and 6, Jan. 13, 20, 27, Feb. 3 and 10, 1922, pp. 54–56, 97–100, 133–137, 170–173 and 212–215, 25 figs. Discusses maintenance and supply of power and its utilization as two interdependent questions which must be considered concurrently, and their supervision should be under one responsible command. Jan. 13: Running repairs; cleaning of engines. Jan. 20: Washing out of boilers; tube sweeping. Jan. 27: Sheer legs; electric wheel drops. Feb. 3: Preparing engine for work; mechanical handling of firebox ashes, method of dealing with engines in locomotive yard; breakdowns. Feb. 10: Distribution of locomotives for passenger and freight train arrangements in a given district.

Tonnage Rating. Practical Points on Dynamometer Car Tonnage Tests, O. O. Carr. Ry. Rev., vol. 70, no. 13, Apr. 1, 1922, pp. 451–455. Observations on Illinois Central show inaccuracy of office ratings and false economy of reducing tonnage to increase train speed.

RAILWAY SHOPS

Welding Practice. Standards of Railroad Shop Welding Practice, G. M. Calmbach. Ry. Elec. Engr., vol. 13, no. 2, Feb. 1922, pp. 51–56, 18 figs. Typical examples of boiler welding practice and general rules.

RAILWAY SIGNALING

Audible Signal. The Federal Signal Company's Audible Signal. Ry. Elec. Engr., vol. 13, no. 3, Mar. 1922, pp. 97–98, 1 fig. Describes experiments on Boston & Albany in Massachusetts and New York.

Missouri, Kansas & Texas Installations. The M. K. & T. Signaling Program. Ry. Signal Engr., vol. 15, no. 3, Mar. 1922, pp. 93–95, 10 figs. Describes installation with new ideas in pole-line construction, trunking and battery housing, of Missouri Kansas & Texas.

RAILWAY TIES

Life. A Means of Determining the Average Life of Ties, V. K. Hendricks. Ry. Age, vol. 72, no. 12, Mar. 25, 1922, pp. 779–783, 2 figs. Explanation of fluctuations in requirements on new lines and method of anticipating them.

Renewal Cost Calculation. Diagram for Calculating Annual Cost of Cross Ties, E. R. Cary. Eng. & Contracting, vol. 57, no. 11, Mar. 15, 1922, pp. 245–246, 2 figs. Describes method of making nomograph or alignment diagram.

RAILWAY TRACK

Curves. Railway Curves: Superelevation and Main-

tenance, E. E. R. Tratman. Eng. News-Rec., vol. 88, nos. 11 and 12, Mar. 16 and 23, 1922, pp. 446-449 and 489-492, 2 figs. Shows variations in practice and opinion. Influence of modern locomotives; relations of curvature to gage and grades; checking and marking.

RAILWAYS

Alaska. Completing the Government Railroad in Alaska. Ry. Age, vol. 72, no. 13, April 1, 1922, pp. 813–817, 8 figs. Describes Alaska railroad opened between Seward, on Resurrection Bay, and Fairbanks, in interior, on Feb. 5, 1922, a distance of 467 miles.

REFRIGERATING MACHINES

Compression. The Compression Refrigerating Machine, Gardner T. Voorhees. Ice & Refrigeration, vol. 62, no. 3, Mar. 1922, pp. 223–226, 1 fig. Study of floating heat question and clearance effect. (Continuation of serial.)

REFRIGERATION

Brine Spray. Brine Spray Refrigeration, S. C. Bloom. A.S.R.E. Jl., vol. 8, no. 4, Jan. 1922, pp. 308–321 (includes discussion) 10 figs. Describes experiments carried out with Webster nozzles and overhead spray systems.

RESEARCH

Industrial. A Plan for the Development of Industrial Research in Canada, S. F. Ruttan. Honorary Advisory Council for Sci. & Indus. Research, Dominion of Can., Bul. no. 10, 1921, 8 pp. (Abstract.) Address before Chem. Congress, New York.

RIVETS

Manufacture and Types. Riveting (Etude sur le rivetage). Ouvrier Moderne, vol. 4, no. 11, Feb. 1922, pp. 443–447, 12 figs. Metal used; manufacture of rivets; standard types of rivets; etc.

ROLLING MILLS

Drives. Factors which Influence the Size of Rolling-Mill Drives, L. Rothera. Iron & Coal Trades Rev., vol. 104, no. 2818, Mar. 3, 1922, pp. 306–308, 8 figs. Choice of sections to be rolled; output required; methods of rolling; drafting of rolls; number of passes taken. From English Elec. Jl.

Equipment. Adds New Rolling-Mill Equipment, Joseph Horton. Iron Trade Rev., vol. 70, no. 11, Mar. 16, 1922, pp. 746–748, 4 figs. Modern machinery installed in plants of Wm. Beardmore & Co., Ltd., Glasgow, Scotland, in transforming plant from war to peace-time production.

Friction Drive. A Friction Drive for Rolling Mills. Engineering, vol. 133, no. 3453, Mar. 3, 1922, p. 247, 3 figs. Describes new patented form of driving arrangement making use of friction rollers instead of ordinary gearing between engine and mill.

Sheet-Steel Rolling. The Possibility of Improved Methods of Rolling Sheet Steel, Sumner B. Ely. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 175–178. Author does not think that a continuous sheet mill is impossible; believes extensive scientific experiments on the problem should be conducted. (Abstract.) Paper read before Engrs.' Soc. Western, Pa.

ROPE DRIVE

Continuous and Multiple Systems. Power Transmission by Ropes. Eng. & Indus. Management, vol. 7, no. 10, Mar. 23, 1922, pp. 287–289, 3 figs. Questions of cost and efficiency construction of rope pulley drives; relative merits of continuous and multiple systems.

S

SAFETY

Organization in Industrial Plant. Safety Organization, Harry A. Schultz. Safety, vol. 9, no. 3, Mar. 1922, pp. 56–74, 8 figs. Discusses in detail safety organization of an industrial plant, duties of safety committees and safety engineers, educational activities, first aid and rescue, etc.

SAND, MOLDING

Handling Equipment. Solving Sand Problem in a Steel Foundry, Edwin F. Cone. Iron Age, vol. 109, no. 15, Apr. 13, 1922, pp. 985–988, 6 figs. Mechanical equipment shakes out castings and prepares old and new sand with minimum of labor. Other features.

Uses and Abuses. Uses and Abuses of Molding Sands, Eugene W. Smith. Iron Age, vol. 109, no. 13, Mar. 30, 1922, pp. 860–861. Typical American sands and their composition; sand for various metals. Discussion. Paper read before Chicago Foundrymen's Club.

SCHOOLS, TECHNICAL

Ottawa. Wide Range of Instruction is Being Given, W. W. Nichol. Can. Machy., vol. 27, no. 11, Mar. 16, 1922, pp. 48–49, 4; figs. Activities of Ottawa Technical School, and its equipment. Subjects cover machine-shop practice, automobile mechanics, welding and cutting, structural and mechanical drafting, etc.

Toronto. This School Shows Remarkable Progress. Can. Machy., vol. 27, no. 11, Mar. 16, 1922, pp. 35–39, 8 figs. Describes the Technical High School, Toronto, and its facilities and equipment.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Automatic. 2-In. Automatic Screw Machine. Engineering, vol. 113, no. 2932, Mar. 10, 1922, pp. 286–290, 12 figs. Details of machine constructed by Brown & Sharpe Mfg. Co., Providence, L. I. Largest size stock it will work is $2^3/_8$ in. in diam., turning any up to 5 in. and feeding any length up to 6 in. It turns out from 3 to 180 pieces per hr.

Set-Up Instructions for Automatic. Set-Up Instructions for Brown & Sharpe Automatics, Samuel R. Gerber. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, p. 607. Gives list of setting-up operations for automatic screw machines and detailed explanation of operations.

SCREW THREADS

Comparator. Screw-Thread Measuring Comparators (Gewinde-Messkomparator), C. Büttner. Betrieb, vol. 4, no. 9, Feb. 11, 1922, pp. 289–292, 11 figs. Describes construction and function of a new optical screw-thread measuring machine for maximum accuracy, with which all dimensions can be determined in coefficients of measure.

Cutting Tools. Influence of the Automotive Industry on Thread-Cutting Tools, C. N. Kirkpatrick and G. G. Vink. Am. Mach., vol. 56, no. 13, Mar. 30, 1922, pp. 479–481, 5 figs. Development of interchangeability in automobile industry. Changes in methods of manufacturing threading tools. Design of Landis die head.

SEAPLANES

Lift and Drag. Full Scale Determination of the Lift and Drag of a Seaplane, Max M. Munk. Nat. Advisory Committee for Aeronautics Technical Notes, no. 92, Apr. 1922, 5 pp., 1 fig. Speed, barometric pressure, and number of revolutions of engine were measured, including tests with stopped engine. Results of gliding tests are used for computation of lift and drag coefficients, and by making use of them, results of engine flights are used for computation of propeller efficiency.

SHAFTS

Torsional Vibration. Torsional Vibrations in Shafts and the Nazzaro Damper (Le vibrazioni torsionali negli alberi delle distribuzioni e lo smorzatore "Nazzaro"), Pasquale Borracci. Industria, vol. 36, no. 2, Jan. 31, 1922, pp. 26–28, 5 figs. Explains origin of torsional vibrations and describes the Nazzaro device for controlling them.

SHERARDIZING

Experiments. Experiments With Sherardizing, Leon McCulloch. Metal Industry (N. Y.), vol. 20, no. 3, Mar. 1922, pp. 97–98. Formation of coating, with special reference to amount and effect of iron in coating.

SLOTTING MACHINES

Production Work on. Production Work on Slotting Machines. Machy. (Lond.), vol. 19, no. 492, Mar. 2, 1922, pp. 657–659, 6 figs. Operations advantageously performed on slotting machines or shapers of vertical type.

SMOKE ABATEMENT

Problems. The Smoke Problem, O. P. Hood. U. S. Bur. of Mines Reports of Investigations, serial no. 2323, Feb. 1922, 5 pp. Brief summary of problems. Smoke problem in England, and list of publications of Bur. of Mines dealing with problem.

SOOT BLOWERS

Steam Saving with. Steam Saving with Soot Blowers, Robert June. Textile World, vol. 41, no. 13, Apr. 1, 1922, pp. 75–76, 4 figs. Charts showing economy of improved equipment and extent of loss from excessive blowing.

SPECIFIC HEAT

Air, Steam and CO_2. The Specific Heats of Air, Steam and Carbon Dioxide, W. D. Womersley. Roy. Soc. Proc., vol. 100, no. A 706, Feb. 1, 1922, pp. 483–498, 10 figs. Describes experiments with improved Hopkinson calorimeter and gives results of hydrogen-air and carbon-monoxide experiments.

STACKS

Venturi. Venturi Stacks, A. W. H. Griepe. Combustion, vol. 6, no. 4, Apr. 1922, pp. 166–175, 18 figs. Describes Venturi-Evase-Prat-Stacks and their functioning, advantages and disadvantages, and compares different systems.

STANDARDIZATION

Norway. Standardization in Norway (Standardiseringsspörsmaalet i Norge). Teknisk Ukeblad, vol. 69, no. 8, Feb. 24, 1922, pp. 69–73. Report of committee to Norwegian Society of Industrials giving review of standardization work in countries abroad.

Progress. Progress in Engineering Standardization, C. W. Ham. Am. Mach., vol. 56, no. 13, Mar. 30, 1922, pp. 465–466. Advantages of simplified designs and adoption of uniform methods. Shop operation simplified, number of jigs reduced, stocking of parts in large quantities becomes possible. Work of American Engineering Standards Committee in establishing national and international standards.

Society Automotive Engrs. Work of. S.A.E.'s Recent Standardization Work. Automotive Industries, vol. 46, no. 14, Apr. 6, 1922, pp. 768–770, 2 figs. Revision in ball-bearing standards; Bessemer steel and wire spring stock; distributor, magneto and bumper mountings; motor-boat controls; passenger-car frames.

STEAM ENGINES

Back Pressure, Reducing. Using Exhaust Velocity To Reduce Back Pressure in Steam Engine. Power, vol. 55, no. 14, Apr. 4, 1922, p. 542, 3 figs. Prof. Stumpf and his associates, in designing a uniflow locomotive, have been able, by modification of exhaust ports and piping, to reduce back pressure on cylinder.

STEAM GENERATORS

Efficient. Modern Steam Generators for the Efficient Utilisation of Gaseous Fuels and the Efficient Recovery of Waste Heat, P. St. G. Kirke. West of Scotland Iron & Steel Inst. Jl., vol. 29, Part 3, Dec., Session 1921–1922, pp. 28–34 and (discussion) 34–36, 9 figs. on supp. plates. Discusses boiler development, including the Hopwood, Spencer-Hopwood, Bonecourt, Kirke and other types.

STEAM POWER PLANTS

Fuel Conservation. Fuel Conservation in Industrial Power Plants, David Moffat Myers. Gen. Elec. Rev., vol. 25, no. 2, Feb. 1922, pp. 95–98. Effecting economies in steam plants by proper equipment of recording instruments selected to suit local conditions.

Heat Balance and Steam Distribution. Heat Balance and Steam Distribution in a Large Service Plant, S. D. Kutner. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 488–491, 1 fig. Tells how steam, hot water and power are charged to different departments in large building supplied from an isolated power plant.

STEAM TURBINES

Modern Installation. A Modern Steam-Turbine Installation in Spitzbergen (Eine moderne Dampfturbinen-Anlage auf Spitzbergen), A. C. Gogstad. Schweizerische Bauzeitung, vol. 79, no. 12, Mar. 25, 1922, pp. 149–151, 4 figs. Describes central station and equipment delivered by Oerlikon Machine Works, Switzerland.

STEEL

Alloy. See ALLOY STEELS.

Chrome. See CHROME STEEL.

Stainless, Cutlery of. Making Stainless Steel Cutlery, R. G. Hall. Iron Trade Rev., vol. 70, no. 13, Mar. 30, 1922, pp. 896–897. Carbon content of 0.30 to 0.45 per cent and chromium 13 to 15 per cent is recommended. Roll scale must be eliminated and working tools kept sharp to prevent cause for oxidation. Stainless tests. See also (abstract) in Iron Age, vol. 109, no. 13, Mar. 30, 1922, pp. 855–856.

Structural. See STRUCTURAL STEEL.

STEEL CASTINGS

Economical Production. Steel Casting Plant Has Liaison Service, G. P. Blackiston. Iron Age, vol. 109, no. 14, Apr. 6, 1922, pp. 925–927, 5 figs. How Detroit Steel Casting Co. coöperates with its customers in designing parts for effective production and decrease of waste.

STEEL, HEAT TREATMENT OF

Structural Parts. Heat Treating Steel For Structural Parts, Horace C. Knerr. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 178–183, 10 figs. Means of estimating carbon content from microstructure after annealing; comparison of effects of heat treatment on various steels from mild to tool steel.

Principles. Theory of the Heat Treatment of Steel, Walter M. Mitchell. Forging & Heat Treating, vol. 8, nos. 1, 2 and 3, Jan., Feb. and Mar. 1922, pp. 52–56, 114–118 and 162–166, 20 figs. Jan.: Critical temperatures; constitution of slowly cooling steel. Feb.: Constituents of suddenly cooled steels; practice in heat treatment. Mar.: Discusses hardening and tempering and deduces schedule of heat treatment.

STEEL MANUFACTURE

Basset Process. Steel Direct from Ore by Basset Process, Fritz Wuest. Iron Age, vol. 109, no. 15, Apr. 13, 1922, pp. 989–991, 2 figs. Its chief features and advantages. Critical discussion of claims for French process by German engineer. Cost of plant. Translated from Stahl u. Eisen, Dec. 22, 1921.

High-Speed and Tungsten. Notes on the Manufacture of High-Speed and Tungsten Steels, J. W. Weitzenkorn. Chem. & Met. Eng., vol. 26, no. 11, Mar. 15, 1922, pp. 504–508, 14 figs. Steps taken in studying segregation in high-speed and tungsten steel. Structural disposition of carbides after various heat treatments, with or without previous mechanical work.

Losses, Reducing. Reducing Losses in Steelmaking, F. G. Cutler. Iron Trade Rev., vol. 70, no. 15, Apr. 13, 1922, pp. 1040–1042, 2 figs. Method of comparing total combustion efficiency of iron and steel plant from time to time is proposed. Economic use of blast-furnace and coke-oven gas. (Abstract.) Paper to be presented before Am.Soc.Mech.Engrs.

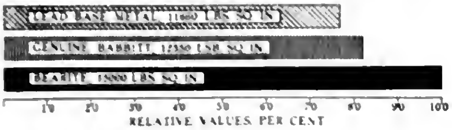
STEEL WORKS

Calcutta, India. New Plant of the Indian Iron and Steel Company, Limited. Iron & Coal Trades Rev., vol. 104, no. 2815, Feb. 10, 1922, p. 198, 3 figs. Describes design and equipment.

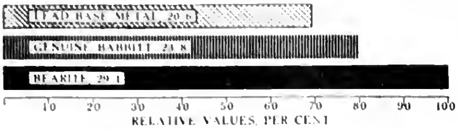
Electric Power in. The Application of Electric Power in the Iron and Steel Industry, W. S. Hall. Iron & Steel Elec. Engrs. Assn., vol. 4, no. 3, Mar. 1922, pp. 127–140 and (discussion) pp. 140–151. Brief analysis of sources of waste fuel in iron and steel manufacture; determining whether expenditure for recovering waste fuel is desirable. Problems of power generation and transmission.

Power-Plant Management. Steel Works Power Plant Management, Robert June. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 197–201, 3 figs. Fixed charges and maintenance; manner of figuring depreciation of power-house equipment.

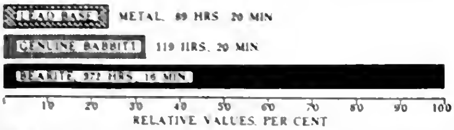
THE RELATIVE PHYSICAL PROPERTIES OF BEARITE, GENUINE BABBITT AND TYPICAL LEAD BASE METAL



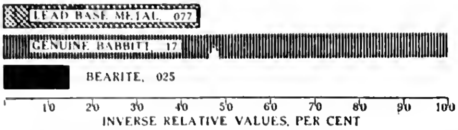
COMPRESSIVE STRENGTH: showing pressure required to reduce the test pieces 1 per cent of their original height.



BRINELL HARDNESS: indicating, not only the hardness, but the relative tenacity of the metals.



RELATIVE LIFE: the average time required to remove 1 gram of metal, with water lubrication, under varying loads and speeds.



COEFFICIENT OF FRICTION: showing the average coefficient, with water lubrication, under varying loads and speeds.

A Chart that Made History

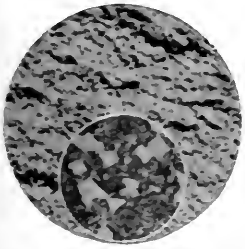
The engineer who fails to keep abreast of modern bearing practice is neglecting a factor vital to the efficient operation of his machinery.

Since 1839, the year in which Isaac Babbitt patented his famous formula, tin, copper, antimony and lead have been the foundation of all standard bearing metals. The one outstanding development since that time is the process of alloying these elements invented by the late A. W. Cadman. Did you know this?

The chart above shows the remarkable improvement in all the physical properties of babbitt made possible by this process with negligible increase in first cost.

Cadman metals, ACORN, tin-base, and BEARITE, lead-base, are guaranteed to double the life of a bearing. They cannot cut or score the shaft. They are literally the accepted standards of the world.

Engineering Bulletin M-1 is the Bearing Metal Handbook for 1922.



TYPICAL LEAD BASE METAL

Larger photo actual size, note the coarse structure. Insert is same metal magnified 100 diameters. Note the crystals which cause wear and indicate structural weakness. The analysis of this metal is identical with that of BEARITE.

CADMAN BEARITE

Note the fine, close grain in the full size photo and the elimination of the crystals in the microphoto. The unique life of BEARITE is due to the perfect alloying thus indicated.

(Clip the coupon or simply enclose your card in an envelope)

A.W. Cadman Manufacturing Co. Pittsburgh Pa.

Master Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletin M-1, samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:.. Position:........................

Company Name:...

Address:...

STOKERS

Underfeed. A New Type of Underfeed Stoker. Steam, vol. 29, no. 3, Mar. 1922, pp. 75–77, 7 figs. Describes stoker built by Detroit Stoker Co., Detroit, Mich., made in two designs, one a single retort, side cleaning stoker, for boilers up to three or four hundred horsepower, and the other a multiple retort end cleaning type for large installations.

STREET RAILWAYS

Car Truck. The Brill 79-E Single Truck. Tramway & Ry. World, vol. 51, no. 13, Mar. 16, 1922, pp. 126–127, 2 figs. Has wheels of 24 to 26 in. in diameter in place of 30 to 33 in., as in 21-E single truck.

Cars, Safety. Recent Developments in Car Design, H. H. Adams. Elec. Ry. Jl., vol. 59, no. 12, Mar. 25, 1922, pp. 520–522, 7 figs. Describes automatic treadle-operated exit door of new double-door Chicago safety car. (Abstract.) Paper read before Ill. Elec. Rys. Assn.

Shallow-Conduit Construction. Installing Shallow-Conduit Construction in Washington, D. E. Dunn. Elec. Ry. Jl., vol. 59, no. 11, Mar. 18, 1922, pp. 449–452, 14 figs. Describes replacing old type of deep tube cable construction with new shallow tubes by Capital Traction Co.

Toronto. Toronto Takes Over Street Railways. Elec. Ry. Jl., vol. 59, no. 12, Mar. 25, 1922, pp. 505–511, 12 figs. Principal features of franchise; statistics of Toronto traffic; municipal operating organization; financial arrangement, etc.

STRUCTURAL STEEL

Compression Members. The Measurement of Compression Members (Ueber die Bemessung von Druckstäben), H. Bohny. Bauingenieur, vol. 3, no. 5, Mar. 15, 1922, pp. 135–141, 10 figs. Discusses results of tests carried out in Material-Testing Bureau, Berlin-Lichterfelde (see same jl., no. 1, 1922, p. 8 and Zentralblatt der Bauverwaltung, no. 5, 1922, p. 26), and compares them with other experimental results.

SUGAR

Hawaiian Islands. Experimental Work in the Hawaiian Islands. Int. Sugar Jl., vol. 24, no. 278, Feb. 1922, pp. 66–69. Annual Report of Experiment Station on superintensive cultivation, improvement of cane by bud-selection, soil investigations, and forestry work.

Manufacturing Machinery, Hawaii. Progress in Hawaii in the Design of Sugar Manufacturing Machinery. Int. Sugar Jl., vol. 24, no. 278, Feb. 1922, pp. 81–85, 7 figs. Summary of report of Committee on Manufacturing Machinery, appointed by Hawaiian Sugar Planters' Assn. Juice heaters; Kopke clarifier; Daniels' centrifugal discharge; revolving cane cutting knives.

SUPERPOWER PLANT

Advantages and Prospects. The Superpower System, Henry Flood, Jr. Steam, vol. 29, no. 2, Feb. 1922, pp. 37–40. Summarizes advantages of superpower and immediate outlook for its realization.

SWAGING

Hot. Hot Swaging. Machy. (Lond.), vol. 19, no. 494, Mar. 16, 1922, pp. 717–722, 10 figs. Discusses difference in operation of cold and hot swaging, arrangements for heating work, work-holding devices, and gives examples.

T

TERMINALS, RAILWAY

Passenger. On the Question of Terminal Stations for Passengers (all countries, except those using English language), Louis Maccallini. Int. Ry. Assn. Bul., vol. 4, no. 3, Mar. 1922, pp. 553–573, 7 figs. Report on arrangements for reducing number of movements of locomotives and empty rolling stock at passenger terminal stations.

TESTING MACHINES

Bearings. Testing Machine to Show Relative Merits of Bearings, R. W. Sellow. Belting, vol. 20, no. 3, Mar. 1922, pp. 51–53, 4 figs. Describes machine which shows relative difference in power consumption of various types of bearings; by its method of driving bearing shafts and of applying load to bearings it is adaptable to any reasonable conditions of test.

Hardness. A New Impact Hardness Testing Machine (Schlaghärteprufer nach Prof. Rich. Baumann, Stuttgart). Allgemeine Automobil-Zeitung, vol. 22, no. 43, Oct. 22, 1921, pp. 31–32, 5 figs. Describes new apparatus designed by Richard Baumann, head of material-testing bureau of Technical Academy, Stuttgart. Its cost is said to be about one-fifth that of Brinell testing machine, it is light in weight and easily handled.

TEXTILE INDUSTRY

Cotton Printing. Colors and Process of Printing Cloth (Matières colorantes et procédés d'impression dans l'Industrie des toiles imprimées), Georges Lanorville. Nature, no 2497, Feb. 11, 1922, pp. 81–84, 3 figs. Colors used for cotton prints and processes of impressing and fixing them on fibre.

TEXTILE MACHINERY

Embroidering Machines. Automatic Embroidering Machines, Oskar Spohr. Eng. Progress, vol. 3, no. 3, Mar. 1922, pp. 55–59, 16 figs. Automatic machines controlling mechanical motion of needle and shifting frame for material in accordance with predetermined pattern. Pattern card and Jacquard arrangement.

[See also COTTON GINS.]

TEXTILE MILLS

See COTTON MILLS.

THERMOCOUPLES

Platinum : Platinum-Rhodium. Life Tests of Platinum : Platinum-Rhodium Thermocouples, C. O. Fairchild and H. M. Schmitt. Metal Industry (Lond.), vol. 20, no. 11, Mar. 17, 1922, pp. 245–246. Discusses deterioration at high temperatures, requiring frequent replacement or recalibration. Published by permission of Bur. of Standards.

TIME STUDY

Motion Study and. Time and Motion Study, Eric Farmer. Eng. & Indus. Management, vol. 7, no. 9, Mar. 9, 1922, pp. 247–250 and 251, 4 figs. Examples of motion study. Experiment in sweet dipping.

TOOLS

Machinists', Manufacture of. Machinists' Tools and Their Manufacture. Engineering, vol. 113, no. 2932, Mar. 10, 1922, pp. 290–292, 7 figs. Particulars of tools and manufacturing methods adopted for their production in works of C. A. Vandervell & Co., Ltd., London. Deals with production of calipers and dividers, vee blocks and clamps, scribing blocks, etc.

TRACTORS

Chain-Track. The New Transport. Motor Transport, vol. 34, no. 890, Mar. 29, 1922, pp. 341–345, 12 figs. Describes chain-track tractors which embodies principles introduced into 25-mile-an-hour tanks that appeared after war.

Farm. The Hermite Single-Wheel Tractor (Tracteur Monoroue, Système L'Hermite), E. Weiss. Génie Civil, vol. 80, no. 6, Feb. 11, 1922, pp. 133–134, 4 figs. Describes agricultural tractor whose single driving wheel can be turned in its place and whose engine has no valves.

Standards in Manufacture. The Value of Standards in Tractor Manufacture, P. M. Heldt. Soc. Automotive Engrs. Jl., vol. 10, no. 4, Apr. 1922, pp. 270–272. Outlines history of systematic introduction of standards in mechanical manufacture. Discusses steel and other standards, such as tractor hitches, belt speeds, connections between parts or machines made in different plants, screw sizes, lug attachment, etc.

Two-Wheeled, Stability of. Stability of Two-Wheeled Tractors, P. M. Heldt. Automotive Industries, vol. 46, no. 11, Mar. 16, 1922, pp. 614–616, 4 figs. Principles and calculation of torque, pressure, drawbar-pull, etc.

TUBES

Billet-Piercing Machine for Making. An Improved Billet Piercing Machine for Solid Drawn Tube Making. Metal Industry (Lond.), vol. 20, no. 11, Mar. 17, 1922, p. 255, 1 fig. Describes machine made by Fisher, Humphries & Co., for piercing copper billets as well as steel billets.

Seamless. The Manufacture of Seamless Tubing, Philip Davidson. Raw Material, vol. 5, no. 2, Mar. 1922, pp. 46–52, 27 figs. Describes operations at Scoville Mfg. Co.'s works, Waterbury, Conn.

TUBING

Seamless Steel. Experiments With Weldless Steel Tubing As Used in Construction, W. W. Hackett. Practical Engr., vol. 65, nos. 1820 and 1821, Jan. 12 and 19, 1922, pp. 21–22 and 43–44, 4 figs. Short review of seamless tubes; describes tests made on front forks, plain tubes held in a loose socket, and on tubes brazed 1 in. into thick lugs results of alternating stress tests, showing effects of cut, with sharp corners, in high and medium-carbon steels. (Abstract.) Paper read before Instn. Automobile Engrs.

V

VALVES

Automatic Control. Automatic Control Valve for Hydraulic Presses. Engineer, vol. 133, no. 3455, Mar. 17, 1922, p. 308, 10 figs. Describes Barton-Carr patented control valve which is entirely automatic in its action from first operation onward until point of maximum high pressure is reached.

Manganese Bronze for Stems. Manganese Bronze for Valve Stems, William R. Conard. N. E. Water Works Assn. Jl., vol. 36, no. 1, Mar. 1922, pp. 32–36 and (discussion) pp. 37–39. Deals with valves as used for water-works purposes.

VENTILATION

Electric. Electric Ventilating, Wm. T. Reace and Geo. C. Breidert. Elec. Jl., vol. 19, no. 3, Mar. 1922, pp. 119–123, 8 figs. Use in the home, retail stores, industrial plants, restaurants, and for farmers. Right and wrong way to install ventilating fans. Unit heaters.

Temperature, Humidity and Air-Motion Effects. Temperature, Humidity and Air Motion Effects in Ventilation, O. W. Armspach and Margaret Ingels. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 2, Mar. 1922, pp. 173–190, 17 figs. Consideration of fundamental laws underlying loss of heat from human body and resulting feelings of comfort or discomfort in air under various conditions of temperature, humidity and rate of air movement.

VOCATIONAL TRAINING

Blind. Blind Efficiently Operate Machine Tools, Hubert Hermanns. Iron Age, vol. 109, no. 11, Mar. 16, 1922, p. 733, 5 figs. Siemens-Schuckert Works in Berlin conduct series of experiments to determine proper training methods.

W

WAGES

Incentive System. Incentives and Rate-Setting Applied to the Smaller Plant and Varied Product, E. Wadsworth Stone. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 205–208. Points out that incentives of fixed or predetermined nature will of themselves fail of their full power to obtain desired results if they do not parallel and include good will and hearty coöperation of workmen and management.

Outlines Incentive Wage System, William P. Butler. Abrasive Industry, vol. 3, no. 2, Feb. 1922, pp. 39–41, 2 figs. Discusses essential conditions to make incentive system successful.

Piecework Payment. Interpreting Average Hourly Earnings on Semiautomatic Operations, Paul Faltin and Leon Blog. Management Eng., vol. 2, no. 4. Apr. 1922, pp. 215–219, 1 fig. Method outlined applies to piecework system of wage payment.

WASTE ELIMINATION

Economic Fundamentals. Elimination of Waste and Improvement of Efficiency. What are the Economic Fundamentals? W. R. Ingalls. Min. & Metallurgy, no. 183, Mar. 1922, pp. 33–37. Writer points out that miscalculations in industry will decrease along with increase in transparency in industry, meaning acquisition of knowledge about it and thereby ability to see through it and ahead.

Factories. Searching Out the Invisible Wastes, C. J. Morrison. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 196–197. Calls attention to persistent and prevalent sources of loss found in every factory, which can generally be eliminated.

WATER POWER

Mechanical Storage. The Mechanical Storage of Water Power. Elec. Rev. (Lond.), vol. 90, no. 2311, Mar. 10, 1922, pp. 327–330, 9 figs. Describes Walkeburn hydroelectric scheme. Low-pressure turbines consist of two large double-runner, horizontal Francis turbines, 110 hp. each, running at speed of 200 r.p.m.; the Pelton wheel runs at 1,000 r.p.m. and is coupled direct to 155-kw. generator; arrangement of generator pumps and gearing.

Mechanical Storage of Water Power as a Factor in Textile Production. Electrician, vol. 88, no. 2284, Feb. 24, 1922, pp. 229–233, 6 figs. Describes hydroelectric installation at Henry Ballantyne & Sons' Tweedvale and Tweedholm mills, special feature of which is method adopted for water storage during non-working hours.

Resources, Canada. Water Power Resources of Canada, J. T. Johnston. Can. Engr., vol. 42, no. 13, Mar. 28, 1922, pp. 343–346. Review of hydroelectric development; power utilized in central station and pulp and paper industries. Many water powers not yet developed.

United States. Developed and Potential Water Powers of the United States. Elec. World, vol. 79, no. 11, Mar. 18, 1922, pp. 531–532, 1 fig. Government compilation indicates that capacity of waterwheels installed in plants of 100 hp. or more is 7,852,948 hp. Almost 80 per cent in public-utility generating plants.

WEIGHING

Substitution. Weighing by Substitution, C. A. Briggs and E. D. Gordon. U. S. Bur. of Standards Technologic Papers, no. 208, Feb. 21, 1922, pp. 177–192, 3 figs. Describes plan for making substitution weighings, applicable either to equal-arm balances or compound-lever scales, that has been developed in connection with standardization of large weights of Bureau of Standards. Record form and computation sheet is presented.

WELDING

Boiler. Boiler Welding, Edward H. Heidel. Acetylene Jl., vol. 23, no. 9, Mar. 1922, pp. 431–435 and 470, 15 figs. Gives restrictions placed on locomtives boiler welding known as A.R.A. restrictions. Directions for autogenous, electric and gas welding of boiler parts.

Hyde Process. Hyde Welding Process, D. Richardson. Welding Engr., vol. 7, no. 3, Mar. 1922, pp. 32–34. Describes method of uniting iron and steel which partakes of nature of both welding and brazing, consisting of uniting surfaces by means of molten copper, the copper impregnating mass of metal to be joined.

Job. Some Problems of the Job Welding Shop, S. W. Miller. Am. Welding Soc. Jl., vol. 1, no. 2, Feb. 1922, pp. 42–46. Difficulties in repair work in welding shop are said to be in work itself; in varied natures of metals that are of same general type; financial problems; and guarantees on work.

Locomotive Fireboxes. Welding Firebox Seams. Ry. Rev., vol. 70, no. 12, Mar. 25, 1922, pp. 429–430. Editorial endorsing objections of Bur. of Locomotive Inspection to autogenous welding of firebox seams.

[See also BOILERS, Welding; CAST IRON, Welding; ELECTRIC WELDING; ELECTRIC WELDING, ARC; LOCOMOTIVE BOILERS, Welding; OXY-ACETYLENE WELDING; RAILWAY SHOPS, Welding Practice.]

WIND TUNNELS

Massachusetts Institute of Technology. The Aerodynamical Laboratory of the M.I.T., Edward P. Warner. Aviation, vol. 12, no. 11, Mar. 13, 1922, pp. 308–310, 3 figs. Recent additions of two new wind tunnels greatly increase operating capacity of America's oldest research establishment. Constructional details.

MECHANICAL ENGINEERING

Volume 44 July, 1922 Number 7

Some Notes on Railway Refrigerator Cars

A Collection of Facts Relating to Principles of Railway Refrigerator-Car Operation and Information About Various Types of Cars and Methods of Design and Construction

By W. H. WINTERROWD,[1] MONTREAL, QUEBEC, CANADA

An efficient and economical railway refrigerator car is one which provides adequate air circulation, adequate protection to the lading, adequate quantity and degree of refrigeration, quick initial cooling, uniform temperature, dry air, space to permit proper methods of loading, and good car construction to minimize maintenance and increase time in service.

The literature of this subject being to some extent scattered, this paper is an attempt to include under one heading some of the most interesting and important facts regarding principles and methods involved in railway refrigerator-car operation, as well as to present some information regarding the types of cars and methods of construction used by various railways and private-car owners.

The data were collected directly from the railways and private-car owners in an endeavor to sense the general trend of design and construction, and as there are signs on the horizon which indicate a renewed activity in the construction of railway equipment, this information is presented in the hope that it will serve to reëmphasize the great importance to the railways of efficient and well-maintained cars of the refrigerator type.

THE importance of efficient and well-maintained railway refrigerator cars to the people and railways of North America cannot be overemphasized. The *Railway Equipment Register* for March, 1922, shows that the railways and private-car owners own approximately 153,000 cars of this type; figures from the same source indicate that this is about 6 per cent of all the cars owned, and approximately 13 per cent of all the box- or house-type cars listed.

Refrigerator cars are important in the life of the people because they are used principally to carry the bulk of the nation's perishable food-stuffs. They are important to the railways because they are factors in the production of revenue. When hauls were short and the variety of perishable commodities few, the problem of transporting and protecting the commodities from heat or cold was comparatively simple. Increasing distances and a greater variety of perishables not only made necessary greater numbers of, and more efficient, cars, but involved the establishment of railway divisional and terminal facilities, upon which the successful operation of this type of equipment is contingent.

In this paper the author has attempted to include under one heading some of the most interesting and important facts regarding principles and methods involved as well as to present some information regarding the type of cars and methods of construction used by various railways and private-car owners. The data were collected directly from the railways and private-car owners in an endeavor to sense the general trend of design and construction, and as there are signs on the horizon which indicate a renewed activity in the construction of railway equipment, this information is presented in the hope that it will serve to reemphasize the great importance to the railways of efficient and well-maintained cars of the refrigerator type.

The information which follows deals entirely with cars in which refrigeration is obtained by means of ice and salt. Many interesting efforts have been made to evolve a mechanical means of refrigeration, but the problem has been difficult of satisfactory and economical solution.

Refrigeration of Commodities in Transit Involves Many Factors

The prevailing method of obtaining refrigeration is by means of naturally circulated air cooled by contact with ice, or ice and salt, placed in suitable receptacles called bunkers located at each end of an insulated car. Some modifications of this system will be touched upon very briefly later.

Circulation is assisted and made most efficient by means of insulated partitions, called bulkheads, placed in front of the containers and so constructed that the relatively warm air must pass over the top of them to reach the ice, or ice containers. The air becoming chilled, and therefore heavier, sinks toward the floor and reaches the body of the car by passing through a space beneath the bulkheads.

These insulated partitions also assist in protecting the lading nearest the ice containers. Without bulkheads, and when salt is used with the ice to hasten and increase refrigeration, that part of the lading nearest the ice frequently freezes, an undesirable and disastrous occurrence with some commodities. At the same time that portion of the load near the center and top of the car may remain at too high a temperature, an equally undesirable condition.

As a further aid to circulation, particularly in cars where the lading is piled or stacked, a slatted wooden structure known as a floor rack is of very great value. These racks, on the top of which the lading may be placed, consist of longitudinal runners 3 or 4 in. high, with cross-slats fastened to the top of them. They are hinged to the side walls of the car and are divided in the middle so that they can be turned up to make the floor accessible. These racks permit the cold air which flows beneath the bulkhead to circulate freely toward the center of the car and up through the lading.

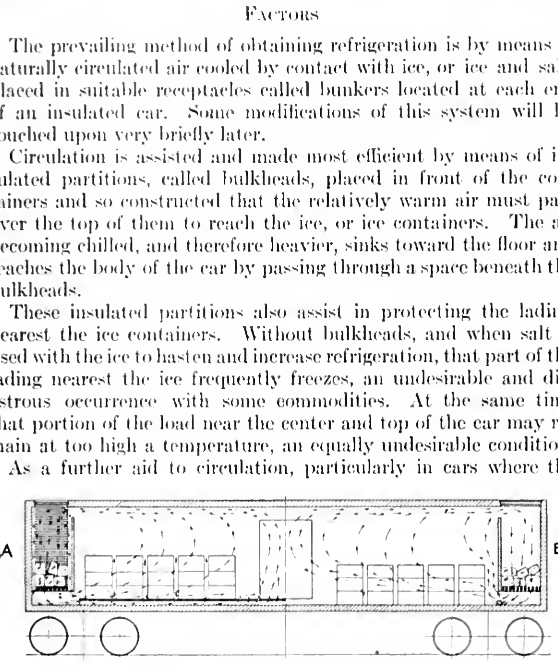


Fig. 1 Diagram of Air Circulation

Illustrations of Effect of Design

The "A" end of the car, Fig. 1, shows the relative arrangement of bunkers, bulkheads, and floor racks, and the resultant trend of air circulation.

It is highly desirable that there be no obstruction to the flow of cold air where it passes beneath the bulkheads. The "B" end of the car, Fig. 1, shows how an obstruction at that point can act as a dam or deflector of the air currents, and partly or entirely defeat the object of the floor racks, and even cause frosting of the lading against the insulated bulkhead. If floor, bunker, or splashboard construction necessitates a ledge beneath the bulkhead, it should be kept as low as possible and the floor rack and bulkhead so designed to provide sufficient area for a free flow of air. At the "B" end the lading is shown piled directly on the floor and the air currents directly indicate the advantage of floor racks.

---

[1] Chief Mech. Engr., Canadian Pacific Railway Co. Mem. Am.Soc.M.E.

Abridgment of a paper presented at a joint meeting of the Metropolitan Section and the Railroad Division of the A.S.M.E., and the A.S.R.E., New York, May 16, 1922. All papers are subject to revision.

To obtain the greatest advantage from circulation, the contents of the car should be loaded so that the air can come in contact with a maximum surface with a minimum of restricted circulation. It is easy to understand that boxes or containers placed closely against each other and against the walls of the car cannot be cooled quickly or properly preserved at as uniform a temperature as when placed so that air can flow between them, or generally speaking, throughout the entire load.

The temperature of the circulating air is affected by the type and size of ice containers or bunkers. The chief considerations in the construction and capacity of the bunkers are the refrigeration required to replace the loss due to transmission and the refrigeration required to cool the car quickly and maintain its contents at the required temperature. The loss in transmission in turn depends upon insulation, car construction and maintenance; factors which will be more fully discussed later.

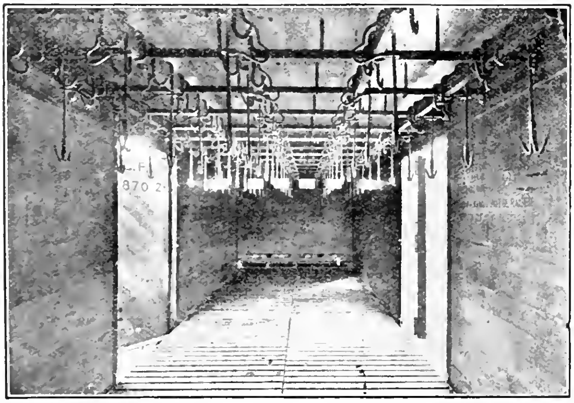


Fig. 2 Meat Rack and Hook Installation

A basket bunker is shown in the "A" end of the car in Fig. 1, and a box bunker in the "B" end.

The sides of the basket bunker are constructed of wire mesh. The bottom consists of a slatted wooden structure. The bunker is placed in position so that air space exists around the outer surfaces, this construction permitting the air behind the bulkhead to come in contact with a maximum ice area, while the open spaces around the bunkers facilitate circulation.

The bottom of the box bunker shown at the "B" end of the car in Fig. 1 is also slatted. The walls are formed by the bulkhead and by the sides and end of the car. In an endeavor to make the refrigerator car more productive and useful for general purposes, some builders have applied collapsible box bunkers. In this design the bulkhead is swung up, or to one side, and fastened. The slatted rack is swung or folded back against the end of the car. In this way the space occupied by the bunker is made available for general lading.

Another very important factor is the size of the car and its proportions, particularly with reference to the distance between the bulkheads. If this distance is too great, the air may not be at a low enough temperature when it reaches the center of the car to properly refrigerate the load at that point, particularly near the top of the car. Under such conditions a portion of the load near the bulkheads may be sufficiently chilled while the upper and center part of the load may be too warm.

Importance of Temperature of Entering Load

If heat is not removed from certain commodities prior to loading it is highly desirable to remove it as quickly as possible after loading. Tests and general experience show that if the heat is not promptly reduced, the commodities either spoil en route or reach their destination in such condition that their market value is greatly reduced. Quick cooling after loading is generally attempted by precooling the car, by the use of cars in which maximum and most efficient air circulation can be obtained, and by mixing a proper amount of salt with the ice or by placing coarse rock salt on top of the ice.

Precooling the car may be accomplished by the use of ice and salt, but at many points where a large tonnage of fruit or meat originates, the cars as well as the lading are often precooled by mechanical means.

Precooling means less ice in transit, a matter of economy to shippers and railways alike. Some commodities can be frozen hard and therefore require little or no icing en route, the lading itself supplying the necessary refrigeration. This not only insures better condition in transit but is an added economy.

Humidity or moisture content of the air in the car is almost as important as temperature. Generally speaking, if refrigeration is effective and a high initial rate of cooling obtains, the air is kept sufficiently dry due to condensation taking place on the surface of the ice, or ice containers. In this way the moisture given off by some classes of lading is also deposited. Excess of humidity, if not fatal, is highly injurious to many commodities.

Insulation the Most Important Consideration

Finally we come to the matter of insulation, the most important factor in connection with efficient and economical refrigeration in a railway car. The function of the insulation is to afford protection to the lading by minimizing heat transmission through the walls, roof, and floor of the car. To do its work properly it must be by nature a poor conductor of heat. Other desirable qualifications are reasonable cost, strength, adaptability, durability, light weight, and imperviousness to moisture.

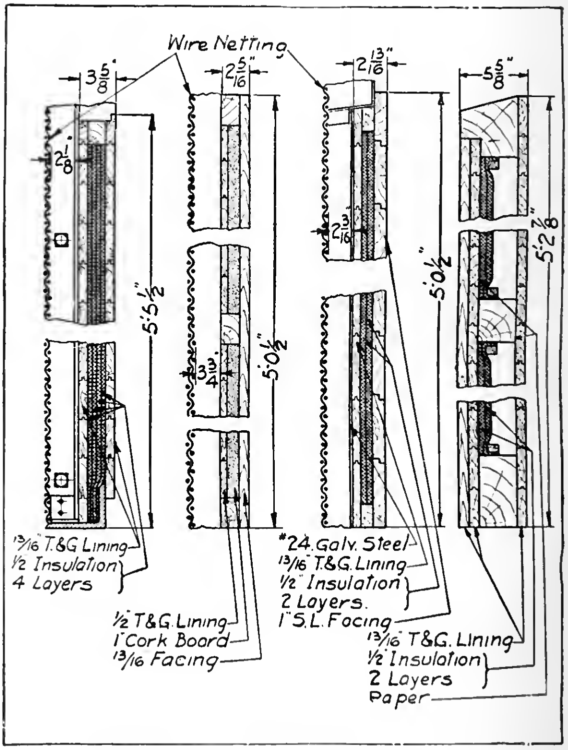


Fig. 3 Cross-Sections of Bulkheads

This subject might well be divided into two parts, insulating materials and insulation, because the general subject involves methods of car construction and maintenance in addition to the consideration of materials and principles of heat transmission.

The whole subject is capable of analysis, but that the principles involved are not broadly known is indicated by the fact that in very recent years cars have been built without proper or sufficient insulation. These cars, which do not properly protect their lading, are huge consumers of ice and expensive to operate and require a great deal of maintenance to keep them in service.

It is evident from the foregoing that an efficient and economical

railway refrigerator car is one which provides adequate air circulation, adequate protection to the lading, adequate quantity and degree of refrigeration, quick initial cooling, uniform temperatures, dry air, space to permit proper methods of loading, and good car construction to minimize maintenance and increase time in service.

SOME NOTES ON EXISTING CARS

In an endeavor to sense the trend of refrigerator-car design, proportions, and construction, the author addressed an inquiry to a number of railways and private-car owners. The replies, while not complete, were very generous. A comparison of the most interesting returns is shown in Table 1, and makes a very interesting study, although in any consideration of this table the fact must not be overlooked that possibly some of the railroads or owners, if building equipment today, might modify their designs.

Every road or owner represented owns at least one thousand cars. As far as possible the cars shown were chosen from quantities built in comparatively recent years.

Types of Cars and Ice Containers

Generally speaking, the cars can be divided into two types: one equipped with brine tanks and generally used for carrying meats; the other, equipped with bunkers and used principally for carrying commodities such as eggs, butter, vegetables and fruit.

In connection with this distinction, based on ice containers, it is interesting to note that Dr. Pennington has stated that a car of the basket-bunker type, such as the U. S. Railway Administration Standard, will carry meat hung from rails quite as successfully as a car built especially for meat. The statement is also made that there is not visible in practical results the advantages supposed to accrue from the retention of the brine, provided coarse rock salt is place on top of the ice in the bunker and so forced to bore its way through the whole mass before finding an exit.

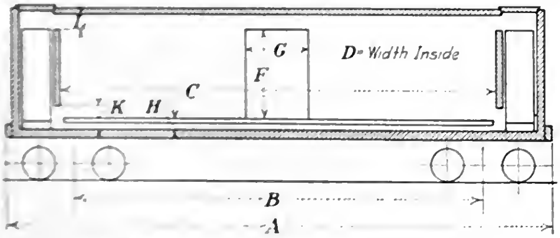
But there is a very important problem in this connection that must not be overlooked if salt is to be used with ice in a basket bunker, and that is the method of disposing of the brine. It is common knowledge that if brine falls on journal boxes, side frames, arch bars or other truck parts, as well as upon rails, tie plates, bridge members, etc., the resulting damage is great and a factor involving heavy maintenance cost.

The subject is so important that the American Railway Association interchange rules specify that after July 1, 1922, no car carrying products which require for their refrigeration the use of ice and salt and which are equipped with brine tanks, will be accepted in interchange unless provided with a suitable device for retaining the brine between the icing stations.

Twenty-seven railroads and owners are represented in Table 1. Out of this number the principal cars of sixteen are equipped with bunkers and the remainder with brine tanks. Out of the sixteen, eleven or practically 69 per cent are of the basket type; the remaining five, or approximately 31 per cent, are of the box type. The majority of the cars recently built, or now under construction are equipped with the basket type of bunker. The demand for refrigeration and the special-service car, as well as greater efficiency of the permanent basket type, appear to be decreasing the demand for the collapsible bunker.

Another distinction that prevails and will prevail as long as cars are built for some particular service is the difference in construction due to the commodity to be transported.

In meat cars the lading is hung on hooks suspended from a meat rack placed just below the ceiling. This rack generally consists of stringers and cross-bars supported by the roof and walls of the car. In a car of this type it is necessary to make the framing heavier so that in addition to its other functions it will adequately support the weight of the lading. A meat rack and hook installation is illustrated in Fig. 2. Very often additional lading is stowed or placed on the floor racks beneath the suspended load, in order to obtain the full carrying capacity of the car.



Sketch Showing Dimensions Referred to in Table 1

Bulkheads.—The majority of the cars tabulated are equipped with solid bulkheads. These are either built into place or are hinged from the walls or ceiling so that they can be swung open. A few cars, however, are equipped with the syphon system, in which the bulkhead consists of a framework holding a series of galvanized iron louvres supposed to direct the air back and down into the bunkers.

The general trend seems to be to use two layers of $^1/_2$-in. hair felt between two walls of $^{1}/_{16}$-in. matched-and-dressed wood lining. An interesting exception, and on a quite recent car, is the use of one layer of 1-in. cork insulation. Some bulkheads are constructed of two walls with a few layers of waterproof paper between them. Occasionally an air space is contained between the walls. In one instance, in addition to a dead-air space, two layers of $^1/_2$-in. hair felt are provided. Some cross-sections of bulkheads are shown in Fig. 3.

Space Below Bulkheads. The space between the bottom of the bulkhead and the car floor varies considerably, ranging from 7 in. to 2 ft. 7 in. On the car with the 7-in. space the bulkhead is brought right down to the level of the floor rack. On the bottom of this bulkhead a canvas strip is fastened to prevent cold air passing out above the racks. The cars with the very large openings at both bottom and top of bulkheads are generally used for meat shipments.

The majority of cars have a bottom opening of from 9 to $15^3/_4$ in. The average is about 12 in.

As the floor racks on these cars average about $4^1/_2$ to 5 in. in height, it can be seen that the cold air has access to the body of the car above the rack as well as through the space beneath it.

The author has endeavored to ascertain if there is any relation between the size of the openings above and below the bulkhead and the velocity of the air in circulation, but inquiry has not produced anything definite. There is some unanimity of opinion, however, in favor of the design in which there is an opening of from 2 to 7 in. above the floor racks.

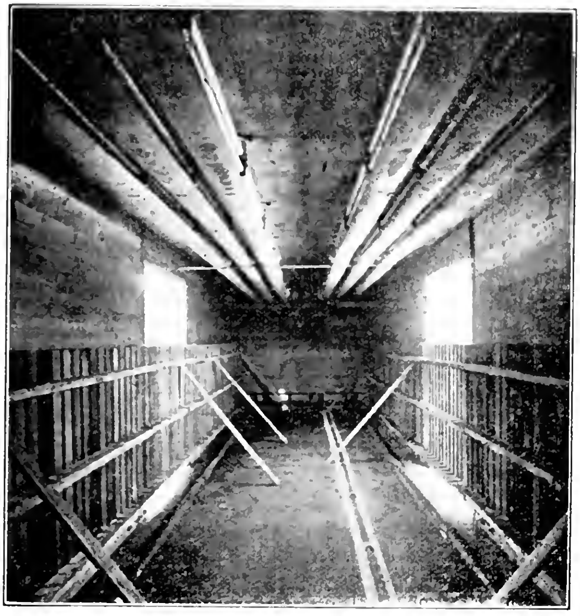


Fig. 4 Interior of Car with Overhead Brine Tanks; Showing also Heater Pipes on Floor

In the matter of efficient refrigeration the distance between bulkheads is an important one. The tabulation shows that this varies between 28 ft. 8 in. and 38 ft. 10 in. The general trend is between 32 and 34 ft. On the latest cars the spacing is approximately 33 ft., or slightly greater. The size of the standard egg crate has been a large factor in the establishment of the exact dimension.

Car Construction and Maintenance

An impression seems to prevail that the life of a railway refrigerator car is about six to eight years. In 1919 a committee of the Mechanical Section of the American Railway Association reported that the average life of railroad-owned wooden refrigerator cars, dismantled was 17.1 years, and of private-line wooden refrigerator cars, dismantled, 21.9 years, making the average life for all wooden refrigerator cars, dismantled, 19.4 years.

The life of refrigerator cars equipped with steel under-frames or steel framing and superstructure is a matter upon which there are few data, because such cars are comparatively modern. There seem to be no reasons, however, barring those of possible evolution, why such cars should not have a long life and require little for maintenance by reason of their better design and construction.

It is not difficult to appreciate the causes responsible for the high cost of maintenance of old wooden cars; the refrigerator type does not stand alone in this class. But in addition to more severe traffic conditions, this type of car had required attention on account of the difficulty in keeping moisture away from the insulation as well as from the wooden framing and flooring. If the insulation becomes broken, wet or sags so that air can circulate around it, the car rapidly loses its efficiency. Table 1 and the cross-sections in Figs. 5 to 13 inclusive, give a general idea of some types of cars, and what has been done to improve design and construction. Figs. 12 and 13 represent cars of relatively low efficiency. Figs. 5 to 11, inclusive, show more modern cars and indicate the more recent trend in the matter of improved insulation and general construction.

Table I Refrigerator Cars

(See sketch on page 421 for key to dimensions)

Service	Road or Owner	A	B	C	D	E	F	G	H	K	L	Type of Bulkhead	Tank or Bunker	Floors					Sides					Roof						Type of Underframe
														Layers					Layers						Layers					
		Over Striking Castings, ft-in.	Truck Centers, ft-in.	Between Bulkheads, ft-in.	Width Inside, ft-in.	Height Clear, ft-in.	Door Height, ft-in.	Door Width, ft-in.	Height of Floor Rack	Height Opening Below Bulkhead	Height Opening Above Bulkhead			Wood	Waterproof Paper or Fabric	Air Space	Insul. Mat'l.	Kind of Insulating Material	Wood	Waterproof Paper or Fabric	Air Space	Insul. Mat'l.	Kind of Insulating Material	Type of Outside Roof	Wood	Waterproof Paper or Fabric	Air Space	Insul. Mat'l	Kind of Insulating Material	
Freight	1	42-5¼	31-2	31-4¾	8-7¾	6-8 Meat Rack 7-3½ Ceiling	6-9⅝	5-0	5½″	7″	16½″	Solid, Swinging to Side	Brine Tank	4	2 Paper	2	4	1″ Keystone Hairfelt	3	......	2	3	½″ Keystone Hairfelt	Outside Metal	5	1 Paper	1	6	½″ Keystone Hairfelt	Steel
	2	41-8½	30-8	33-2¾	8-2¾	7-0$\frac{1}{16}$	6-8⅛	4-0	4⅞″	12″	11″	Solid, Rigid	Basket Bunker	2	1 Paper	..	1	2″ Cork	3	2 Paper	3	3	½″ Keystone Hairfelt	Outside Metal	3	1 Paper	2	4	½″ Keystone Hairfelt	Steel
	3	42-1½	31-1½	33-2¾	8-2¾	7-0$\frac{7}{16}$	6-8¼	4-0	4¾″	12″	12″	Solid, Rigid	Basket Bunker	2	......	..	1	2″ Cork	3	3 Fabric	1	2	1″ Insulation	Outside Metal	3	2	2	3	....	Steel
	4	40-8½	29-10½	32-2¾	8-0½	7-2	6-4¼	4-0	⅞″ Slat	...	3½″	Swinging to Roof	Bunker (Collap.)	3	1 Paper	1	4	½″ Insulite	3	4 Paper	3	4	½″ Flaxlinum	Wood	5	5 Paper	3	4	½″ Flaxlinum	Steel
	5	34-0 Endsills	24-0	28-8	8-1	7-4½	6-0	4-0	...	2′-7″	17″	Solid, Swinging to sides	Brine Tank	5	8 Paper	3	1	1″ Hairfelt	4	6 Paper	2	1	1″ Hairfelt	Wood	5	5 Paper	4	2	1″ Hairfelt	Steel
	6	42-1½	31-1½	33-2¾	8-2¾	7-0$\frac{7}{16}$	6-8¼	4-0	4¾″	2′-7″ 12″	14″	Solid, Rigid	Basket Bunker	2	......	..	1	2″ Cork	3	1 Fabric	1	2 1	½″ Keystone 1″ Hairfelt	Outside Metal	3	1 Fabric	2	2 2	½″ Keystone ¼″ Hairfelt	Steel
	7	36-11½	26-0	29-10¾	8-2¼	7-1⅞	6-3	5-0	4½″	12½″	14⅞″	Solid, Swinging to side	Brine Tank	4	2 Paper	3	1 1	Keystone Woolfelt	3	4 Paper	2	1	Keystone	Wood	5	3 Paper	2	1 1	Keystone Sawdust	Steel
	8	37-9½ Endsills	26-10	36-0 Bet. Ends	8-3⅜	8-0$\frac{1}{16}$	7-0	6-0	....	....	....	....	Ice Boxes at roof	3	......	4	3	½″ Flaxlinum	3	2 Paper	3	2	½″ Flaxlinum	Outside Metal	3	....	2	[illegible]	½″ Flaxlinum	Steel
	9	37-10½	.....	31-0¼	7-9¾	7-1⅜	5-9¾	4-0	....	2′-6″	16¾″	Solid, Rigid	Brine Tank	5	6 Paper	3	1 1	½″ Hairfelt 1″ Hairfelt	3	3 Paper	3	1	½″ Hairfelt 1″ Hairfelt	Wood	6	....	5	2	½″ Hairfelt	Wood
	10	42-1½	31-1½	33-1¾	8-2¾	7-1	6-4¾	5-0	4¾″	15¼″	11½″	Solid, Rigid	Basket Bunker	2	......	..	1	2″ Cork	2	2 Paper	2	4	1″ Flaxlinum	Outside Metal	3	1 Paper	2	1 1	½″ Hairfelt 2″ Hairfelt	Steel
	11	40-10 Endsills	30-9⅝	33-5¼	8-2⅝	7-5⅛	6-4	4-0	....	16″	12″	Solid, Rigid	Box Bunker	5	1 Paper	2	3	½″ Hairfelt	3	2 Paper	3	3	½″ Hairfelt	Outside Metal	3	1 Paper	2	4	½″ Hairfelt	Steel
	12	43-3½	32-0	31-6	8-10½	7-3½	6-3¾	4-0	....	12″	12″	Solid, Rigid	Basket Bunker	5	4 Paper	3	4	Woolfelt	..	......	..	..	....	Wood	5	5 Paper	5	4	Woolfelt	Steel
	13	41-2	30-1	32-10½	8-10½	7-2$\frac{7}{16}$	6-5	4-0	4¾″	12″	10$\frac{15}{16}$″	Slat Syphon Rigid	Box Bunker	4	1 Fabric	2	4	½″ Flaxlinum	3	.....	1	4	½″ Flaxlinum	Outside Metal	3	....	2	5	½″ Flaxlinum	Wood
	14	40-9½ Endsills	31-9½	33-6¾	8-2¾	7-0$\frac{7}{16}$	6-8¼	4-0	4¾″	....	....	Rigid	Basket Bunket	2	......	..	1	2″ Cork	3	2 Paper	1	4	½″ Arctic Keystone	Outside Metal	3	....	2	1 2	½″ Arctic Keystone 1″ Hair	Steel
	15	40-0 Endsills	30-0	32-6⅞	8-3¼	7-4$\frac{13}{16}$	.....	4-0	$\frac{15}{16}$″ Slats	11″	3¼″	Syphon, Swinging to Roof	Bunker (Collap.)	4	7 Paper	1	2	½″ Flaxfelt	3	3 Paper	3	4	½″ Flaxfelt	Wood	4	6 Paper	3	4	½″ Flaxfelt	Steel Center Sills
	16	40-0 Endsills	30-0	33-1½	8-3¼	7-4$\frac{13}{16}$	.....	4-0	$\frac{15}{16}$″	15¾″	8¼″	Solid, Rigid	Box Bunker	4	1	2	4	½″ Arctic Keystone	3	.....	3	4	½″ Arctic Keystone	Wood	4	....	3	4	½″ Arctic Keystone	Steel Steel Center Sills
	17	41-8	30-10	33-2¾	8-2⅝	7-2½	5-9¼	4-0	....	12½″	12″	Solid, Rigid	Basket Bunker	2	......	..	1 1	½″ Insulite 1½″ Cork	2	1 Paper	1	1 1	½″ Insulite 1½″ Insulation	Wood	3	1 Ruberoid 1 Waterproof Coat	1	1 2	2″ Hairfelt ½″ Insulite	Steel
	18	41-4¾ Endsills	31-6	33-0	8-4⅞	7-2⅛	5-8¼	5-0	5″	....	10″	Solid, Rigid	Basket Bunker	3	......	1	1	2″ Cork	3	2 Paper	2	4	½″ Insulation	Outside Metal	3	....	2	4	....	Steel
	19	40-0 Endsills	30-0	32-10	8-3⅝	....	6-2¼	4-0	....	....	....	Slat Syphon Rigid	Box Bunker	3	1 Paper	2	2	½″ Linofelt	3	2 Paper	3	2	½″ Linofelt	Wood	3	1 Paper	3	1 2	⅜″ Insulation ½″ Linofelt	Steel
	20	41-10	30-2	32-7	8-4⅝	7-4	5-10	4-0	...	10″	8″	Slat Syphon, Rigid	Box Bunker	5	1 Fabric	3	3	½″ Hairfelt	3	4 Paper	3	2	½″ Hairfelt	Wood	5	6 Paper	4	3	¼″ Hairfelt	Steel
	21	38-7⅛	26-10½	30-11½	8-4	7-1	5-11½	4-0	5″	9″	14″	Solid, Rigid	Box Bunker	4	1	2	2	½″ Hairfelt	3	2 Paper	3	2	½″ Hairfelt	Wood	5	2 Paper	3	2	½″ Hairfelt	Steel
	22	41-11½ Endsills	31-8¼	32-10	8-3	7-1$\frac{3}{16}$	6-3⅝	4-0	5″	11⅝″	12″	Solid, Rigid	Basket Bunker	2	2 Paper	1	1	2″ Cork	2	9 Paper	1	4 2	½″ Hairfelt Cork at bottom	Outside Metal	3	13 Paper	1	6	½″ Hairfelt	Steel
	23	37-3¼	26-4	30-4⅜	7-10⅞	7-2$\frac{3}{16}$	6-2¼	4-0	....	2′-4″	21″	Solid, Rigid	Brine Tank	5	5 Paper	3	3	½″ Hairfelt	5	5 Paper	4	3	½″ Hairfelt	Wood	5	7 Paper	4	3	½″ Hairfelt	Steel
	24	42-6	32-6	32-11½	8-4⅞	7-3$\frac{3}{16}$	6-2	4-2	Slat	12″	12½″	Solid, Rigid	Basket Bunker	2	3	2	2	1″ Corkboard	2	2 Paper	3	3 3	½″ Keystone Cork at bottom	Outside Metal	2	2 Paper	5	4	½″ Keystone	Steel
Passenger	25	48-8¾	31-0	38-4¾	8-7⅞	7-3½	6-9⅝	5-0	5½″	7″	18½	Solid, Swinging to sides	Brine Tank	3	2 Paper	1	4	½″ Keystone	3	......	2	3	½″ Keystone	Outside Metal	5	1	4	6	½″ Keystone	Steel
	26	45-0 Endsills	33-8	38-10	8-1⅞	7-2½	6-3	5-0	4½″	10″	15″	Solid, Swinging to side	Brine Tank	3	1 Paper	2	2	½″ Keystone	4	1	1	4	½″ Keystone	Wood, Canvas Covered	3	1 Canvas	2	4	½″ Keystone	Steel
	27	43-0	30-4	35-5	8-7⅞	7-4	6-3¾	5-0	4¾″	9⅝″	15¼″	Solid, Swinging to side	Brine Tank	3	1 Paper	2	2	1¼″ Tucork	4	......	4	3	½″ Keystone	Inside Metal	3	....	3	4	½″ Keystone	Steel

The cross-sections really speak for themselves, but a brief discussion under the separate headings Floors, Walls and Roofs will be of some interest.

Floors.—The chief problem in floor construction is to make the structure waterproof, as well as a good insulator.

The insulating value of all materials that absorb moisture is greatly decreased when water is absorbed. In addition, water causes most of the insulating materials popular in refrigeration construction to become mushy and sag or drop out of place. It also causes wood floors lining and framing to decay or weaken, thereby making it more difficult to keep the general structure tight.

Nearly all the modern or at least recently built floors employ a construction involving cork as an insulating material. To keep moisture away from the cork various waterproofing compounds or waterproof materials are used.

The one exception to this general trend is shown in Fig. 11, where the insulation consists of four massed layers of $^1/_2$-in. hair felt. Moisture is kept away from the top of the insulation by means of two layers of floor boards between which is laid a layer of waterproofing compound. The surface of the top floor is covered with a layer of waterproofing compound into the surface of which sand has been rolled.

Figs. 12 and 13 show a floor insulation with intervening dead-air spaces. To be insulators, however, they must be dead-air spaces; for once circulation starts their efficiency is destroyed.

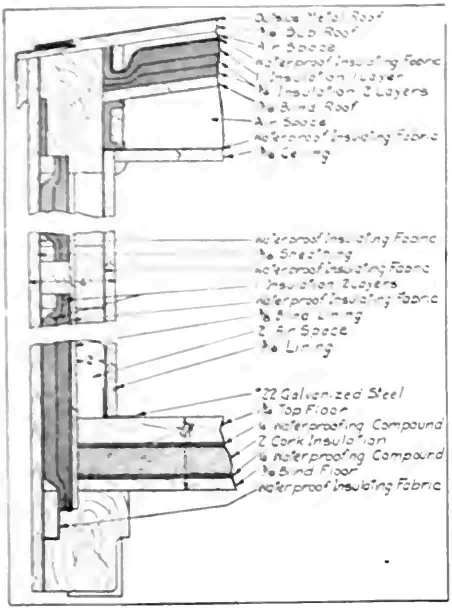


FIG. 5

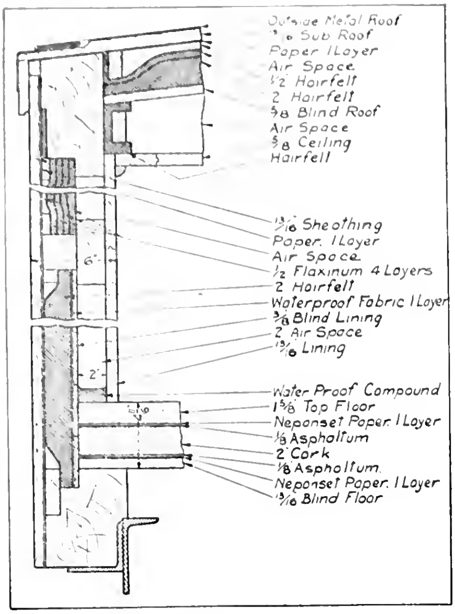


FIG. 6

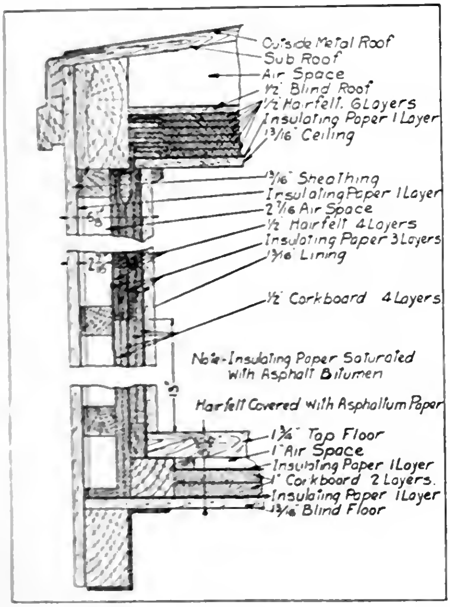


FIG. 7

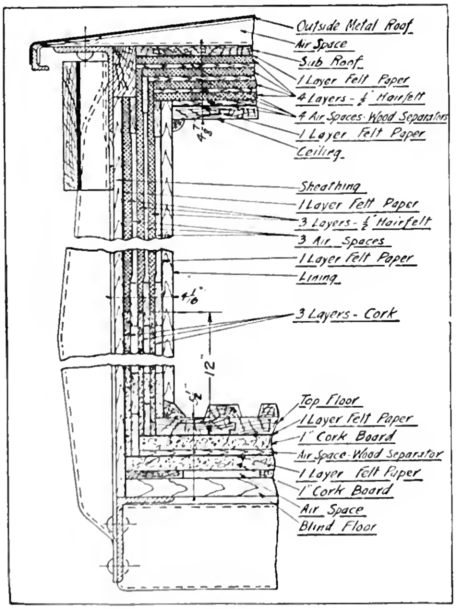


FIG. 8

FIGS. 5 TO 8 TYPES OF REFRIGERATOR CARS

It has been intimated that in some cases cork as a floor insulator has not been entirely satisfactory because in time it becomes brittle and crumbles. Specific information on this subject would be very valuable, as it would indicate whether the trouble was inherent or due to some particular method of construction.

Walls.—In connection with a waterproof structure it is interesting to note the various methods employed at the junction of the floor and side walls to keep water from getting past the lining and into the insulation. This point has been a source of great trouble. Some particularly interesting methods of construction at this point are shown in Figs. 6, 9, 10 and 11.

An exceedingly interesting example of waterproof construction is con-

tained in some all-steel refrigerator cars designed by W. F. Kiesel, Mem. Am.Soc.M.E. Mechanical Engineer of the Pennsylvania Railroad. The proportions of these cars were described in the *Railway Review* of February 3, 1917. The body of the car consists of an all-steel container placed within an outer container, the space between the walls being filled with insulation. The writer understands that at the floor the sections of the inner container are welded together, thus making the floor practically one piece and watertight and thereby affording maximum protection to the insulation.

Inspection of the various cross-sections indicates a general trend toward massing wall insulation and eliminating air spaces between the layers of insulation. As a rule the insulation is applied in a continuous strip from door post to door post. The advantage of applying insulation in this way lies in the fact that a continuous or unbroken surface presents no joints or openings through which air can pass or circulate. It has been the experience that where insulation is applied in sections, unusual construction is required to prevent eventual air circulation. Wall insulation is rarely less than 2 in. thick on the most recent cars. In some cases this insulation is applied in two massed layers. In one case the single layer is 2 in. thick. In the majority of cases four massed layers of 1/2-in. insulation are used.

The construction employed by the U. S. Railway Administration is indicated in Fig. 5 and shows the insulating material massed beneath the outside sheathing. Air space is provided between the inner lining and the blind lining. This construction was advocated as a method of preventing damage to the insulation should nails be driven through the inside lining.

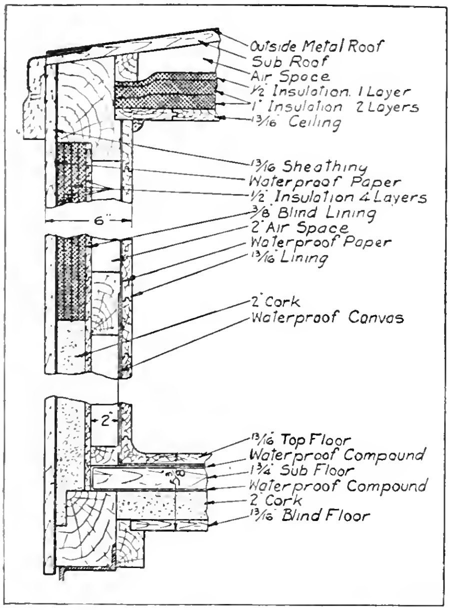


Fig. 9

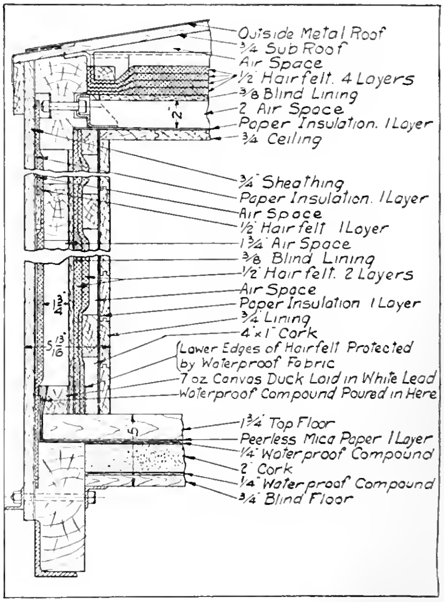


Fig. 10

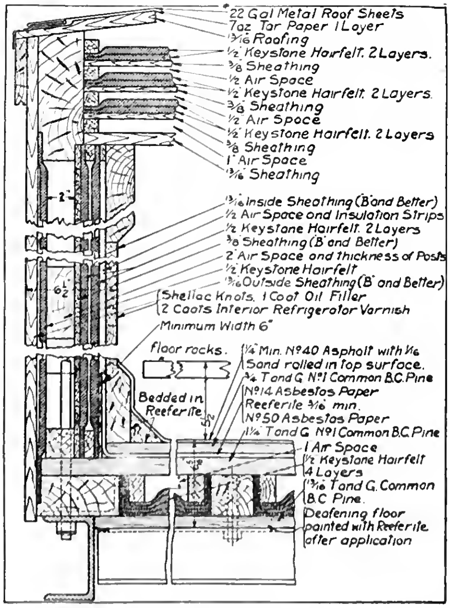


Fig. 11

Figs. 9 to 11 Types of Refrigerator Cars

A great many cars are insulated in this way, but there are some interesting exceptions, one of which is shown in Fig. 7. The advantage claimed for such construction is that of a car becomes cornered or damaged to such an extent that sheathing is cut or broken, the insulation stands a much better chance of remaining intact or becoming only slightly damaged, and the lading not subjected to risk caused by loss of cold air. It is also claimed that by the use of properly constructed wood forms or spacers, and the proper loading methods, no necessity should exist for driving nails through the inside lining. A great many railroads are conducting an educational campaign in this connection. Two interesting wall structures are shown in Figs. 7 and 8. In these figures it will be seen that layers of cork board are used below the insulation, the hair felt starting at a point 13 in. above the level of the floor.

Another arrangement in which cork is used is shown in Fig. 10. In this cross-section the two inner and massed layers of hair-felt insulation come right down to the floor level. A slab of cork board is placed between the hair felt and the inner lining. The hair felt is protected at the floor line with canvas duck laid in white lead. The bottom of the insulation behind the sheathing is protected by waterproof compound poured into a channel or gutter provided for the purpose. The compound in this gutter joins the compound laid above the flooring cork thus forming a continuous waterproof section.

Roofs.—The tendency at present is to apply massed insulation in the roofs. As a rule the most modern cars have 2 to $2^1/_2$ in. of insulation applied in this way. The car shown in Fig. 7 is provided with 3 in. of such insulation.

Some cars are equipped with a carefully designed double-board roof with waterproofing compound between the layers. There are many advocates of this type of roof, but it is interesting to note the number of outside metal roofs that are applied to cars of this type. The advocates of the outside metal roof claim a saving in weight and greater protection to the sub-roofs and insulation from moisture, claiming that with proper insulation the metal roof has no effect on the interior temperature of the car.

Doors and Hatches.—Doors and hatches are being made with more insulation and are being strongly and properly constructed so that they will fit the door openings tightly, and not permit any loss of refrigeration due to leakage. In this connection, any other openings into the car should be so constructed that they can be kept tightly in place and easily maintained. An efficient door-locking device is no small item in keeping doors tight and thereby maintaining the efficiency of the car.

Painting.—Refrigerator cars should be kept well painted in order to preserve all exterior surfaces. This is in the interest of obtaining long life for the car. Metal parts should be given particular attention in this respect.

The author believes that refrigerator cars should be painted with a light or non-heat-absorbing color. Dark colors absorb heat. An inquiry addressed to the owners of white and yellow cars indicated that no specific data existed on the subject, but it was the general belief that the light colors were an advantage in this respect.

Insulation

It has been stated that the function of the insulation is to afford protection to the contents of the car by minimizing heat transmission through the walls, roof, and floor. A good insulator must not only be a poor conductor of heat but must be a material having the qualifications of reasonable cost, adaptibility, durability, light weight, imperviousness to moisture, freedom from odors, and be proof against vermin. In any study of insulating materials for use in railway refrigerator cars, these factors must all be kept in mind.

TABLE 2 THERMAL CONDUCTIVITY OF INSULATING MATERIALS

Material	Remarks	Thermal Conductivity [1]	Density [2]
Air	If no heat is transferred by radiation or convection	4.2	0.08
Calorax	Fluffy mineral powder	5.3	4.0
Kapok	Hollow vegetable fibers, loosely packed	5.7	0.88
Pure Wool		5.9	6.9
Pure Wool		5.9	6.3
Hair Felt	Fibers perpendicular to heat flow	5.9	17.0
Pure Wool		6.3	5.0
Slag Wool	Loosely packed	6.3	12.0
Keystone Hair	Hair felt and other fibers, confined with building paper.	6.5	19.0
Mineral Wool	Loosely packed	6.5	12.0
Cornboard	No artificial binder, low density	6.5	6.9
Mineral Wool	Fibers perpendicular to heat flow	6.9	18.0
Cotton Wool	Medium packed	7.0	5.0
Pure Wool	Very loose packing, probably air circulation through material	7.0	2.5
Insulite	Pressed wood pulp	7.1	12.0
Mineral Wool	Firmly packed	7.1	21.0
Linofelt	Vegetable fiber confined with paper, flexible and soft	7.2	11.3
Ground Cork	Less than $\frac{1}{16}$ in.	7.4	9.4
Cornboard	No artificial binder	7.3	9.9
Balsa Wood	Very light wood, across grain	7.5	7.1
Balsa Wood	Same sample with 13 per cent waterproofing compounds	8.3	8.0
Flaxlinum	Felted vegetable fibers	7.9	11.0
Fibrofelt	Felted vegetable fibers	7.9	11.0
Rock Cork	Mineral wool and binder	7.9	16.0
Balsa Wood	Across grain, untreated	8.3	7.4
Cornboard	With bituminous binder	8.4	16.0
Balsa Wood	Medium weight wood	9.2	8.8
Sawdust	Various	9.7	12.0
Air Cell (½-in.)	Corrugated asbestos paper, enclosing air spaces	11.0	8.8
Air Cell (1-in.)	Corrugated asbestos paper, enclosing air spaces	12.0	8.8
Asbestos Paper	Built up of thin layers	12.0	31.0
Balsa Wood	Heavy	14.0	20.0
Fire Felt Sheet	Asbestos sheet coated with cement	14.0	26.0
Fire Felt Roll	Flexible Asbestos sheet	15.0	43.0
Cypress	Across grain	16.0	29.0
Asphalt Roofing	Felt saturated with asphalt	17.0	55.0
White Pine	Across grain	19.0	32.0
Mahogany	Across grain	22.0	34.0
Oak	Across grain	24.0	38.0
Maple	Across grain	27.0	44.0
Virginia Pine	Across grain	23.0	34.0

[1] Thermal Conductivity in B.t.u. per day (24 hr.) per sq. ft. per deg. fahr. per in. thickness

[2] Density, lb. per cu. ft.

A material with low thermal conductivity, but one which is difficult to apply economically, is undesirable. On the other hand, there may be materials easy to apply but which will not stay in place or which will not retain their insulating value under service conditions; these are equally undesirable. In addition the material should be of a kind easily handled as well as easily applied.

It seems to be generally conceded that the best insulating materials are those which contain a very great number of minute dead-air cells, or interstices containing dead air. If these air cells become filled with moisture, the thermal conductivity of the material is increased. This is one of the reasons why it is so important to protect insulation from water, and why it is desirable to use a material highly resistant to moisture.

Some materials when subjected to moisture fall out of place or sag, and if a large air space, or pocket, is not formed, air circulation frequently results, the effect of which greatly decreases the efficiency of the car.

Thermal Conductivity.—The subject of heat transmission through the walls of a railway refrigerator car is one upon which there is some difference of opinion, this difference dealing largely with variables or factors which have not yet been reduced to absolute terms.

In calculating heat transmission through a compound wall it is essential to know the thermal conductivity of the various materials contained in the structure.

The most recent determinations of thermal value of various materials are shown in Table 2, taken from a paper on The Thermal Conductivity of Heat Insulators, by M. S. Van Dusen, in the October, 1920, Journal of the American Society of Heating and Ventilating Engineers.

Péclet's formula for the total heat transmission through a compound wall is

$$H = \frac{1}{\frac{1}{K_1} + \frac{D}{C} + \frac{D_1}{C_1} + \frac{D_2}{C_2} + \text{etc.} + \frac{1}{K_2}} \quad \ldots\ldots\ldots\ldots [1]$$

in which

H = Heat transmitted per sq. ft. per hr., B.t.u.
K_1 = Inner surface conduction
K_2 = Outer surface conduction
D, D_1, D_2, etc. = Thickness of each element in wall, in.
C, C_1, C_2, etc. = Thermal conductivity (per hour) of elements corresponding to thickness D, D_1, D_2, etc., per in. thickness per sq. ft. per deg. fahr.

If the difference between inside T_1 and outside T_2 temperatures is considered, Equation [1] should be multiplied by $(T_1 - T_2)$ and becomes

$$H = \frac{T_1 - T_2}{\frac{1}{K_1} + \frac{D}{C} + \frac{D_1}{C_1} + \frac{D_2}{C_2} + \text{etc.} + \frac{1}{K_2}}$$

The thermal conductivity of each material shown in Table 2 is stated in B.t.u. per day.

In the formula, thermal conductivity C, C_1, C_2, etc., is stated in B.t.u. per hour. To be used in the formula each thermal-conductivity figure in the table must be divided by 24 to bring it to the required hourly basis. For example, Table 2 shows the thermal conductivity of white pine wood as 19.0. In this case C for white pine is $C = 19/24 = 0.790$.

Available information indicates that in the original formula $1/K_1$ was 2.0, but modern practice indicates this to be too high a value. It is felt that by assigning a value of 0.5 to $1/K_1$ refrigerator-car conditions are very nearly approximated, and this value is taken in the calculations mentioned below.

$1/K_2$ is a factor generally conceded to have a value so small that it can for all practical purposes be eliminated from the equation.

In order to illustrate the application of the formula, as well as to indicate the difference in the efficiency of walls, roofs and floors in cars of different design, calculations are given in the complete paper of the car cross-sectioned in Fig. 5, which is used as an illustration of good construction and relatively high efficiency. The car shown in Fig. 12 is used in comparison in order to show the greater rate of heat transmission or lower efficiency caused by different methods of insulation and construction. The comparative results are given in Table 3.

Materials and Workmanship

Proper materials are a very important factor in refrigerator-car construction. The right grade of lumber should be used wherever required, and it should be properly dried before being placed in the car. Workmanship should be of the best. Insulation should be handled carefully, care being taken to see that it does not become torn or damaged.

Lumber which has received preservative treatment has been given considerable attention by car builders and car owners for several years, and much of it is now in service. Sufficient time has not elapsed to indicate what increased life can be obtained, but experience to date indicates treated lumber to be more durable and a kind that will resist moisture and decay.

No objection can be made to it on account of any odor caused by treatment. In treating, the lumber is submerged for a number of hours in hot creosote oil, after which it is placed in a drip rack and permitted to drain. It is estimated that this treatment will result in large saving, doubling the life of the roofing boards and sills, and effecting considerable saving in labor that would otherwise be necessary to properly maintain these parts in the course of time.

An interesting report in connection with the use of treated lumber for use in the construction of cars was presented recently before the American Wood Preservers' Association. This report calls attention to the fact that decay is the principal cause of failures in lumber, and that great economy is possible by the use of a preservative.

It is evident that if some of the wooden parts of a refrigerator car can be made moisture-proof or highly resistant to moisture, the efficiency of the car can be maintained at a much higher average.

The author has been advised that some refrigerator cars are in service in which balsa wood is the principal insulating material. This wood is very light in weight having in its natural state a density of 7.1 lb. per cu. ft. It is a South American wood that grows very rapidly, and is of cellular structure. Table 2 shows it to have a thermal conductivity of 7.5 in its natural state and 8.3 when treated with waterproofing compounds.

It would be of great interest to know if treated or untreated balsa wood is used between the ordinary walls of a car as insulation, or if the material figures largely in the construction of the superstructure of the car, such as lining and sheathing. Its strength is insufficient for its use in framing.

TABLE 3

Comparison of B.t.u. per sq. ft. per deg. diff. fahr. per 24 hr. in cars shown in Fig. 14 and Fig. 23.

	Including Air Space		Excluding Air Space	
	Fig. 14	Fig. 23	Fig. 14	Fig. 23
Roof	1.702	2.328	1.953	3.12
Wall	2.172	2.80	2.388	3.768
Floor	2.46	2.544	2.46	3.21

It would also be of interest to know if the material is durable and efficient in this class of service, if any modification of car structure is necessary for its use, and if any reduction of car weight can be accomplished by its employment.

Other Systems of Refrigeration

In the cars described in the cross-sections and tabulation, refrigeration is accomplished by means of air circulation, the air being cooled by contact with ice or ice containers placed at the ends of the car.

One modification of this system is a car in which ice containers are placed just below the roof and in the center of the car. In this system it is claimed that maximum refrigeration can be applied where the air within the car is at its highest temperature.

There do not appear to be a great number of cars of this type in modern service. The principal objections to such a system are decreased head room in the center of the car, weight of ice near the roof of the car, and difficulty of adapting this system for use with meat racks placed below the ceiling of the car.

Another system consists of a brine tank built into the roof at each end of the car. These tanks extend about 9 in. below the ceiling and are heavily insulated on top, sides and bottom. The tanks at each end of the car are connected to each other by pipes hung about 2 or 3 in. below the ceiling. The pipes are not insulated. In each tank is a partition running lengthwise of the car. In one partition are some check valves opening to the right; in the other partition some check valves open to the left. The theory is that when ice and salt are placed in the two tanks the swaying of the car in motion automatically circulates the brine through the pipes, refrigeration being accomplished by contact of the air within the car against the surface of the pipes connecting the two tanks. Comparatively speaking, this system has not been in service a very great length of time. The advantages claimed for it are increased loading space, decreased consumption of ice, uniform temperatures, and a car that can easily be changed from a refrigerator to a heater car. The author understands that these cars are being tested in various fields of service. It would be interesting to have some information regarding the ability of this system to supply refrigeration when the car is not in motion, and what the system can accomplish in the way of quick precooling when the car is placed at the loading shed or platform.

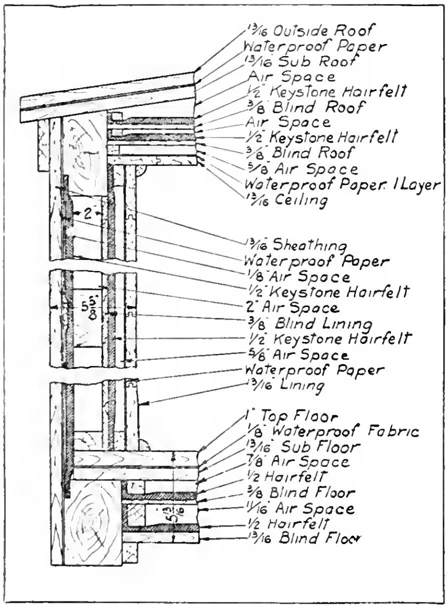


Fig. 12

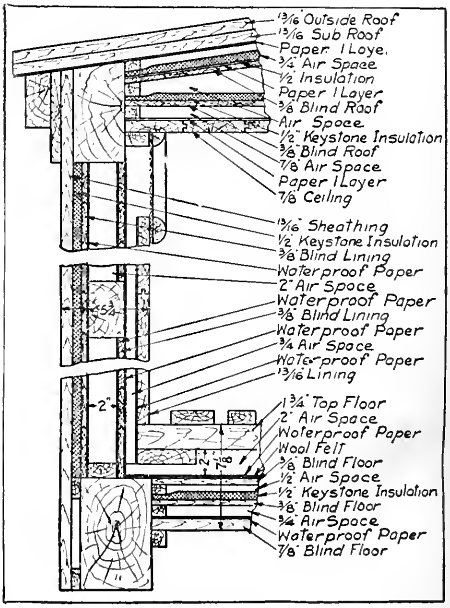


Fig. 13

Figs. 12 and 13 Types of Refrigerator Cars

The interior of such a car is shown in Fig. 4. This illustration shows the floor racks propped up against the side walls so that the piping along the floor beneath the racks can be seen. This piping is used when the system is used to heat the contents of the car. Canvas troughs are placed beneath the piping located beneath the ceiling in order to catch any condensation or frost slush that may drop from these pipes.

Precooling

The importance of precooling the lading and the resulting economy in the use of ice and labor were mentioned in a preceding paragraph. There are two distinct methods of precooling cars and lading. The first is known as shippers' precooling; and the lading is placed in cold-storage rooms in which the proper temperature is maintained, and where the lading is allowed to remain until it cools to the proper temperature, after which it is loaded quickly into cars that have been pre-iced. The second method is known as the carrier's precooling, and generally consists of a system in which the car is loaded, after which the interior of the car and the lading are precooled by mechanical means. In one system of this kind, at a point where a large tonnage of citrus fruit originates, cars are placed at a precooling dock where the ventilator hatches are connected with large air pipes, and the lading is precooled by means of a forced circulation of cold air. The air is brought to a low temperature in the cooling rooms of the plant, and passes through a long concrete tunnel and into a pipe connected to the hatchway at one end of the car. The air passes through the entire length of the car and out through another pipe connected to the hatchway at the opposite end of the car, and thence back to the cooling room through another concrete tunnel. The cold air passes through the car at a rate of 6000 ft. per min. at a temperature ranging from 12 to 20 deg., for a period of 30 min., after which the pipes on the hatchways are reversed and the cold air is forced through from the opposite end of the car. These pipes are reversed every 30 min. for a period of 4 hr. when the process of precooling is complete. It is stated that citrus fruit loaded into the cars at temperatures of from 80 to 90 deg. can be brought down to 45 deg. within this time. After the car is cooled in this manner it is iced to capacity.

Recently a very interesting and large precooling plant has been erected in the vegetable section at Sanford, Florida, and is operated by the shippers. From this section large shipments of celery are made from January until June. After a careful analysis of the desirable points of an efficient precooling plant, the shippers at this point decided to branch into an entirely new field by adopting a novel method of removing the heat from the celery. This consists of causing a large volume of cooled water to flow over the celery. The average temperature of the water used in this plant is approximately 35 deg. fahr., and it has been stated that the temperature of celery can be brought down from 75 deg. to within 2 deg. of the temperature of the water within 20 min. This plant has a cooling capacity of approximately 15 cars per 24 hours.

Another system of precooling involves the freezing of the lading and a precooling of the car by means of a brine-spray system. When commodities can be frozen hard and shipped in a precooled car, refrigeration may be entirely accomplished or helped to a very great extent by the frozen lading.

Great economies are possible due to precooling. Where small tonnage originates little precooling has been done by mechanical methods on account of the high cost of the plant and equipment. Most mechanical precooling is done where large tonnage originates. At such points the shippers frequently combine to build such a plant. Precooling is receiving more and more attention in connection with various commodities and additional economy in the way of ice and labor may be expected.

General Conclusion

The inquiries upon which these few notes on railway refrigerator cars are based indicate that a very great improvement has been made in refrigerator-car construction and design, particularly within the last few years, but there is also evident indication that the field of investigation in connection with cars of this type is still a most fertile one. Some fairly recent cars indicate that subject of refrigeration in transit is not appreciated in some quarters as it should be. The subject of efficient refrigeration is a most important one, because cars that can be kept in continuous service with a minimum cost of maintenance and which are sufficiently efficient to protect the lading in transit, mean dollars and cents to the railways.

The Accuracy of Boiler Tests

By ALFRED COTTON,[1] ST. LOUIS, MO

This paper points out the unavoidable inaccuracies involved in reports of boiler tests and the absurdity of assigning values carried out to the one-hundredth of one per cent to items which cannot possibly be measured so closely.

The various factors which enter into boiler-test computations are taken up one by one and errors which may be made are covered and the best methods of reducing them considered.

The most important elements are of course the determinations of water and coal used, and of steam produced, both as to quality and quantity. It is shown how the error in obtaining the B.t.u. in the coal burned may easily reach 2.5 per cent in either direction, the water evaporated may be at least one per cent out of the way, and hence the efficiency reported may be 3.5 per cent too high or low.

A LARGE proportion of boiler-test reports are presented with heat-balance figures carried to one-tenth and even one-hundredth of one per cent. Those who have had much experience in boiler testing know that such apparent accuracy is impossible at present and therefore misleading. In a heat balance recently published the percentage portion does not add to an even hundred. Since the last item is simply the difference between what is known and 100, why not make it agree? The deviation from 100 makes it appear that the items are very precise indeed.

How accurate is it possible to make a boiler test? To determine this, every item entering into it must be considered.

First consider the measurement of the water. If the water is carefully weighed or measured by suitable meters the amount fed may be ascertained well within plus or minus 1 per cent. If meters are used, they may be calibrated before the test, and perhaps afterward as well, to insure this accuracy. Proper precautions may be taken to prevent leaks from blow-off cocks, in feedwater heaters, and so forth. Care can also be taken to see that the condition of the water in the gage connections is the same at the end as at the beginning of the test. If this is not done, error may be introduced to the extent of 1 or 2 in. due to the difference in the weight of cold water in the gage connections before blowing off, and of hot water afterward. With an eight-hour test run at rating, the error may be more than 1 per cent from this cause.

Quality of Steam—Steam Sampling

Then there is the quality of the steam to be accounted for. The entrained water in the sample can be ascertained very closely, but it is sometimes stated with much greater precision than the observations warrant, or than is necessary. A boiler-test report was seen recently wherein the proportion of water in the steam was given to one-ten thousandth of one per cent!

The temperature of the steam in the expansion chamber of a throttling calorimeter need only be read to the nearest degree; and when averaging the readings, the result need not be expressed beyond one-tenth of a degree. A glance at a steam table will show that the variation is so slight that carrying it further is futile.

But does the sample of steam so examined represent the bulk steam? That is something which is not known, and the more elaborate discussion given in the complete paper seems to show that it is *not even nearly representative.*

The design and position of the sampling tube are matters of some contention. It is accepted practice to perforate the sampling tube and place it horizontally across the pipe. It is probable that entrained water is commonly in such small particles that it is easily carried in suspension at usual steam velocities. Water flowing along the bottom of the pipe is likely to be mostly condensed steam, and is therefore rightly avoided by placing the sampling pipe horizontally.

The A.S.M.E. sampling tube is made of $^1/_2$-in. standard pipe and is provided with twenty $^1/_8$-in. holes arranged in "irregular or spiral rows," and usually in a more or less regular helix. It should be inserted in the steam main "at a point where the entrained moisture is likely to be most thoroughly mixed." The word "likely" is highly commendable.

It is most probable that the design of a steam-sampling device should be somewhat similar to that of a rain gage; and if this is the case, the A.S.M.E. tube is as unsuitable for its purpose as anything which could well be contrived. One of the fundamental requirements in the location of a rain gage is to avoid the proximity of objects which might shelter the instrument or cause eddies. This requirement is ludicrously violated by the downstream holes in this steam-sampling tube. It would appear that the best position for the holes is directly upstream, and that all holes should be in a line facing in that direction instead of being distributed around the tube. For the smaller steam pipes, a smaller number of large holes could be used, placing them at least, say, 3 diameters center to center, and making their total area about equal to the twenty $^1/_8$-in. holes or, say, 0.25 sq. in.

The most accurate results would be attained with such upstream holes if the velocity of the steam entering the holes approximated that of the bulk flow along the steam pipe. Then the steam and water particles would enter the holes with the least disturbance of their general direction, and consequently the sample would be most representative.

It seems reasonable to think that the actual water present in the steam may be very much less than that observed when we use the A.S.M.E. tube.

If there is much priming, the error in determining the amount of water carried over may approach plus or minus 5 per cent of that evaporated. But assuming orderly operation and careful observation, the accuracy of the report on water evaporated may be from plus or minus 1.5 to 2 per cent; but it cannot well be guaranteed to be closer.

Estimating Coal Consumption

The next item to be considered is the coal, and this may easily be weighed well within plus or minus 1 per cent. However, this is but the coal fed to the furnace, and to know the quantity actually burned in relation to the water evaporated, we must be sure that there is the same amount of fuel in the furnace and in the same stage of combustion at the end of the trial as at the start. The only way to find this out is to look at it. Only those who have done this know how impossible it is to accomplish much more than make a careful guess, and it must be done quickly because conditions are changing momentarily. It is not uncommon for different observers to vary in their estimates to the extent of 10 or even 20 lb. of coal per sq. ft. of grate area. In a test during which a total of 250 lb. of coal was burned on each square foot of grate, the error from this source might amount to over 5 per cent. The error will depend on the length of the test, and for 12-hour tests may very reasonably be placed at not less than plus or minus 1 per cent.

Coal Sampling and Analysis

But, unfortunately, this coal weight does not mean anything of itself. We must at least know the weight of *dry* coal; and if the moisture present in the coal is much over 2 per cent, allowance should be made for the heat used to evaporate and superheat it. To find out how much moisture there is in the coal, we must have a representative sample, and then we must analyze it for moisture *while it is representative.* While working down a laboratory sample the coal will either gain or lose moisture. In a warm, drafty room and especially on a warm floor, it will generally lose moisture, perhaps as much as the equivalent of 3 per cent of the coal or even more. While it is properly bottled up, no further change will occur; but at the laboratory, while being finely ground and while weighing samples, further change will undoubtedly occur and this may be either in increase or reduction of moisture. During all these processes of sampling from the coal pile to the laboratory

---

[1] Research Engineer, Heine Boiler Co. Mem. Am.Soc.M.E.

Abridgment of paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

drying oven it does not seem possible to certify the moisture closer than plus or minus 1 per cent, and it may easily be out plus or minus 2 per cent. Taking the alternative method of drying the coal during the test, there is the difficulty of securing a representative sample, for we are now sampling coal which has not been weighed to the firing floor or hoppers; and there is also the further difficulty of crude drying and weighing apparatus. However, this method is likely to be a little more accurate than the orthodox one, and with reasonable care in selecting samples, results may be obtained within plus or minus 1 per cent.

On examining the report of any boiler trial, the first thing looked for is the efficiency at the trial load. Without this, the report does not generally convey information of very much value. To get the efficiency we must know the heating value of the coal; and whether the heating value is found by calculation from the analysis or by the calorimeter, the essential feature is the extent to which the sample is representative. To fully satisfy this requirement it should have come from widely distributed points in the original bulk coal used during the trial. Of course, this condition is very far from being reached even with the orthodox method of quartering down, unless the test is with powdered coal. Still, such a sample is reasonably representative if the work of getting it has been conscientiously done.

Summary of Errors

It is well here to summarize the possible errors and see where they may lead, and this has been done in the following tabulation, keeping them even lower than suggested.

	Error
Coal:	
Weighing	± 0.5 per cent
Estimating amount of fuel in furnace at start and stop	± 0.5 per cent
Total error of weighed coal	± 1.0 per cent
Variation between original percentage of moisture and that in laboratory sample plus failure of sample to truly represent bulk	± 1.0 per cent
Failure of heat-value sample to represent bulk	± 0.5 per cent
Total error in analysis	± 1.5 per cent
Total error in B.t.u. in coal (weight and analysis) on which efficiency is based	± 2.5 per cent
Water:	
Weighing or metering, starting and stopping test, gage glass, leaks	± 0.5 per cent
Failure of sample of steam to truly represent bulk steam as to entrained water	± 0.5 per cent
Total error in water evaporated	± 1.0 per cent

B.t.u. in coal burned may vary 97.5 to 102.5 per cent.
Water evaporated may vary from 99.0 to 101.0 per cent.
Reported efficiency may vary from 99.0/102.5 to 101.0/97.5, or 96.6 to 103.6.

Therefore if the efficiency really attained in any boiler trial is 78 per cent, the report may show as low as 75.4 per cent or as high as 80.8 per cent if all the errors happen to be in one direction. It may be thought that this possible error is placed at a higher figure than occurs in practice; but it must be remembered that generally the errors will be in different directions and so tend to neutralize each other, and it will be seldom that they are all one way. Consequently if a sufficiently large number of trials are made on the same boiler under the same conditions, some of the tests will nearly always be found to deviate from the average quite as much as the total possible error here suggested.

If the coal and water deductions are relied on, we know the efficiency and the load. But in view of what has been said it is very doubtful if the regular carefully conducted boiler test burning hand- or stoker-fired coal can be guaranteed to be closer than within plus or minus 3 per cent.

The Heat Balance

The heat balance is often considered as a final check on the correctness of the test. A boiler-test report without a heat balance is just as good as the other kind as far as efficiency at load is concerned. But the heat balance confers dignity and precision on the test report because all the items add up to 100 and this seems to prove the correctness of everything concerned in it. However, since it does not "balance" or rather that we *make* it balance, the term "heat balance" is not without humor. If accountants submitted items in their balance sheets called "unaccounted for" amounting to $5 in every hundred dollars there would be considerable unpleasantness. Of course, a heat balance is different because there is the excuse that no way has been discovered to find out the amounts of some of the items and the others are not as accurate as is generally believed. There is a case of four consecutive tests made on the same boiler by an engineering professor of deserved repute and large boiler-testing experience, in which the "unaccounted for" was respectively 8.7, 0.4, 6.4, and 7.4 per cent. The trials run by Dr. Jacobus on the Delray boilers were among the most careful ever made, and the "unaccounted for" item runs from 1.51 to 4.83—a difference of over 3 per cent. Incidentally, the efficiencies in the series of tests vary over plus or minus 1 per cent from their average rating-efficiency curve.

The real value of a heat balance lies in the presentation of the various losses and their amounts, and therefore it is more a *statement* than a *balance.*

Care has to be taken to get an average sample of flue gas. Its composition sometimes varies greatly across the width of the setting—as much as 5 per cent of CO_2 according to some experiments, though perhaps some of this variation was caused by the quality of the gases changing rapidly between taking samples. It seems likely that if the gas sample is drawn from some point well within the gas flow, it is fairly representative, for if that were not so, the "unaccounted for" would show a still larger variation than it actually does. This also applies to exit gas temperature, where the radiation effect may affect the readings 50 deg. fahr. With care in placing the instruments the error is perhaps within plus or minus 20 deg. fahr., or about plus or minus 1 in the percentage of heat loss to the stack.

Efficiencies

Even the efficiency as now reported does not provide a proper basis for making comparison between different trials under different conditions. An efficiency of 75 per cent with a steam pressure of 225 lb. is a better performance than the same efficiency at 75 lb. pressure. To be serviceable for comparison, the efficiency should be based on what is theoretically possible in each individual case, and this is governed by the temperature of what is being heated and not by the temperature of the atmosphere.

At first sight it appears that it is not theoretically possible to get the exit gas temperature below that of the boiling point. Therefore the efficiency should be based on perfect combustion with the theoretical amount of air and the products of combustion cooled to the boiling point for the existing pressure. This is not very difficult, and the 100 per cent figure would be set for the particular fuel and steam pressure under consideration. The efficiency would be the percentage of the figure attained on the test and might be called the "actual" efficiency to distinguish it from the efficiency as now reported, which might be called the "theoretical" efficiency.

Whether the mean temperature of the water in the boiler or that at the gas exit should be used, is another consideration. In a horizontal water-tube boiler, for instance, the lowest tubes may be 15 ft. below the water level. The added pressure due to this head of water is 6 lb., making a total pressure of 156 lb. when the gage pressure is 150 lb. This increases the boiling point 3 deg., and either the water is hotter at the bottom of the boiler or no steam is made there.

The temperature to be used is really dependent upon the extent to which the cold feedwater is segregated. The boiling point may be considered as the proper temperature to use with a boiler in which the feed is so mixed with the circulation that no cold water comes in contact with the heating surface, while with a separate economizer or a flash boiler the temperature of the feedwater should be adopted. But difficulties at once arise with boilers where there is partial segregation. In boilers having integral economizers the feedwater may be wholly or partly segregated. In integral economizers of the Badenhausen type, for instance, there is considerable circulation within the economizer, and the temperature of the water where the gases leave will certainly be

well above that of the entering water. A somewhat similar condition obtains in the rear bank of the Stirling boiler, which is, or used to be, often called the "economizer bank."

It appears, then, that the design of boiler must be taken into consideration and the temperature chosen be that of the boiling point, or of the cold feedwater, or somewhere between these points according to the extent of segregation of the incoming feed. A chart like Fig. 1 could be used and a position on the curve agreed upon for every type of boiler, such as the following:

POSITION	TYPE OF BOILER
A	Horizontal water-tube
	Scotch marine
	Horizontal return tubular
B	Stirling with rear circulators
C	Stirling without rear circulators
D	Boilers with integral economizers having free circulation
E	Boilers with integral economizers having restricted circulation
F	Boilers with separate economizers
	Flash boilers.

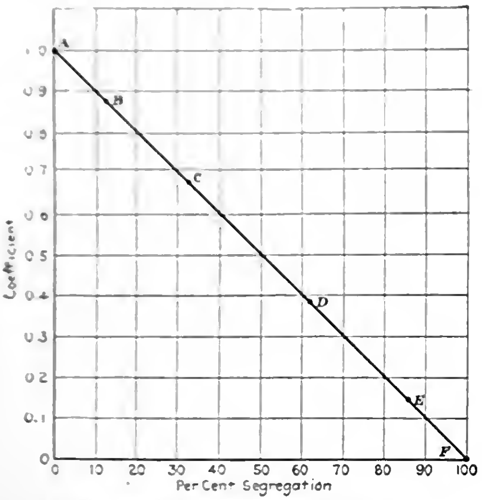


Fig. 1 Effect of Segregation of Feedwater

It is not intended to propose that the positions thus suggested by way of illustration be accepted, either absolutely or relatively. But as an example, with a boiler having 25 per cent segregation, the coefficient as read from the chart is 0.75. Suppose the boiling point is 370 deg. and the feedwater enters at 130 deg., then the difference is 240 deg. and 0.75 of this is 180 deg. Then 180 + 130 = 310 deg. fahr., which is the temperature to be used.

It might be advisable to make some kind of an allowance for the rate of driving, because this would have some effect on the temperature to be used in those boilers having partial segregation of the feedwater.

Probably the simplest way to dispose of the matter is to take the temperature of the water in the boiler at the point where the gases leave, making regular observations during the test. In this way there would be no contention whatever as to the proper temperature to use. The average of these observations would be recorded in the test report.

The efficiency based on the temperature of the water in the boiler is the only efficiency by which different boiler performances may be intelligently compared. But it must be remembered that the limit of temperature on which it is based is artificially imposed. It may be considerably lowered by the installation of an economizer, and perhaps still more so by apparatus yet to be devised or more generally adopted. When an economizer is added it may be that the efficiency—which will now be based on the feedwater temperature—is lower than before. Of course, this is quite proper because this is really the actual efficiency of the apparatus as a heat generator and absorber. But for the comparison of one steam plant with another or for changes in the circumstances of the same plant such as the addition of the economizer, the efficiency based on the heat value of the coal must be used. Therefore it appears highly necessary that both of these efficiencies be reported in every test. These efficiencies may be stated as:

$$\frac{\text{B.t.u. in steam}}{\text{B.t.u. in dry coal}} = \text{Theoretical Boiler and Furnace Efficiency}$$

$$\frac{\text{B.t.u. in steam}}{\text{B.t.u. available}} = \text{Actual Boiler and Furnace Efficiency.}$$

All comparisons of efficiency are properly based on the load in percentage of the boiler rating. When a superheater forms an integral part of the boiler, the heating surface is greatly increased. The efficiency is greater owing to the increased heating surface reducing the temperature of the escaping gases. But still the efficiency is plotted against boiler rating, in other words, against boiler heating surface only. This is wrong. The combination should be rated at some higher horsepower than that of the boiler only. It would be a very difficult matter to decide how much to allow for superheating surface as its heat-transfer rate is quite different from that of boiler heating surface. But superheating surface should be rated as the equivalent of so much boiler heating surface.

The same thing applies to economizers. What is the proper way to report a boiler test where there is an economizer? I quote from a test report case of unquestionable authority:

Water-heating surface	4400 sq. ft.
Builder's rating	440 hp.
Economizer heating surface	6290 sq. ft.
Hp. developed for boiler	1231
Hp. developed for boiler and economizer	1350
Percentage of rating developed for boiler	277
Percentage of rating developed for boiler and economizer	305

What is the meaning of the last item? The one above it is the regular statement of percentage of rating. But the boiler did not develop more horsepower or a higher percentage of rating because there was an economizer near it. The economizer did this extra work—not the boiler. What percentage of the *rating of the economizer* did the economizer develop?

The steam, or its equivalent when electric motors are used, consumed in driving stokers and mechanical-draft apparatus should always be ascertained and reported as a percentage so that it may easily be deducted from the efficiency by any one sufficiently interested. In testing all or most other apparatus, the efficiency is output divided by input; but in boiler testing we do not know yet how to accurately measure the output. We weigh the water going in and boldly state it as output. Surely the available steam sent away from the boiler is the real output, and if so, all steam used to make the boiler and its accessories work should be allowed for. As conscientious engineers we have always strictly seen to it—and shall continue to do so—that such things as internal-combustion engines, hot-air engines and the like shall be tested with a brake so that we know exactly what is their actual output; and the more power they consume in making themselves work, the worse for them. But we seem to prefer to avoid telling any one what the real output of a boiler is.

Economizers raise the efficiency by lowering the flue-gas temperature, and they sometimes do this to a point where the gas temperature is too low to produce sufficient chimney draft, in addition to increasing the draft resistance. So an induced-draft fan is used, but the power taken to drive it is rarely considered.

The following very imposing array of data is sometimes presented:

Water evaporated, actual, per lb. of coal as fired
Water evaporated, actual, per lb. of dry coal
Water evaporated, from and at 212 deg., per lb. of coal as fired
Water evaporated, from and at 212 deg., per lb. of dry coal
Water evaporated, from and at 212 deg., per lb. of combustible.

These items are sometimes carried to one-thousandth of a pound and none of them means anything. Any kind of evaporation per pound of coal in any condition is without meaning unless the heating value of the coal is known, and knowing this the efficiency, which is what is desired, can be easily determined.

In *The Engineer* (London) of February 25, 1921, H. V. Whittaker suggests basing the evaporation on "standard coal" and he further suggests giving this theoretical coal a value of 12,600 B.t.u. If all tests were reported on the basis of this standard coal we would

have a definite standard for the comparison of different performances. But why not go a step further and drop the meaningless evaporation per pound of coal altogether and report the result as B.t.u. in the steam per 100 B.t.u. in the coal? This figure is the efficiency without further ado. There is nothing difficult about it. In calculating the test, the B.t.u. in one pound of liquid is subtracted from the B.t.u. in one pound of steam, superheated or otherwise, and multiplied by the weight of water evaporated. The "factor of evaporation" disappears, and the correction for moisture in the steam is just as easy. The B.t.u. per pound of coal is multiplied by the coal weight and divided into the B.t.u. taken up by the steam. The quotient is readily expressed as B.t.u. in the steam per 100 B.t.u. in the coal. The B.t.u. per hour taken up by the steam is easily converted into the obsolescent "boiler horsepower."

The object of all boiler tests is comparison either with some other test or group of tests or with our general experience, which is the same thing. The report should therefore contain everything which will show the relative arduousness of the conditions under which the test was made, including the variation in load.

Tolerances

In all manufacturing operations it is realized that nothing can be made absolutely correct. Therefore tolerances are allowed. Whether the suggested plus or minus 3 per cent for boiler trials is considered too large or not, the fact remains that the performance of guarantees is demanded without any tolerance whatever. It is said that if guarantees should carry a tolerance of, say, minus 2 per cent, manufacturers would raise their guarantees by 2 per cent, relying on this margin. If all manufacturers followed this policy they would be on an equal footing and no commercial harm would be done. As matters stand now, however, the prudent manufacturer virtually sets his own tolerance by guaranteeing something less than he knows he can accomplish; while if the proposed tolerance is adopted he can guarantee all he knows he can do, and let the tolerance take care of the testing errors.

There is nothing whatever to be gained by reporting efficiency more closely than the nearest tenth of one per cent, or even the nearest half. Not only is such apparent precision as 1 in 1000 unwarranted by the exigencies of boiler testing; but engineering judgment is quite unable to make use of it. It is mentally impossible to differentiate between the relative values of 79.9 and 80.1 per cent efficiency and it seems only sensible to call it 80 per cent. Especially is such overprecision absurd, inasmuch as it is not certain that it was not really 79 or 81 per cent, or even a little further away.

Discussion On Accuracy Of Boiler Tests

The discussion of Mr. Cotton's paper was opened by Grant D. Bradshaw[1] who emphasized the author's contention that unavoidable errors creep into a boiler test which, in the aggregate, amount to a considerable figure if they do not compensate one another. That it is doubtful if the accuracy of a boiler test can be guaranteed closer than within plus or minus 3 per cent, he said, was substantiated by Dr. Jacobus' tests on the Delray boilers, where the unaccounted-for item was from 1.51 to 4.83 per cent. This gives to the figure for radiation and unaccounted-for losses a considerable importance when judging the probable value of results. The problem of sampling steam for the determination of its moisture content, he said, was closely allied in principle to that of collecting a gas sample, where differences in the velocity of gas in the steam and in the collecting tube could not be allowed without error.

Henry Kreisinger[2] wrote that errors in making boiler tests were frequently as large as the author gave them, and in some cases even larger. Only by making several trials of 24 hours or longer at the same rating could dependable results be obtained, he said. He discussed some of the sources of error, such as those in measuring the weight of water evaporated, determination of temperature of superheated steam, the collection and preparation of the coal sample, and gave some comparative figures of coal analyses made at different laboratories from the same sample.

The heat balance, he wrote, if accurately computed, is perhaps the most valuable part of a boiler-test report as it shows what the principle losses are and indicates the accuracy of the test. He agreed with the author in the matter of reporting boiler-test results directly in B.t.u. absorbed per pound of coal, or in B.t.u. absorbed per 100 B.t.u. in the coal, and favored dropping the terms "equivalent evaporation" and "factor of evaporation."

W. A. Carter[3] read a discussion which he had prepared in collaboration with C. F. Hirshfeld,[4] C. Harold Berry[5] and Paul W. Thompson.[6] These engineers made a distinction between commercial and research tests, and thought that the probable errors cited by the author were considerably larger than were justified by experience in reasonably careful commercial testing. Treating tests from the research point of view, they discussed the limitations of accuracy which their experience had taught them to expect. They maintained that overall efficiency as now computed expressed fully the accomplishment of the combination of boiler, furnace and grate, and for strictly commercial testing no other result was desired.

I. E. Moultrop[7] wrote that the degree of reliance which can be safely placed upon the results of a boiler test depends on a knowledge of the conditions under which the test was made, and that the value of the results of the test depends upon the experience of the men who conducted it. He commented on a number of subjects, such as steam sampling, determination of coal consumption, the term "actual efficiency" used by the author, and tolerance.

G. C. Vennum[8] wrote that the heat balance of a boiler test was the best medium for judging the accuracy of the report, and for drawing conclusions as to characteristics of performance. He did not believe that the schedule for reckoning the performance of different boilers under various conditions, as proposed by the author, would offer a good basis for comparison. What was wanted was a knowledge of the relation between the energy in the fuel and the energy available in the steam. Boiler design, feedwater temperature, steam pressure and superheat are all factors in the result, he said, and cannot be adjusted to give a true statement of efficiency.

E. H. Tenney,[9] while agreeing that the possibilities of error in conducting a boiler test are within the limits of accuracy, wrote that the author had not pointed out a method for the elimination of such error. Experience has proved, he said, that a boiler test conducted by reputable engineers, in accordance with the present standards laid down by The American Society of Mechanical Engineers, gives results which can be relied upon and which are accurate for comparison with other trials and conditions. He made a point of the necessity of extending the period of the test over 24 hours, or more, and that a heat balance serves as a check on the reported results.

John E. Bell,[10] in acknowledging the truth of the author's statements about the errors in reporting boiler trials, expressed the opinion that very few boiler tests have been made in this country that are accepted unreservedly. He wrote of the difficulty of sampling coal and of determining a satisfactory analysis and heat value. Importance can be attached only to a long series of tests each of at least 24 hours' duration, checked by duplicate tests, he said, and even such tests are worthless unless every effort has been made to attain the highest efficiency and to eliminate all sources of error. The heat balance is used to determine the importance to attach to such tests. He agreed with the author as to the absurdity of carrying results to an unnecessary number of decimal places.

(Continued on page 437)

---

[1] Pres., Andrews-Bradshaw Co., Pittsburgh, Pa. Mem. Am.Soc.M.E.

[2] Majestic Bldg., Milwaukee, Wis.

[3] Research Engr., Detroit Edison Co., Detroit, Mich. Assoc-Mem. Am.Soc.M.E.

[4] Ch. Research Dept., Detroit Edison Co., Detroit, Mich. Mem. Am. Soc.M.E.

[5] Engr., Vice-Pres., Detroit Edison Co., Detroit, Mich. Mem. Am. Soc.M.E.

[6] Tech. Engr., Power Plants, Detroit Edison Co., Detroit, Mich. Assoc-Mem. Am.Soc.M.E.

[7] Assist. Supt., Constr. Bureau, Edison Elec. Illum. Co., 39 Boylston St., Boston, Mass.

[8] M. E., Elec. Bond & Share Co., 71 Broadway, New York, N. Y.

[9] Ch. Eng. Power Plants, Union Elec. Light & Power Co., St. Louis, Mo., Mem. Am.Soc.M.E.

[10] Cons. Engr., 111 Broadway, New York, N. Y., Mem. Am.Soc.M.E.

Economics of Water-Power Development

Discussion of Production, Maintenance and Selling Costs and Fixed Charges—Many Business Hazards and Sometimes Enormous Unrecoverable Losses

By CURTIS A. MEES,[1] CHARLOTTE, N. C.

ECONOMICS as applied to this particular subject relates to the planning and administration of hydroelectric plants in a manner such as to avoid wastefulness and extravagance.

The question of water-power development as a paying proposition, however, is another matter, and since each of these concepts covers a very wide field, it seems preferable at this time to touch, in a very general way only, on the essential factors pertaining to both problems in such a manner as to elicit profitable discussion thereon.

Only in very rare instances is it practicable to depend on water alone for the production of power for commercial purposes, and auxiliary power sources are therefore presumed to be a necessity and their construction and operation is herein considered as concomitant to water-power development.

The power business is akin to that of manufacture, as this term is usually conceived, and the conduct of this business is in many respects successful or unsuccessful in that measure in which the precepts for efficient and profitable manufacture are observed.

In other respects special problems are presented because the product after manufacture must be sold and delivered to the consumer, for instantaneous use in a circumscribed market; and while the selling cost is dependent entirely on the immediate operation of the law of supply and demand, the selling price is generally fixed by regulation.

Just as this is true of any manufacturing enterprise, the success of a power development depends not alone on the perfection of the Physical Structure, i.e., the mechanical equipment, and the Production Structure represented by the operating personnel, but in even greater measure on the efficient functioning of the Commercial Structure and the adequacy and flexibility of the Financial Structure. Many monumental developments are, by the well informed, known to be failures.

It should be readily appreciated, therefore, that in any abstract discussion such as this it is impracticable to attempt anything beyond merely setting forth various items that particularly require consideration in an analysis of the commercial features of a power development, and pointing out in general terms their effect on net earnings, or the margin between selling cost and selling price.

Factors of Selling Costs

Selling cost is made up of raw-material cost, fabrication cost and delivery cost. In each of these costs we have both variable elements subject to fluctuation with quantity production and susceptible to modification, and fixed elements which are not affected by applied economics, once the physical structure has been completed.

To each of these classified accounts there must of course be disbursed, either directly or in proper proportion, managerial supervision, clerical expense, cost of tests and experimental research, and a multiplicity of similar charges which occur in all manufacturing business and involve no peculiar features.

The raw-material cost may be determined by any or all of the following items: rental of water; land and water rights for reservoir; conditioning of reservoir; hydraulic control works; fuel delivered to plant; fuel-handling and storage facilities.

In establishing the feasibility of a development in view of these items, it should be noted that the unit cost of fuel is indeterminate unless quality is fixed by specification. The cost of fuel itself fluctuates with the market, generally in such a manner as to affect all competitors alike. Loss or deterioration in storage is a variable applying equally to fuel or water in a reservoir, and for water as well as fuel the unit cost is indeterminate unless quality and quantity are fixed by specification.

The cost of overflowed lands determines a fixed charge but the useful volume of water available and the effective head at which it may be used are variables, the proper determination of which constitutes the most difficult task involved in power-plant engineering and without the determination of which no unit is established for distribution of the cost.

Curiously enough, the requirements, of purchasers of the product of this factory have a decided influence on the unit cost of the raw material, because while water may momentarily be available, its non-use at that particular moment may result in its utter loss. Prevention of such loss, to the greatest possible extent, is of course an extremely important consideration in the planning of details of the development.

The cost of structures such as dams, gates, pipe lines, coal crushers, oil tanks, etc., determines fixed charges for water or fuel. Operation and maintenance of these structures are variables, and in planning them the engineer may choose whether fixed charges or the variables shall be increased or decreased. For instance, on the one hand a reservoir may be carefully cleared and the expense of so doing becomes a capital cost, or on the other hand only little clearing may be done and floating débris must then be removed from the racks from time to time. This expense then becomes an operating cost.

Fabrication Cost

Of the three cost elements, fabrication is least affected by fortuitous circumstances. In a broad sense this cost is made up of fixed charges growing out of the capital cost of erected power-generating equipment, suitably provided with necessary or desirable adjuncts, housed or located outdoors as the case might be, and of operating charges which include wages, supplies, repair parts, etc. Capital cost of the plant may, however, and quite properly so, lie between wide limits for the same output of product, depending on two totally distinct provisions: uniformity of stream flow and character of service requirements, both as to continuity and uniformity.

It must be borne in mind that the manufactured product is kilowatt-hours, that the time element is just as important as the capacity element and that, in general, a sale is consummated only when capacity is available at the instant of use and for the period of use. Thus the hours of use for any given market must be most carefully predetermined for the proper selection of prime movers, and beyond this capacity must also be provided equivalent to the maximum instantaneous demand for current, else the product will not be salable.

It is readily apparent, therefore, that, in general, only one-half as much generating equipment is necessary for a 24-hour load as for a 12-hour load and that for a 24-hour load only one-half as much equipment is required to produce a perfectly uniform output as for a demand which fluctuates from zero to double the average load.

Capacity for the water-power plant having been fixed by the character of the load, there follows the determination of proper capacity for the auxiliary plant.

While this choice may possibly be dependent on a volume of output imperatively continuous, it is much more likely that it will hinge on meteorological criteria. One need only to mention that, in the first place, the run-off from any drainage area or the discharge of a stream fluctuates between very small quantities at times of drought and quantities sometimes many thousand times greater when in flood with, in general, little regularity about the occurence of either stage, and that, in the second place, the average usable discharge for some years is considerably lower than for others.

Natural stream flow is determined either by measured discharge or by computed run-off based on recorded rainfall. From these data there is estimated the average annual stream flow and these determinations will approach correct values according to the length

---

[1] Mees & Mees. Mem. Am.Soc.M.E.

Presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

of the period of observations considered. These findings should be modified by an accuracy factor.

Depending on the topography of the development site, either at the power plant or on the drainage area above it, storage capacity may be created of such extent as to afford either daily or seasonal regulation. By daily or weekly regulation is meant the conservation of natural stream flow during either 24 hours or 7 days for use during those hours only when load can be sold. By seasonal regulation is meant the controlled, artificial increase of natural stream flow out of waters stored during periods of run-off in excess of the usable quantity.

Regulated stream flow having been estimated for each year and for the average of all years of record, it will be found that, when daily discharges are plotted as shown on Fig. 1, one can very readily forecast what power output is continuous and what additional output may be sold for any predetermined portion of the year, as this is fixed by low-water stages.

For high-water stages, while there will be an excess of water available, it frequently happens that loss of head results from this cause and in that event restriction of output must be determined similarly as for low-water stages.

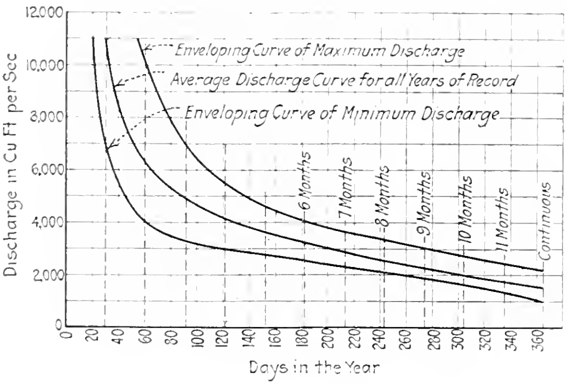


Fig. 1 Stream Flow During Various Portions of the Year

Only in exceptional cases is it commercially practicable to develop a water-power plant for an output based on absolute minimum stream flow, and it is therefore customary to base earnings on that output which may be produced in the average year.

The equipment of the auxiliary plant is then primarily fixed by that capacity which may be necessary to supplement the water output of the lowest year to bring it up to that of the average year. Beyond this, except for possible emergency capacity, it becomes a question of dollars and cents, based on salability of secondary power and rates which may be secured for this service, as to the extent to which one can afford to install auxiliary equipment for the conversion of short-term water output into continuous combined water and auxiliary output.

Dependent on local conditions, the capacity which must be installed for emergency service might finally be the determining factor in equipment selection. It may happen that in flood a water-power plant may be completely incapacitated through loss of head so great as to make impossible the maintenance of synchronous speed. Ice blocks also might completely prevent operation of a plant. For such cases, under certain load conditions it might become imperative to provide 100 per cent stand-by capacity.

Legitimate capital cost and resulting fixed charges must therefore be most carefully determined for each individual project and comparative figures are not necessarily indicative of their propriety.

Another so-called fixed charge is quite beyond control and that is taxes. Cost of supplies and repair parts are regulated by the law of supply and demand and cost of labor may or may not be determined similarly according to the extent to which organized labor can enforce its dicta as to rules and rates.

One phase of control as to fabrication cost is of particular importance in this business and that is the continuous, most efficient conversion of raw material into the finished product. This is not a question of workmanship but rather one of intelligent direction. Loss in kilowatt-hours produced out of available water and per unit of fuel may, under improper allocation of part loads to various equipment items, be considerable and difficult of detection.

Delivery Cost

Delivery of power may be effected either direct to the ultimate consumer or at wholesale to a distributor and the cost of delivery depends very largely on the method in vogue or proposed, but the greater cost of retail service is offset by a rate differential such that in the end earnings on the unit of investment are not, in general, materially affected by the adoption of one rather than the other of these plans.

A transmission system may be considered to be composed of trunk lines, secondary lines and feeders. The cost of trunk lines depends primarily on the proximity of the power plants, principal and auxiliary, to each other and to the center of load, whereas the cost of secondary lines and feeders depends largely on quantity requirements, both as to capacity and period of use, or what is synonymous, the number of consumers served and the density of the market.

Secondarily the cost of transmission lines is affected by the relative importance of assured continuity of service and in addition the locality variable enters into the problem. Urban work, values of land, size of properties crossed and similar circumstances greatly affect the cost of lines. The rigors of climate, cyclones and the prevalence of electrical disturbance require careful consideration and arbitrary regulations as to structural details must frequently be observed whether the cost is justified or not.

Conductor cost should be balanced for permissible line loss at prevailing rates, and transformers, to prevent excessive core losses, should be so proportioned as to carry capacity loading as much as possible.

Fixed charges for distribution plant, based on right-of-way costs, leases or fees and equipment and structures costs may therefore also vary between very wide limits with perfect propriety.

Operating costs of the system depend on topography, multiplicity of lines, substations and terminals and their accessibility by rail or highway, weather conditions and special maintenance requirements for city lines, stream or railroad crossings.

Factors of Selling Price

Selling price depends on either the cost of a competitive product or rates fixed by a regulatory body; i.e., in the last analysis, by the purchaser.

The competitive product may be either purchased electrical power or produced power. Regarding the practicability of competition with purchased power, there can of course be no controversy. However, the feasibility of building a water-power plant or system for the competitive sale of electricity with that otherwise produced is not always so readily established. The selling cost of high-load-factor power, produced in large volumes with fuel at reasonable cost, is not, in general, appreciably higher than that produced by water, if in the latter case the transmission cost amounts to much.

In small fuel plants, however, and particularly when operating at a low load factor, it is at the present time impossible to produce power at a cost as low as that at which reasonably near and economically developed water power can be delivered.

But the efficiency of water-power-plant equipment and the overall efficiency of water-power production are already very high and only little improvement can ever be effected, while the efficiency with which fuel power is produced, both as to fuel transportation and conversion, is exceedingly low and great improvement may confidently be expected. Hence the present margin between selling costs of power produced by these several methods is not so great but that a pronounced improvement in the effective use of fuel may, in a great measure, jeopardize the investments made in water-power plants.

Effect of Regulation

To regulation we owe general recognition as public utilities and as such we are granted eminent domain for transmission-line rights of way, and sometimes for water rights. This means that we cannot be arbitrarily stopped from proceeding with certain plans

of development and that we do not have to pay very much more for property rights and easements than the market value thereof.

The impression prevails that, under regulation, the income of a utility is guaranteed. This is an utter fallacy. The income is merely limited, and in too many cases unfairly limited. Within the last few years earnings on securities have in too many instances had to be paid out of funds which should properly have been devoted to maintenance, or possibly unwise curtailments have had to be made in personnel. Deferred maintenance is the most serious disease with which a utility may be afflicted.

Theoretically, regulation is not so bad because, to that extent to which it is insisted that a high standard of service shall be maintained without discrimination as to rates, it benefits those who conscientiously administer this industry. This, however, is practice or service regulation and not rate regulation. Where competition is free, economic law operates to prevent continued exorbitant profit taking, the art is developed, and progress is made. Particularly with the power industry would this be the case.

Bearing on this question, the following issues are important:

Permitted rates of return on investment are inadequate
Certain otherwise irretrievable losses of income may not be covered by rates
Certain non-insurable risks may not be offset out of rates
Unfair competition is not throttled
Efficiency receives no reward.

A public utility that is not constantly expanding is decadent. New money must at frequent intervals be secured to finance extensions required from time to time, oftentimes under instructions of the commissioners.

In principle the returns on investment permitted under regulation are intended to be sufficient only for payment of interest and dividend, and for the perpetuation of the investment out of a depreciation reserve. The establishment of a sinking fund, out of earnings, is not proposed and borrowed money must therefore be kept in perpetuity.

It is of course both logical and proper that the depreciation reserve fund should be reinvested in the property to cover cost of extensions, but this money should in the first place, under healthy growth, be inadequate, and furthermore, once so invested the resources of the corporation become so non-liquid as to expose the administration to considerable financial embarrassment in cases of emergency when immediate funds should be available. At such times the desperate need for money is naturally and not without warrant taken advantage of because credit has been impaired.

Composition of Financial Structure

The financial structure which supports this industry is, in general, composed of:

A Lender: To whom payment of interest is compulsory under the security which he holds and which amounts to the entire property owned.

The lender sees to it that this is a safe risk. His criterion generally is that estimated net earnings shall be at least two times and generally two and one-half times the bond interest.

A Preferred Investor: In stock whose payment in dividends is substantially guaranteed under a lien subordinate only to the bondholders' equity. This investment is attended with all sorts of management and non-insurable structural risks.

A Speculative Investor: In common stock whose dividends are paid only if there is anything left over.

Customary and proper rates of return under respective security holdings may be set up as follows, based on the existing actual, not legal, interest rate for short-term collateral loans of equal volume:

	Per Cent				
Actual interest rate..	4	5	6	7	8
Bond interest.............	5	6	7	8	9
Preferred-stock dividend ...	7	8	9	10	11
Common-stock dividend....	10	$11^{1}/_{2}$	13	$14^{1}/_{2}$	16

One court held that the average rate of return on the entire investment should be three per cent above the existing interest rate.

The actual rate of return on capital ordinarily invested in any business enterprise is oftentimes lost sight of because it is confounded with the percentage of net profits made on units of output. If a turnover can be made four times in a year and a net profit of 6 per cent is made each time on the goods sold, the actual rate of return is 24 per cent and not 6 per cent. This is not at all an extraordinary performance.

A power plant is exceedingly fortunate if it makes a turnover once in four or five years. Returns permitted under regulation lie between 6 and 8 per cent. Some commissions may possibly, but not to our knowledge, allow more.

An ideal organization is one-third each of bonds, preferred and common stock and, with brokerage included as a capital cost, net earnings should be permitted as follows, as based on actual interest rates: 4 per cent and $7^{1}/_{3}$ per cent; 5 per cent and 8.5 per cent; 6 per cent and $9^{2}/_{3}$ per cent; 7 per cent and $10^{5}/_{6}$ per cent; 8 per cent and 12 per cent.

When commissions arbitrarily fix a rate of return which is not in keeping with financial conditions, money must be secured from such sources and at rates such that interest payments will remain within earnings. The result of non-observance of these fundamentals has been that utilities have been compelled to mortgage too large a part of their equities, bonded indebtedness has become dangerously great, and no new funds are available. Today permissible earnings are, in general, insufficient to attract new capital.

Unrecoverable Losses

Based on the law that utilities should not make unjust profits, it should equitably follow that they are entitled to protection against unjust losses. In financing such undertakings reliance is placed on constancy of return and rates are predicated on probable normal output. Industrial activity, however, varies in cycles and a falling off of normal business cuts into earnings in a manner which cannot be guarded against because, in general, equipment capacity kept in readiness to serve under contract provisions cannot be otherwise put to work. Contract minima, ordinarily, assure nothing more than the earning of bond interest alone.

Losses of output and therefore earnings are sometimes seriously affected by storm or flood conditions, against which the property cannot be guarded. Fire and breakdowns may, without fault on the part of the operating personnel, render normal service impossible and emergency service under any of these conditions is apt to be very expensive, but nevertheless practically obligatory. Interference with business by strikes, declaration of martial law, etc., mean unavoidable loss of income.

Against none of these contingencies can the management protect itself as this is customarily done and essential to safe business conduct, i.e., by the setting aside of a contingency or, as it has been called, a "stabilization," fund.

As to water power particularly, a development condition prevails which must be taken into account. The cost of prime movers is almost invariably only a small percentage of the total cost of all structures which must be completed in order to be able to manufacture any power whatever and the progressive development of the plant to meet the growing requirements of the market is more or less impracticable. Overdevelopment, therefore, is the rule, and since, for purposes of rate fixing, earnings are predicated on possible output instead of on probable demand, certain losses of income occur during the period required to bring sales up to the developed output capacity.

Under these unalterable circumstances the loss of earnings which are necessary to offset interest and dividend payments and the setting aside of funds to cover a depreciation which is actually going on, may legitimately be treated as development costs, either to be included in the capital cost on which the rate of return is based, or otherwise covered in the rate composition. One court, however, has held that any compensation for business losses in the adjustment of rates leads to a "reductio ad absurdum."

Quite enormous losses have been incurred by power companies due to great delay in the granting of those higher rates which the commissions by their own rulings have established as having been justified. Such requests of course grew very largely out of increased operating costs and to that extent to which they represent operating costs only and not the earnings of capital invested during the period of high prices, a future reduction in rates is to be expected. It remains to be seen whether it will be permitted that losses already sustained can be recouped before reductions in rates are ordered.

Floods may destroy dams and cause tremendous damage to persons and property. Lightning may burn up transformers and other equipment. Falling trees, wind or sleet storms may cut transmission lines in two and by short-circuit magnify the direct damage. Death-dealing currents take their toll of life regardless of even extraordinary precautions and, while such a risk is insurable, the amounts involved are limited and in any event defense in litigation is very costly.

Premature destruction of structures and equipment is not covered by the depreciation reserve and accidents requiring the outlay of additional capital without a corresponding increase in earning capacity can be covered only by a contingency reserve, provision for the accumulation of which should be included in the rate structure.

The antiquation or obsolescence of parts or even the whole of the plant through the possible development of novel equipment or methods for power production at lower selling cost than that possible with equipment now available or even by water power at all, is not too remote a happening to be given consideration, and this contingency should, in a measure at least, be offset by liberal present earnings.

That efficiently operating public utilities promote the welfare and growth of any community is obvious. If, therefore, the regulatory bodies would take a proper pride in the efficiency of the utilities which they regulate and would do everything to make it possible for the companies to deliver on sound financial bases the best service at the lowest rate, they would be doing their communities a signal service. Also in order to allay much of the antagonism toward public utilities fostered by political attacks, regulatory bodies should demand of all utilities under their jurisdiction, including the municipal plants, a uniform system of accounting such as to expose many of the fallacies now entertained.

Rates for electrical current are presumably based on cost of the service, painstakingly predetermined for each particular case. Cost of service is, however, susceptible to considerable modification depending on the degree of efficiency attained in administration of the property. If earnings are absolutely limited, the incentive to efficiency is lost and that is one of the most discouraging features of rate regulation. Zealous communism is only a theory.

Having in broad terms indicated some of the more vexing problems that confront the industry, an attempt will now be made to present as concisely as possible a schedule of economic considerations, the observance of which may lead to more satisfactory solution of these problems.

As to the Physical Structure

Design and Construction of Plant:

1 *Thorough Preliminary Study:* Geologically, meteorologically, legally and commercially. Such study requires time and money and both are too often curtailed.

2 *Control of Entire Stream:* To make regulation most effective and to prevent competitive injury.

3 *Degree of Stream-Flow Utilization:* The extent to which secondary power may be developed for sale or conversion into primary power.

4 *Best Use of Land or Water Rights:* Mechanical or automatic pond-level control to maintain a maximum head.

5 *Plan of Development or General Layout:* Location, utilization of site, (extent, method) progressive construction and stream regulation, location of auxiliaries, territorial control of market.

6 *Type of Structures or Detail Layout:* Kinds of dams, character of water channels, equipment setting, equipment housing, effective design for tail race, use of adjunct equipment, and belt-transmission trunk lines.

7 *Type of Equipment:* Prime movers suitable for characteristic load and service. Effective accessories. Adequate recording instruments, High-efficiency draft tubes and use of ejectors or tail-water elevation control. Air coolers for generators. High-potential generation or transmission. Automatic or semi-automatic generating stations and substations.

Selection of Auxiliary Equipment. Ordinarily this should be high-capacity, quick-response, equipment of low first cost. Dependability is much more important than economy of operation, although low attendance costs are to be attained if possible. For this purpose there are best adapted steam turbines and boilers equipped with mechanically atomizing oil burners or powdered-coal-burning equipment. Heat balance is of secondary importance. Electrically operated auxiliaries are better for quick starting.

8 *Capacity of Equipment, Unit and Total:* Adaptability for characteristic load changes. Maintenance of balance, large and small units. Amplitude of reserve capacity. The cost of prime movers alone is generally only a small proportion of the total development cost and sufficient spare capacity should be installed.

9 *Economical Construction:* Effective building organization, executive, clerical, supervisory. Conscientious inspection. Economical purchasing. Reduction of unproductive construction period to the economical minimum. Assurance of service continuity by careful testing out.

10 Interconnection between power systems.

As to the Production Structure

Operation of Plant—Production and Distribution:

Routine:

1 Regular inspection and tests; owner's installation and customer's installation.

2 Effective service records and accounting.

3 Proper use, maintenance and loading of equipment.

4 Maintenance of balance between water and auxiliary power. Assuming storage to exist, it is generally best when an auxiliary plant requires operation, to operate it at full load, taking peaks on the water-power plant.

5 Fuel-efficiency control. Volume purchase by combined interests on specification basis under strict supervision.

6 Perfect load dispatching based on meteorological observations.

Administrative:

1 Proper selection of employees.

2 Education and training of employees—general, specific. Explicit written instructions should be furnished each employee setting forth his duties, methods of accomplishment and reasons for performance. Maintenance of discipline.

3 Development of loyalty and coöperation in employees. This may be brought about by fair dealing, manifest integrity of purpose, welfare work, encouragement by public recognition of especially meritorious service, appreciative adoption of suggestions and partnership in the business which should be made easy.

4 Acquirement of expert detail knowledge of the business in a manner to make information instantly available for effective analysis and synthesis.

5 Research and investigation to perfect methods which information should be coöperatively interchanged.

As to the Commercial Structure

Selling the Service:

1 Perfection of service.

2 Saturation of system; development of rural loads.

3 Selection of load. While the service requirements in a given market are quite characteristic, some improvement is generally possible. The diversity factor may be improved, the maximum demand may be cut down and the load factor may be raised by the encouragement of off-peak loading. Electrolytic processes, electrical industrial heating, domestic use of heat in all manner of appliances, and off-peak pumping and similar intermittent service suggest themselves as desirable loads.

4 Protective contract provisions: Service classifications, unavoidable interruptions of service not to be penalized, maximum demand limitations, power-factor penalties and bonus, fuel clauses, agreement to pass along extraordinary taxes, cost-of-living adjustment.

5 Classified service accounting to detect inadequacy of certain rates.

6 Development of a sympathetic, understanding attitude in consumer by intelligent publicity and helpful advice as to proper use of current and equipment.

7 Avoidance of too preponderant a load from either one or just a few consumers or either one or several closely allied industries.

As to the Financial Structure

Providing Funds:

1 Balance in equities of classified security holders.

2 Adequate working capital provisions.

3 Bond issue under a series mortgage.

4 Consumer partnership.

5 Reinvestment of depreciation reserve.

In all of the above it must be remembered that small plants require different treatment from that accorded to big plants and that isolated plants must be quite differently planned from those forming part of a chain or system.

In the light of what has gone before the question as to whether water-power development is a paying proposition may now more intelligently be answered.

Water-power development *does* pay—never big, however, but even very small plants of high unit cost entirely justify their existence. It *does not* pay at this time because the public will not invest in securities at interest or dividend rates which permit the financing of such undertakings on a basis of present permissible earnings.

However, these facts notwithstanding it is a gloriously constructive work and, because of the individuality of each project and the ever present hazard, it certainly may be ranked as the greatest sport on earth.

Heat Losses from Bare and Covered W. I. Pipe at Temperatures up to 800 Deg. Fahr.

By R. H. HEILMAN,[1] PITTSBURGH, PA.

High-temperature superheated steam running up to 800 deg. fahr. and high-temperature chemical processes are being more and more widely used, and accordingly the question of heat losses from pipes under such temperature conditions is one of importance to the engineering profession.

This paper presents the findings of an experimental investigation conducted in the Mellon Institute of Industrial Research of the University of Pittsburgh. The losses from bare wrought-iron pipes have been measured for temperatures up to and including 800 deg. fahr. They have been studied carefully for pipes of various diameters, and empirical formulas are presented whereby the loss from insulated pipes of any diameter may be readily calculated.

MANUFACTURERS of pipe coverings often are required to guarantee that the application of a specified heat-insulating covering will effect a certain percentage saving of the heat which would be lost entirely from a bare pipe. Since the bare-pipe loss is the 100 per cent value against which the losses from the covered pipe must be compared, it is essential that the loss from the bare pipe shall be known accurately.

Many investigators have studied the heat losses from bare pipes. Perhaps the most noteworthy of those experimentalists was the French physicist Péclet. Owing, however, to the fact that Péclet's experiments were conducted at very low temperatures, while subsequent investigators confined themselves mostly to one pipe size only, the Mellon Institute deemed it advisable to carry on the research to much higher temperatures and on 1-in., 3-in., and 10-in. pipe.

TABLE 1 LOSSES FROM HORIZONTAL BARE-IRON STEAM PIPES

From 100 Lineal Feet of Pipe per Month of 30 Days with Steam in Pipes 24 Hr. per Day. Coal at $4.00 per Ton of 2000 Lb.

Steam Press.	Hot Water			10 Lbs.			80 Lbs.			120 Lbs.			160 Lbs.			200 Lbs.			200 Lbs. and 100° F. Superheat.			275 Lbs. and 250° F. Superheat.		
Temp.	180° F			239.4° F.			324.0° F.			350.0° F.			370.7° F			387.9° F.			487.9° F			664.3° F.		
Pipe Size	Dollars Loss	Pounds Coal	B.T.U. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.T.U. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.T.U. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.T.U. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.T.U. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.T.U. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.T.U. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.T.U. per Lineal Ft. per °F. Diff. per Hr.
½	1.32	526	.605	2.24	897	.670	3.92	1566	.779	4.51	1805	.815	5.25	2010	.846	5.53	2210	.875	8.60	3440	1.040	16.15	6460	1.375
1"	1.91	763	.878	3.26	1305	.973	5.72	2290	1.138	6.25	2601	1.178	7.27	2910	1.242	8.07	3230	1.280	12.56	5026	1.520	30.55	12220	2.600
1½	2.65	1060	1.220	4.54	1818	1.357	7.98	3190	1.586	9.28	3710	1.676	10.42	4165	1.751	11.36	4550	1.804	17.94	7175	2.170	34.30	13720	2.920
2"	3.24	1297	1.491	5.36	2142	1.600	9.78	3910	1.943	11.37	4549	2.052	12.75	5100	2.145	14.00	5600	2.220	22.10	8825	2.670	42.20	16890	3.590
2½	3.86	1545	1.778	6.65	2660	1.984	11.66	4660	2.320	13.66	5460	2.464	15.25	6100	2.564	16.70	6690	2.650	26.64	10650	3.220	50.50	20200	4.300
3"	4.56	1824	2.100	8.24	3292	2.460	13.88	5550	2.760	16.14	6450	2.910	18.04	7210	3.030	19.84	7945	3.150	31.60	12640	3.820	58.25	24300	5.170
3½	5.18	2070	2.380	8.89	3554	2.655	15.82	6325	3.145	18.31	7322	3.305	20.50	8200	3.450	22.60	9040	3.580	35.90	14360	4.345	69.00	27600	5.860
4"	5.78	2305	2.650	9.87	3950	2.950	17.70	7075	3.520	25.50	8200	3.700	22.85	9145	3.842	25.15	10060	3.981	40.10	16040	4.850	72.40	30920	6.580
4½	6.35	2540	2.920	10.94	4370	3.260	19.48	7790	3.878	22.60	9025	4.075	25.30	10120	4.250	27.75	11100	4.400	44.05	17620	5.326	85.60	34240	7.286
5"	6.95	2780	3.200	11.97	4790	3.575	21.25	8500	4.232	24.62	9850	4.450	27.60	11050	4.650	30.40	12140	4.805	49.35	19740	5.960	94.50	37800	8.050
6"	8.20	3280	3.775	14.21	5680	4.240	25.30	10110	5.024	29.30	11720	5.295	32.80	13120	5.522	36.00	14420	5.715	57.50	23000	6.955	112.50	45000	9.580
7"	9.40	3760	4.325	16.18	6470	4.826	29.10	11640	5.782	33.70	13480	6.090	37.60	15040	6.324	41.60	16650	6.560	66.25	26500	8.010	129.00	51550	10.97
8"	11.00	4398	5.050	18.25	7300	5.450	32.60	13030	6.455	37.65	15050	6.840	42.40	16940	7.125	46.05	18420	7.300	74.75	29900	9.050	146.20	58500	12.44
9"	11.62	4650	5.350	20.35	8130	6.070	36.25	14500	7.210	42.10	16840	7.600	47.22	18900	7.950	51.98	20790	8.230	83.50	33400	10.10	162.60	65050	13.84
10"	12.68	5065	5.925	22.05	8820	6.584	40.20	16100	8.010	46.70	18690	8.440	52.30	20910	8.805	57.75	23100	9.150	97.50	39000	11.18	180.00	72000	15.30
12"	15.00	6000	6.995	26.44	10580	7.890	47.40	18950	9.425	55.40	22120	10.00	61.76	24700	10.40	70.00	28010	11.14	109.30	43700	13.22	213.50	85500	18.18
14"	16.60	6635	7.625	28.90	11560	8.620	52.00	20800	10.34	60.50	24200	10.92	67.50	27000	11.36	74.10	29650	11.76	119.40	47740	14.43	233.00	93300	19.85
16"	18.82	7525	8.650	32.80	13120	9.790	58.76	23500	11.70	68.40	27320	12.34	76.10	30410	12.80	84.25	33700	13.35	135.00	54000	16.34	265.00	106000	22.55
18"	21.00	8400	9.650	36.10	14460	10.80	65.40	26150	13.00	76.50	30570	13.80	85.50	34200	14.38	93.75	37500	14.87	151.20	60500	18.30	297.50	119000	25.30

[1] In this table coal has been figured at $4.00 per ton of 2000 lb., 13,000 B.t.u. per lb. of coal; labor, boiler-room expense, etc., taken at $1.00 per ton, making total value of coal fired at $5.00 per ton. Boiler efficiency taken at 70 per cent; air temp. 70 deg. fahr. Experimental data obtained at the Mellon Institute.

The 1-in. pipe was selected for test at the higher temperatures, as the relatively small amount of heat loss from a 1-in. pipe could not greatly affect the room temperature. This pipe was run up to a temperature of 800 deg. fahr. The average room temperature throughout this test was 81 deg. fahr. and the temperature did not vary more than 1.8 deg. fahr. during its progress.

The locations of the curves for the 3-in. and the 10-in. pipes were obtained by experiment at the lower temperatures, as indicated by the solid lines in Fig. 1. The values for the higher temperatures are the result of extending the curves parallel to the curve obtained for the 1-in. pipe. This procedure was necessary because of the fact that the larger pipes could not be raised to the higher temperatures without raising considerably the temperature of the room.

In Table 1 the loss in dollars and cents and in pounds of coal per 100 lineal feet of horizontal bare iron is tabulated for temperatures up to 664 deg. fahr. The loss varies from $1.32 for 100 lineal feet of ½-in. pipe at 180 deg. fahr. to $297.50 for 100 lineal feet of 18-in. pipe at 664 deg. fahr.

THEORY OF HEAT LOSS FROM INSULATED PIPES

In order to calculate the loss of heat from an insulated pipe or boiler, it is necessary to know the total temperature drop from the pipe to the surrounding air; and to enable one to make accurate calculations it is required that the component temperature drops be known.

The total temperature drop from the steam inside a pipe to the outer air can be considered as made up of four components, as follows:

a Drop from steam to the outer surface of the pipe
b Drop from outside surface of the pipe to inside surface of the insulation
c Drop from the inside surface of the insulation to the outside surface of the insulation
d Drop from outside surface of the insulation to the surrounding air.

---

[1] Industrial Fellow, Mellon Institute. Jun. Mem. Am.Soc.M.E.

Abridgment of paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

The temperature drop from the steam to the outer surface of the pipe depends upon the resistance to heat flow offered by the film at the inner surface and the resistance offered by the iron wall of the pipe. No attempt was made to measure this temperature drop in the present investigation, as it was considered to be so small as to be negligible.

The temperature drop from the outer surface of the pipe to the inner surface of the covering for 1-in., 3-in., and 10-in. pipe is shown in Fig. 2. These curves show that the temperature drop increases as the pipe diameter decreases. A test was also made on a 3-in. pipe with an air space of 1.2 in. between the surface of the pipe and the insulation. By comparing this curve with the curve for an air space of 0.1 in., it is observed that the temperature drop for a 1.2-in. air space is only a few degrees more than for an air space of 0.1 in. This is probably due to the fact that for air spaces much greater than 0.2 in. convection currents are increased, thus causing an increase in heat loss. An examination of Fig. 2 shows that the temperature drop for a 0.1-in air space is approximately equal to that for 0.1 in. of commercial insulations, so that this temperature drop can be neglected in calculations and the pipe covering considered as fitting close to the pipe with the pipe temperature and the temperature at the outer surface of the covering as the temperatures bounding the covering.

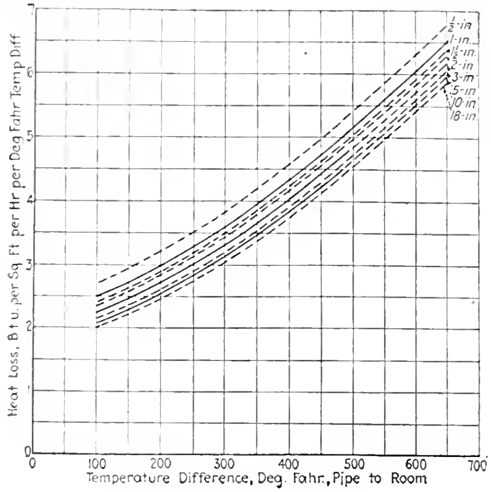


Fig. 1 Bare-Pipe Loss Curves

The drop in temperature, or the temperature-gradient curve through the insulation, depends upon the thickness of the covering and the curvature. In a cylindrical covering the resistance to heat flow diminishes as the outer surface is approached, the temperature drop becomes less, and the gradient curve is bowed downward if the curvature alone is taken into consideration. However, the absolute conductivity decreases as the outer surface is neared, with a consequent bowing up of the gradient curve, and the two tend to counteract each other, so that the temperature-gradient curve may be bowed either up or down or be a straight line, depending upon the curvature of the cylinder. The temperature-gradient curve for a flat surface should bow up.

It is highly desirable that tests should be conducted on commercial steam-pipe coverings of different thicknesses and at different temperatures, in order to obtain mean absolute-conductivity curves for the different thicknesses.

The temperature drop from the outer surface of the insulation to the surrounding air depends upon the amount of heat emitted by radiation and air contact. This in turn is dependent upon the nature of the surface of the body, the shape of the body, the excess of its temperature over that of objects to which radiation takes place, and the absolute value of the temperature of these bodies. Commercial steam-pipe coverings are invariably covered with a canvas jacket. From the above-mentioned facts it is obvious that the loss from a canvas surface at a given temperature is independent of what is under the canvas, so that, if the canvas-loss law can be ascertained, this law may be applied to the loss from steam-pipe coverings and thus the temperature of the outer surface of the insulation, can be determined. In making calculations of heat loss through an insulation, it is absolutely necessary to know the temperatures at the inner and outer surfaces.

Péclet made a careful study of the heat emissivity from various surfaces, canvas surfaces included. As mentioned, however, his experiments were conducted at relatively low temperatures. McMillan[1] made a study of the heat emissivity from a canvas surface in his study of commercial steam-pipe coverings, but confined his experiments to one pipe size only. Nevertheless, McMillan's results in the form of a curve present a readier means of calculating the losses from steam-pipe coverings than do Péclet's, whose observations, while taking all the variables into consideration, are in too complicated a form to provide a ready means of calculation.

Since McMillan's canvas-surface-loss curve was obtained from experiments on one pipe size only, this curve can be used in making calculations on coverings of a diameter approximately the diameter of the coverings tested. In order to be able to calculate the loss of heat from pipe coverings of any diameter, it has been necessary to obtain the canvas-surface-loss curves for various diameters. Accordingly, coverings were tested on the 1-in., 3-in., and 10-in. pipes used in determining the bare-pipe losses. The average outer diameters of the coverings used were 3.1 in., 9.5 in. and 17.2 in. The results of these tests are shown in Fig. 3.

In order to simplify the calculations necessary to determine the loss of heat through coverings of various diameters, an equation for the three curves shown in Fig. 3 has been derived. In this equation

$$T_d = \frac{272.5\,h}{h + \dfrac{564}{D^{0.19}}} \qquad [1]$$

T_d = temperature difference between canvas surface and room, deg. fahr.
h = total B.t.u. loss per hour per square foot of canvas surface
D = outer surface diameter, inches.

This equation is approximately accurate for diameters up to 2 ft.

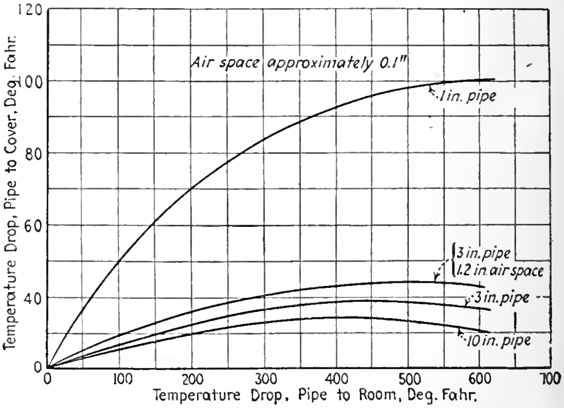


Fig. 2 Temperature Drop from Outer Surface of Pipe to Inner Surface of Covering

Thermocouples were used in determining the canvas temperatures. During this investigation it was found that the couple when just inserted under the canvas, would invariably read low. This difficulty was overcome by inserting it under the canvas for a distance of several inches, this distance depending upon the size of the couple and the temperature of the covering.

Sample Calculations

A covering 2 in. thick, having a mean absolute-conductivity coefficient of 0.56, is placed on a 4½-in. outside-diameter pipe maintained at a temperature of 400 deg. fahr. The temperature of the surrounding air is 700 deg. fahr. Determine the heat flow H in B.t.u. per hour per sq. ft. of pipe surface.

---

[1] Trans. Am.Soc.M.E., vol. 37, p. 928.

The heat flow through a cylinder is given by the following equation:

$$h = \frac{K(T_1 - T_2)}{r_1 \log_e \frac{r_2}{r_1}} \quad \ldots\ldots\ldots\ldots [2]$$

where T_2 is the temperature at the outer surface of the covering. To obtain T_2, knowing only T_1, the pipe temperature and T_3, the room temperature, it is necessary to change the form of the equation so as to include T_4, thus:

$$h = \frac{K(T_1 - T_3 - T_4)}{r_2 \log_e \frac{r_2}{r_1}} \quad \ldots\ldots [3]$$

in which

K = mean absolute conductivity of insulation
r_1 = radius of inner surface of insulation, inches
r_2 = radius of outer surface of insulation, in inches
T_4 = value given by Equation [1].

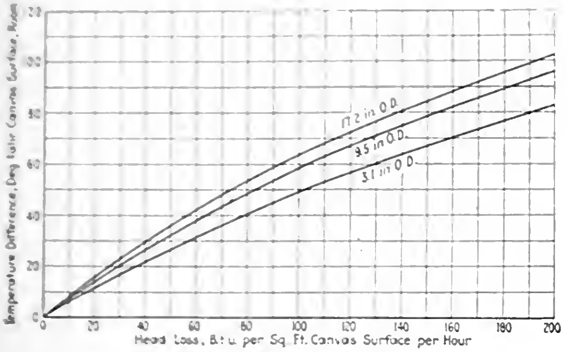


Fig. 3 Canvas-Surface Loss-Curves

Substituting in [3], there results

$$h = 0.56 \left[\frac{400 - 70 - \dfrac{272.5\,h}{h + \dfrac{564}{8.5^{01.9}}}}{4.25 \log_e \dfrac{4.25}{2.25}} \right]$$

$$= 0.207 \left(330 - \frac{272.5\,h}{h + 375}\right)$$

$$= \frac{-\sqrt{363.1 \pm 363.1^2 + 4 \times 25{,}600}}{2} = 60.4$$

whence $H = 60.4 \times \dfrac{4.25}{2.25} = 114$ B.t.u. loss per sq. ft. of pipe surface.

The temperature of the outer surface of the covering can be obtained by substituting the value of h in the equation $T_4 = 272.5\,h/(h + 375)$, reducing to $T_4 = 37.6$. Therefore the temperature of the outer surface of the covering is

$$37.6 + 70 = 107.6 \text{ deg. fahr.}$$

Discussion

In discussing Mr. Heilman's paper, L. L. Barrett[1] wrote that the author's statement that a 0.1-in. air space between the pipe and insulation increased the overall loss was not apparently borne out by the further statement that the temperature drop for a 0.1-in. air space was approximately equal to that of 0.1 in. of insulation. It was unfortunate, he wrote, that the impression was given that conductivity was related to the curvature of the covering. Conductivity was a specific property of the material, independent of shape. He wrote at length on the theory of heat loss from pipes, and the relation between conductivity and temperature.

L. B. McMillan[1] wrote that it was interesting to note that the author's results on losses from various sizes of bare pipes showed smaller differences between large and small pipes than those given by Paulding. He was of the opinion that the author's curves were more nearly correct than Paulding's. He pointed out that temperature drop depended not only on resistance of the air space but also on the amount of heat flowing across the air space and out from the insulation. He also called attention to the apparently contradictory statement regarding the 0.1-in. air space, and to the fact that the absolute conductivity was a specific property of the material and was independent of its shape or size.

B. N. Broido[2] called attention to the property of superheated steam of not readily giving up its heat, and said that, although this was less evident in covered than in bare pipe, it still was an important property to take advantage of in power plants because no covering could be a perfect insulator. In the table of losses from bare-iron steam pipes, he said, the author made the same error as many of the pipe-covering manufacturers in giving the pounds of pressure of the steam and the superheat in degrees fahrenheit, corresponding to the total temperature, which gives the impression that the tests are made with superheated steam actually flowing through the pipe, while as a matter of fact these tests are made with electrically heated pipe. The radiation losses, as well as the temperature of the wall, if superheated steam of the given temperature and superheat were flowing through the pipe, would be considerably less.

Discussion on Accuracy of Boiler Tests

(*Continued from page 430*)

Nevin E. Funk[3] asked whether the author's statements regarding the sampling of steam were a theory or had been subjected to rigorous test. He pointed out that saturated steam was not, as a rule, generated in modern boilers as they are generally equipped with superheaters. He could see no reason for stating the performance of a boiler in B.t.u. per 100 B.t.u. in the coal, as suggested by the author, as it would be the same as stating the efficiency.

Edwards R. Fish,[4] who presented the paper in the absence of the author, said, in closing the discussion, that differences of opinion had been expected, and that the opinions expressed only illustrated the fact that the whole art was more or less uncertain. He spoke of the new boiler test code and its emphasis upon accuracy. The boiler tests shown by the author were of commercial rather than research type and were subject to greater variations than the latter type, but were made by highly trained experts with the best of apparatus and refinements. The author's remarks about sampling steam were based on theory; no attempt had been made to check them.

In a discussion submitted after the meeting R. F. Burke[5] criticized the steam-sampling nozzle recommended by the A.S.M.E. Boiler Test Code and suggested a calorimeter nozzle having three openings, one in the center and one near each side, proportioned so that the velocity of the steam will be the same through the calorimeter nozzle and calorimeter. Mr. Burke spoke of the difficulties of getting accurate coal-consumption figures in short tests. He stated as his belief that the correct way to judge the amount of coal on the grates of an underfeed stoker is by the draft differential, which should be the same at the beginning and end of a test. He called attention to the possibility of error in measuring water unless constant level starting fifteen minutes before the test is maintained throughout the test. He further expressed the opinion that the efficiency of boilers should be determined upon temperature and flue-gas analysis rather than on the amount of coal burned and water evaporated.

---

[1] Mgr. of the Engrg. Dept., Keasbey & Mattison Co., N. Y. City. Assoc-Mem. A.S.M.E.

[1] Cons. Engr., Johns-Manville, Inc., New York, N. Y. Assoc-Mem. Am.Soc.M.E.

[2] Development Engr., Locomotive Superheater Co., New York, N. Y. Mem. Am.Soc.M.E.

[3] Operating Engr., Phila. Elec. Co., Phila., Pa. Mem. Am.Soc.M.E.

[4] Vice-Pres., Heine Boiler Co., St. Louis, Mo. Mem. Am.Soc.M.E.

[5] Heine Boiler Co., Phoenixville, Pa.

The Control of Boiler Operation

Simplified Formulas for Use in Calculating Chimney, Combustion and Absorption Losses —A Proposed Fuel Unit for Bituminous Coal, etc.

By E. A. UEHLING,[1] MILWAUKEE, WIS.

The problem the author sets for himself is to suggest a method that will bring complete and intelligent control of boiler operation, so far as combustion and absorption efficiency are concerned, within the horizon of comprehension and easy execution of the average operating engineer, enabling him to determine heat losses and to separate them into their several components so that he can know just where and to what extent losses occur, and that he may be better able to minimize them by intelligent application of the proper remedy. The author proposes the pound-carbon fuel unit, which he shows to be practically equicalorific, and which in B.t.u. equals 14,450 plus 62,000 times the percentage of available hydrogen.

Formulas are presented for calculating heat losses up the chimney and the combustion and absorption losses are analyzed. The application of the formulas to some scientifically conducted tests is shown.

OUR Government, through its research departments of the Bureau of Mines and the Geologic Survey has made and published thousands of analyses, ultimate as well as proximate, covering all the coals of the United States, Alaska, etc. These analyses are all available and they are both interesting and instructive; but long tables of analyses are of no practical use to the operating engineer. He must have specific information of the ratio of heat input to the heat utilized or the heat wasted, it matters not which, in order to know how efficiently or wastefully his boilers are operating.

The Equicalorific Fuel Unit

The pound of coal as received is and will probably remain the commercial fuel unit, but because of great variation in heating value it is a most unsatisfactory control unit. This has long been recognized by combustion experts, and the pound of combustible has been adopted as the fuel unit for comparing boiler efficiencies. This unit, although it eliminates the variation in heating value due to the ash and moisture in coal, is practically equicalorific only between narrow limits of oxygen.

The heating value of the pound-carbon fuel unit is 14,550 + 62,000H_a B.t.u., where H_a is the available hydrogen per pound of carbon, and for practical control purposes this unit is essentially equicalorific, as is shown in the complete paper.

Methods for Ascertaining Economic Operation

There are two distinct methods for ascertaining the economic operation of a boiler:

- *a* By determining the percentage of the heat in the fuel utilized
- *b* By ascertaining the percentage of heat wasted.

The first is the simpler and therefore most generally practiced way. It answers well as an overall control, but does not raise the endeavor to improve boiler operation beyond the old cut-and-try methods, hence cannot lead to continuous maximum boiler efficiency. The second method, as practiced when attempted at all, is apparently more intricate and difficult than the first, and is but little understood by even the most up-to-date operating engineer. The heat losses are determined by the combustion experts for the purpose of establishing a heat balance, but heat balances mean little or nothing to the average operating engineer, and even when understood and appreciated they are of little or no help to him in controlling boiler operation. The engineer is continually confronted by contradictory advice: On the one hand, he is told that CO_2 is the all-important control factor. Keep CO_2 a maximum and heat losses will be a minimum. Carbon dioxide is the index of efficiency. On the other hand, he is admonished that CO_2 is an unreliable index; high CO_2, because of accompanying CO, is likely to cause greater heat loss than low CO_2. A third person tells him not to bother about CO_2 and CO but to keep air flow and steam flow in unison and maximum efficiency will result. Confronted by such conflicting statements, operating engineers and many power-plant managers become confused rather than enlightened.

Boiler efficiency rests on combustion efficiency and absorption efficiency and these are as distinct one from the other as boiler efficiency is from engine efficiency. The first is a chemical phenomenon which can be adequately diagnosed only by chemical means, and the second a physical phenomenon which must be diagnosed by physical means; without adequate diagnosis the remedy must be guessed at, and if it happens to be guessed correctly it is rarely intelligently and effectively applied. This is a scientific truism which must be borne in mind if we are to attain and maintain maximum economy in the operation of steam boilers. All other methods of control, helpful though they may be, cannot lead to maximum efficiency.

The heat carried to waste up the chimney can be ascertained only by analyzing the gas and measuring its temperature on leaving the boiler. To exercise intelligent control the heat in the gas must be divided into available and unavailable heat. The latter depends on the theoretical maximum percentage of CO_2 obtainable from the fuel used and the temperature of the water in the boiler.

This temperature, below which it is impossible to cool the gas by absorption, depends on the steam pressure which is practically constant for any given boiler, and since the maximum percentage of CO_2 is also constant, it follows that unavailable heat in the gas must be constant. The difference between the total heat and the unavailable heat is the available heat loss. The available heat loss is again composed of two parts, viz., that due to excess air and that caused by excess temperature. This analysis of the heat loss provides the means for intelligent control of boiler operation.

To enable the operating engineer to ascertain and analyze his heat losses he must know the percentage of CO_2, the temperature of the gas as it leaves the boiler and the boiler draft. These three controlling factors must be continuously autographically recorded. The percentage of CO must be kept within tolerable limits, as will be shown further on in the paper.

The temperature of the gas depends on:

- *a* The rate of combustion
- *b* The cleanliness of the heating surface
- *c* The condition of the baffling
- *d* The tightness of the setting.

The boiler draft is affected by all of these conditions and is therefore essential to interpret properly the cause of temperature variation. The product of the square root of the boiler draft and the CO_2 is a reliable index to the rate of combustion when the boiler and setting are in good condition.

Having autographic records of the essential control factors is one thing; to make effective use of the information they contain is quite another. Records of whatever kind are useless unless they are regularly scrutinized and correctly interpreted and compared and the information deduced promptly applied. To apply this information intelligently it must be put into concrete form, i.e., into B.t.u. and percentage of the heat supplied; and here is where the average operating engineer is practically helpless and it is the real cause of the adverse attitude already referred to, his aversion to scientific methods of control. To overcome this attitude heat-loss calculations must not only be brought within the horizon of his ready comprehension, but they must be made so easy that he can make them with the least trouble and expenditure of time.

---

[1] Consulting Engineer. Mem. Am.Soc.M.E.

Abridgment of paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

The Author's Heat-Loss Formulas

In an appendix to his paper on the Physical and Chemical Control of Boiler Operation,[1] the author deduced a set of formulas for calculating the heat losses up the chimney, which are again presented below in slightly modified form. These formulas attracted no attention at the time nor have they since, at least no comment upon them has come to his notice. The reason for this may have been that they are all based on the pound-carbon fuel unit, the advantages of which were not then apparent.

The formulas are as follows:

$L_d = (0.24 + 58.46/CO_2) \times (T - t)$
= B.t.u. carried to waste by the dry gas . . . [1]

$L_c = 10{,}150\ CO/(CO + CO_2)$
= B.t.u. loss due to CO contained in gas . . . [2]

$L_h = H_t \times [(10{,}642 - 9t) + 4.3(T - 212)]$
= B.t.u. carried to waste by the steam contained in the gas:
H_t = weight of total hydrogen per pound of carbon in the coal, including the moisture . . . [3]

$$A_e = \frac{2100}{(1 + 3H_a) \times CO_2} - \frac{100 + 238H_a}{1 + 3H_a}$$
= per cent excess air . . . [4]

$O_e = 21 - CO_2 \times (1 + 2.38H_a)$
= per cent excess oxygen . . . [5]

$MCO_2 = 21/(1 + 2.38H_a)$
= maximum per cent of CO_2 obtainable from the fuel burned . . . [6]

$A_a = 243.6/CO_2 + 8Ha$
= pounds of air supplied per unit of fuel consumed . . . [7]

$G_w = 1 + 243.6/CO_2$
= pounds of dry gas produced . . . [8]

$A_v = 3192/CO_2$
= cu. ft. of dry gas at 62 deg. fahr. . . . [9]

$S_w = 9H_t$
= pounds of steam in gas . . . [10]

Z = square root of the boiler draft . . . [11]

$Z \times CO_2$ = index of rate of combustion . . . [12]

The Control Factors

To establish a heat balance the B.t.u. supplied by the air must be deducted from the heat in the gas, hence the temperature factor $(T - t)$ must be used in Formulas [1] and [3], but as already stated, heat balances are of no use for direct, prompt, and continuous control. To enable the operating engineer to exercise effective control over combustion and absorption efficiency, he must know not only how much heat is carried to waste by the gases, but how much of this heat is available to the boiler and what part of the available heat loss is chargeable to the process of combustion and how much to absorption; and since all the heat brought in by the air is contained in the unavailable part of the heat in the gas, the temperature of the air may be ignored, thus simplifying the formulas by eliminating a variable term. The calculations for determining the two essential control factors are:

$A = (0.24 + 58.46/CO_2) \times T$ = total B.t.u. in the dry gas, and

$B = (0.24 + 58.46/MCO_2) \times T_w$ = unavailable B.t.u. in the dry gas; then

$A - B$ = the theoretically available heat carried to waste by the dry gas. In Formula [3] the term $H_t(10{,}642 - 9t)$ represents latent heat which is all unavailable, hence if we let

$C = (4.3H_1) \times (T - 212)$ = total sensible heat in H_2O in the gas, and

$D = (4.3H_1) \times (T - T_w)$ = unavailable sensible heat in H_2O in the gas, then

$C - D$ = available heat in H_2O contained in the gas, hence

$(A + C) - (B + D) = E$ = total available heat carried to waste up the chimney.

The heat loss E is partly due to combustion and partly to absorption inefficiency.

Combustion and Absorption Losses

Combustion would be 100 per cent efficient if all the combustible elements in the fuel were completely oxidized in the furnace, using the theoretical weight of air required, and absorption would be 100 per cent efficient if it reduced the temperature of the gas resulting from 100 per cent efficient combustion to the temperature of the water in the boiler. The component parts of combustion losses are:

a The heat loss due to excess air
b The heat value of the unburned combustible in the gas $(CO + C_x + H_y)$, and
c The carbon in the ash.

The component parts of the absorption losses are:

a Heat loss due to dirty heating surface
b Heat loss due to defective baffling, and
c Heat loss due to excessive driving.

All these component parts of the waste of available heat can be determined from the interrelation between the three essential autographic records, for any particular time or any desired period, such as a test, a day or a shift, as follows:

Applying our formula we have:

$a = [(0.24 + 58.46/CO_2) - (0.24 + 58.46/MCO_2)]T$
= B.t.u. loss due to excess air.

The combustible constituents in the gas are CO and an undetermined weight of $(C_x + H_y)$. The heat value of the latter probably never exceeds 0.2 of the former in boiler flue gas, and is negligible when CO is kept within proper limits.

$b = 10{,}150\ CO/(CO + CO_2)$ = B.t.u. loss from CO in the gas.

c The B.t.u. loss due to unburned carbon must be determined by analyzing the ash. We have then

$C_{ef} = 100 - (a + b + c)/179$ = combustion efficiency.

The component parts of heat lost to absorption can be located on the autographic charts, but can be quantitatively determined by our formula only in total; thus:

$$A_{ef} = 100 - \frac{(0.24 + 58.46/MCO_2) \times (T - T_w)}{179}$$
= absorption efficiency.

The component parts of absorption loss may, however, be approximately determined, as will be shown by example further on.

Simplification of Formulas

All this may look like a rather formidable array of equations to place before the average operating engineer, with the expectation that he apply them successfully. Such expectation would be futile. The author, however, is not now confronting average operating engineers; he imagines he is addressing scientific as well as practical fuel conservationists and combustion experts, who will understand that the foregoing formulas are applicable to all commercial fuels from coke to natural gas, whereas operating engineers rarely have to deal with more than one kind of fuel at a time. Limiting ourselves for the present to bituminous coal, these formulas, being based on the equicalorific fuel unit, can be greatly simplified and those essential for control reduced to few in number.

In Formula [1] the factor $(0.24 + 58.46/CO_2)$ is equal to the B.t.u. per degree of temperature contained in the weight of dry gas produced in burning one unit of fuel. Letting X equal this value, then XT = total B.t.u. in dry gas per unit of fuel. Substituting the average value of H_a (= 0.051) in Formula [6], we have $MCO_2 = 21/1.128 = 18.6$ per cent = the theoretical maximum percentage of CO_2 obtainable from bituminous coal. Using this value of CO_2 in Formula [1] we have $(0.24 + 58.46/18.6) \times T_w = 3.38T_w$ = B.t.u. of unavailable heat in dry gas. T_w varies with steam pressure, but since this is practically constant for any given boiler plant, $3.88T_w$ is also constant. $XT - 3.38T_w$ = B.t.u. of available heat. Now since X represents the total B.t.u. per degree of temperature in the weight of dry gas resulting from the combustion of one unit of fuel burned with an excess of air, and 3.38 = B.t.u. of heat per degree of temperature in the weight of gas that results when a unit of fuel is burned with the theoretical weight of air required for complete combustion, we have $(X - 3.38)T$ = B.t.u. of available heat wasted because of excess air and $3.38\ (T - T_w)$ = B.t.u. of available heat wasted due to excess temperature.

---

[1] Trans. Am.Soc.M.E., vol. 40, p. 714.

In Formula [2], 10,150 CO ($CO + CO_2$), the factor CO ($CO + CO_2$) represents the weight of carbon burned to CO. This formula can be somewhat simplified by letting $10{,}150 \times CO = Y$ so that Y ($CO + CO_2$) = B.t.u. wasted due to CO.

Our essential control formulas are then:

XT = total B.t.u. contained in dry gas................[A]
$3.38\ T_w$ = B.t.u. unavailable in dry gas..............[B]
$XT - 3.38T_w$ = B.t.u. available in dry gas..........[C]
$(X - 3.38)\ T$ = B.t.u. loss due to excess air..........[D]
$3.38\ (T - T_w)$ = B.t.u. loss due to excess temperature..[E]
$Y\ (CO + CO_2)$ = B.t.u. loss due to CO in gas........[F]
$Z \times CO_2$ = index to rate of combustion..............[G]

The value of $3.38T_w$ is practically constant for any given power plant. The values of X, Y and Z may be read off directly from tables prepared for the purpose or they may be found from curves as shown in Fig. 1. Only a fraction of the B.t.u. in the steam contained in the gas is sensible heat and the greater part of this is unavailable to the boiler. The heat loss represented by Formula [3] therefore has no control value and may be ignored. By substituting the value of $H_a = 0.054$ in Formulas [4], [5] and [6], they reduce respectively to—

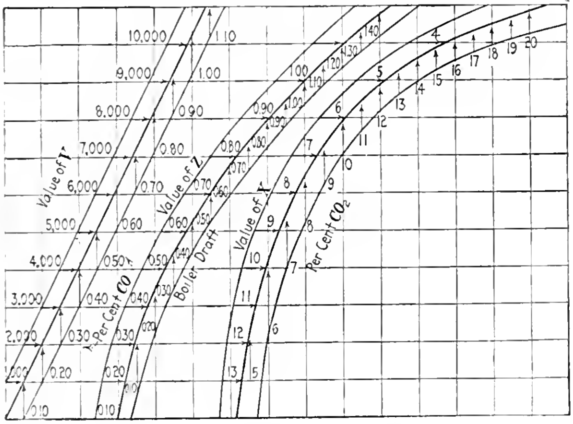


Fig. 1 Values of X, Y and Z

A_e = $1810.35/CO_2 - 97$ = per cent excess air.......[4a]
O_e = $21 - 1.13CO_2$ = per cent excess oxygen........[5a]
MCO_2 = 18.6 = maximum per cent CO_2.............[6a]

The information derived from [4a] and [5a], though not essential for control purposes, may be desirable to have.

Combustion and absorption efficiency are the two factors on which economical boiler operation depends. Maximum absorption efficiency in any given boiler is maintained by keeping the boilers clean inside and out, and maintaining the baffling and setting in perfect condition. The former is a matter of routine conscientiously performed and the latter can be secured by proper and frequent inspection. If the proper tools are supplied, maintaining absorption efficiency is a simple matter. Combustion efficiency, on the other hand, is an entirely different proposition and cannot be maintained by any definite predetermined routine of operation. It depends on numerous and frequent adjustments: The rate of combustion must be adjusted to the steam demand. The draft must be adjusted to maintain the rate of combustion, the coal supply must be kept in harmony with the draft, and the firebed must be kept in condition to make the draft economically effective. The air supply must be adjusted so that the proper proportions enter, respectively, below and above the firebed. None of these adjustments can remain fixed but must be frequently changed as a whole and in relation to one another if maximum combustion efficiency is to be achieved.

It is not possible to maintain maximum combustion efficiency by inspection. Without the aid of the proper and necessary means for getting the essential data, boiler operation is necessarily a more or less haphazard performance, depending on intuition and guessing. To achieve the best results in any undertaking proper instruments must be provided. This is as true of operating boilers as it is of navigating a ship or conducting a scientific research. Suppose that in addition to the steam gage and water glass, which are always supplied (because required by law), the necessary instruments, viz., an Orsat, a continuous recording CO_2 meter and indicator, a recording pyrometer and a boiler draft gage have been properly installed. The first and most important step necessary to insure success is to put some one in charge and hold him strictly responsible for the continuous and correct functioning of the instruments. The principal cause for failure of such instruments is due to overlooking or neglecting this necessity. A further reason why so many installations of these instruments have not led to the results predicted or anticipated is that the operating engineer has had no simple means for getting the information autographically recorded into the form necessary for direct and intelligent application.

The object of the simplified control formulas is to bring the mathematics necessary to determine and locate the losses within easy reach of the average operating engineer, and especially to enable him to make the necessary calculations with the least expenditure of time and trouble. The fact that these formulas are based on the equicalorific fuel unit gives them a much greater practical value than their simplicity would indicate. It makes effective control of boiler operation quite independent of the analysis and heating value of the coal as fired. If the necessary equipment is provided, any up-to-date operating engineer should by the aid of such equipment and the simplified formulas be able to maintain the highest combustion and absorption efficiency that the structural and operating conditions of his plant (including the quality of the fuel used) will permit, and if maximum combustion and absorption efficiencies are maintained, minimum waste of fuel will necessarily result.

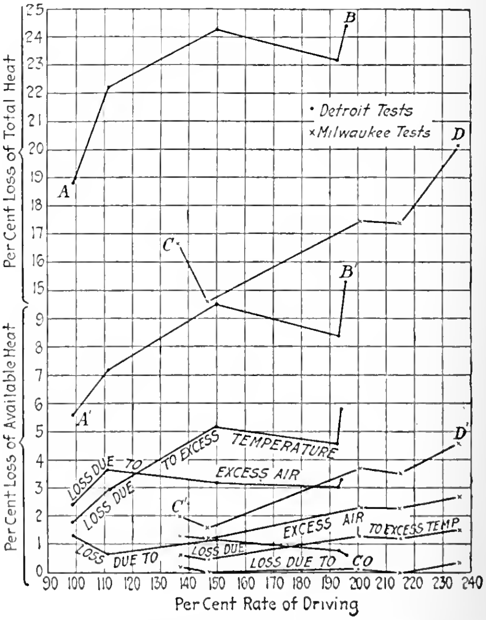


Fig. 2 Graphical Representation of Application of Heat-Loss Control Formulas

Application of Formulas

Tables 1 and 2 show the application of the heat-loss control formulas to ten scientifically conducted tests. These tables are self-explanatory. The tests treated in Table 2 were taken from the series of tests made of the large boilers of the Delray Plant of the Detroit Edison Company by Dr. Jacobus[1] as reported to

---

[1] Trans. Am.Soc.M.E., vol. 33, p. 565.

this Society in the paper which he presented at the Annual Meeting in December, 1911. Table 1 treats of the pulverized-coal tests made by Henry Kreisinger of the boilers of the Lakeside Power Plant of the Milwaukee Electric Railway and Light Co. as reported at the Spring Meeting, 1921. All the five tests reported are represented.

TABLE 1 UEHLING HEAT-LOSS CONTROL FORMULAS APPLIED TO THE PULVERIZED-COAL BOILER TESTS OF THE LAKESIDE POWER PLANT, MILWAUKEE

	Data Essential for Control				
Number of test	1	4	3	2	5
CO_2 = Per cent carbon dioxide in gas	15.8	16.0	11.7	14.6	14.1
CO = Per cent carbon monoxide in gas	0.05	0.00	0.03	0.00	0.09
T = Temperature of gas on leaving boiler, deg. fahr.	434	430	482	475	490
T_w = Temperature of water in boiler, deg. fahr	409	409	411	411	411
B_d = Boiler draft, i.e., resistance to gas through boiler, in water	0.30	0.355	1.03	0.92	1.2
RESULTS OF TESTS					
Pounds of coal consumed per hour	5980	6650	9560	9740	11350
Units of fuel consumed per hour	4111	4319	6331	6545	7424
Per cent rate of driving	137	147	209	215	236
Per cent boiler efficiency	83.3	85.4	82.5	82.6	79.8
CONTROL FACTORS OBTAINED FROM FIG. 5					
X = B.t.u. in dry gas per unit of fuel and degree of temperature	3.94	3.9	4.17	4.24	4.38
Y = 10,150 CO	508	0.0	314	0.0	914
Z = Square root of boiler draft (B_d)	0.55	0.59	1.01	0.957	1.09
ANALYSIS OF HEAT LOSSES					
XT = B.t.u. of total loss of sensible heat in dry gas	1710	1673	2034	2014	2177
XT_w = B.t.u. of unavailable sensible heat in dry gas	1382	1382	1389	1389	1389
$XT - 3.38T_w$ = B.t.u. of available sensible heat in dry gas	328	291	645	625	788
$(X - 3.38)T$ = B.t.u. loss of available heat due to excess air (a)	230 = 1.3%	219 = 1.2%	405 = 2.3%	408 = 2.3%	490 = 2.7%
$3.38(T - T_w)$ = B.t.u. loss of available heat due to excess temperature (b)	96 = 0.53%	68 = 0.41%	210 = 1.3%	217 = 1.2%	277 = 1.55%
$Y/CO + CO_2$ = B.t.u. loss due to CO in gas (c)	32 = 0.18%	00 = 0.0%	20 = 0.11%	0.0 = 0.0%	64 = 0.36%
$a + b + c$ = B.t.u. total loss of available heat in dry gas	358 = 2.0%	287 = 1.6%	665 = 3.7%	625 = 3.5%	831 = 4.6%
$100 - (a + c)\%$ = Combustion efficiency, per cent	98.5	98.8	97.6	97.7	96.9
$100 - b\%$ = Absorption efficiency, per cent	99.47	99.6	98.7	98.8	98.45
$100 - (a + b + c)\%$ = Combined absorption and combustion efficiency, per cent	98.0	98.4	96.3	96.5	95.4
ZCO_2 = Index of rate of combustion	9.16	9.53	11.7	14.6	15.44

TABLE 2 UEHLING HEAT-LOSS CONTROL FORMULAS APPLIED TO TESTS OF LARGE BOILERS OF THE DETROIT EDISON COMPANY

	Data Essential for Control				
Number of tests to which formulas were applied	5	3	6	17	18
CO_2 = Per cent carbon dioxide in gas	14.4	13.5	11.66	14.69	14.16
CO = Per cent carbon monoxide in gas	0.35	0.18	0.31	0.20	0.16
T = Temperature of gas on leaving boiler, deg. fahr.	483	512	662	636	694
T_w = Temperature of water in boiler, deg. fahr.	387	387	388	390	390
B_d = Boiler draft, i.e., resistance to gas through boiler, in water	0.08	0.18	0.31	0.61	0.78
RESULTS OF TESTS					
Pounds of dry coal consumed per hour	6606	8130	11295	13761	14987
Units of fuel consumed per hour	5083	6402	8963	11163	12480
Per cent rate of driving	94.0	113.8	150.7	193.3	195.7
Per cent boiler efficiency	81.15	77.45	75.28	76.73	75.57
CONTROL FACTORS OBTAINED FROM FIG. 5					
X = B.t.u. in dry gas per unit of fuel and degree of temperature	4.3	4.6	4.23	4.22	4.37
Y = 10,150 CO	3510	1850	3225	2000	1600
Z = Square root of boiler draft (B_d)	0.28	0.42	0.555	0.78	0.88
ANALYSIS OF HEAT LOSSES					
XT = B.t.u. of total loss of sensible heat in dry gas	2077	2493	2800	2684	3033
$3.38T_w$ = B.t.u. unavailable sensible heat in dry gas	1308	1308	1311	1318	1318
$XT - 3.38T_w$ = B.t.u. loss of available sensible heat	769	1185	1483	1366	1725
$(X - 3.38)T$ = B.t.u. loss due to excess air (a)	444 = 2.4%	661 = 3.7%	563 = 3.2%	534 = 3.0%	687 = 3.8%
$3.38(T - T_w)$ = B.t.u. loss due to excess temperature (b)	325 = 1.8%	524 = 2.9%	926 = 5.2%	832 = 4.6%	1038 = 5.8%
$Y/CO + CO_2$ = B.t.u. loss due to CO in gas (c)	232 = 1.3%	111 = 0.62%	215 = 1.2%	134 = 0.75%	119 = 0.66%
$a + b + c$ = B.t.u. total loss of available heat in dry gas	1001 = 5.6%	1296 = 7.2%	1704 = 9.5%	1500 = 8.4%	1844 = 10.3%
$100 - (a + c)\%$ = Combustion efficiency, per cent	96.3	95.7	95.6	96.25	95.7
$100 - b\%$ = Absorption efficiency, per cent	98.2	97.1	94.8	95.4	94.2
$100 - (a + b + c)\%$ = Combined combustion and absorption efficiency, per cent	94.4	92.8	90.5	91.6	89.7
ZCO_2 = Index of the rate of combustion	3.74	5.67	8.14	11.46	12.46

The results of applying the heat-loss control factors are graphically shown in Fig. 2. The graph *AB* represents the percentage of total heat wasted, i.e., 100 minus the per cent efficiency as found by tests of the Detroit Edison Company's boilers; and *CD* represents the total heat wasted as found by test of the Milwaukee Electric Railway and Light Co.'s boilers. *A'B'* and *C'D'* show the respective losses of available heat of these two sets of tests as determined by the control formulas. The other graphs show where and to what extent the loss of available heat took place. Comparing graphs *AB* and *CD*, respectively, with *A'B'* and *C'D'*, it will be seen that they are quite similar in contour, and this close similarity demonstrates the reliability of the loss of available heat as an index of boiler efficiency. The reliability of this index can be disturbed only by excessive moisture in the coal or excessive loss of carbon through the grate. The former adds to the unavailable heat and hence cannot be controlled by the operating engineer, and much less by the fireman; the latter can be detected and roughly estimated by observation

and promptly remedied. Fig. 3 shows the rate of combustion in its relation to the combustion index ZCO_2. As the graph shows, this necessarily varies with the type and size of boiler, the arrangement of baffling, etc. The characteristic of the graph must be determined for each type and construction of boiler. This done, it becomes a practically reliable check on the effort of the fireman to burn his proper share of coal in keeping up the steam pressure. Since the percentage of CO_2 is the principal factor in determining combustion efficiency as well as this index, the inefficient fireman is compelled to work harder to make his proper share of the steam.

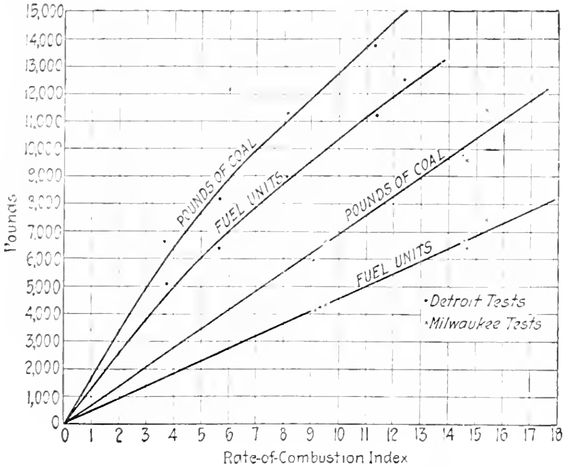


Fig. 3 Relation of Rate of Combustion to Combustion Index, ZCO_2

The loss of available heat up the chimney, as is shown by the tables and graphs, is due to three causes: excess air, excess temperature and CO. The components of this heat loss are shown by the tables and in Fig. 2. These losses can be quantitatively illustrated as shown in Fig. 4. The rectangle *ABCD* represents the total heat carried to waste by the dry gas, and *AGFE* the heat unavailable to the boiler. *EHJD* represents the loss of theoretically available heat due to excess air, *GIHF* that due to excess temperature and *IBCJ* to CO. Now supposing that the excess air had been increased so as to reduce the CO_2 to 10 per cent, the loss of available heat would have been increased by *DCLK*; assuming the temperature to remain the same and the percentage of CO also unchanged the loss due to the latter would be increased as shown by *CJML*. But supposing that the CO had been eliminated by this reduction in CO_2, the gain would have been 1.3 per cent and the loss 4.8 per cent, resulting in a net loss of 3.5 per cent. This is not the place to discuss this phase of the problem, except to call attention to the fact that care must be exercised in eliminating CO at the expense of CO_2, since the loss is liable by far to exceed the gain. Complete combustion is by no means synonymous with most efficient combustion. The greatest practical value of this method of control consists in its simplicity as well as its adequacy. Three autographic records preferably on the same chart are all that is required to furnish the necessary data. The calculations are of the simplest nature and the method is quite independent of the analysis of the coal and its variable heat value as long as it is true bituminous coal, i.e., with oxygen within the limits of 3 to 12 per cent. The heat brought in by the air is contained in the unavailable heat, hence does not affect the reliability of the control. The loss of available heat is the only loss that need be considered because it is the only loss that is controllable. This method of control fixes the responsibility, inasmuch as it separates the heat loss into two parts, namely, combustion loss controllable by the fireman, and absorption loss controllable by the boiler cleaners.

This may be a bold statement considering the present general state of the art and science of boiler operation, but the author hopes and believes that this method of control is a step in the right direction. If it is not, he wants to be set straight; if the method is fallacious, this is the time and place to disprove the claim he makes for it. So far as the equicalorific fuel unit is concerned the author has no fear that it will be upset. There may be exceptional coals within the prescribed oxygen limits that will not come within the practically allowable limits of the equicalorific heating value, but there will be few if any. The average analysis of the coal used in the five Detroit tests varied 4.75 per cent in ash, 2 per cent in oxygen and 804 B.t.u. in heating value, while the separate analyses of the same coal varied as much as 1000 B.t.u.; whereas the variation in the heating value of the pound-carbon fuel unit as determined from the average analysis of the coal used in these tests differs from the equicalorific heating value by only 372 B.t.u. The heating value of the coal used in the five Milwaukee tests varied 834 B.t.u.; the oxygen not being given in the analysis, the variation in the pound-carbon fuel unit could not be determined, but as found from the analyses of representative samples of Illinois coal, the pound-carbon fuel unit is practically equicalorific. The highest heating value of the coal used in the Detroit tests was 14,493 B.t.u. and the lowest of that used in the Milwaukee tests was 11,483 B.t.u., a difference of over 3000 B.t.u., but, as we have seen, this difference in heating value per pound of coal does not affect the constancy of the equicalorific fuel unit nor the practicability of the heat-loss control formulas based thereon.

The author has placed emphasis on the necessity of getting the attitude of mind of the operating engineer in line with the endeavor of the Fuels Division to reduce the consumption of fuel in the production of steam to a minimum. To make worthwhile progress there must be coöperation from the fireman up to the owner or managing director of the steam-power-producing and coal-consuming plants. The urge for the necessary equipment should come from below and be granted from above. To this end education is necessary at the top and at the bottom as well as in between.

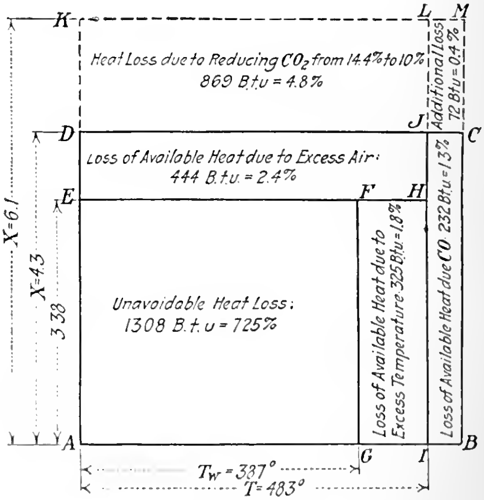


Fig. 4 Heat-Loss Diagram

The ten boiler tests illustrating the application of the author's control formulas show what can be accomplished in the way of economic boiler operation. The average efficiency of boilers in plants the country over is from 15 to 20 per cent below these high standards. The reasons for the slow progress, in the author's judgment, have been: (1) Lack of fundamental control principles which can be readily understood and easily applied by the operating engineer; (2) lack of knowledge and appreciation, by the owners and managers, of the preventable waste of fuel in their plants; (3) lack of coöperation between instrument maker and the purchaser of such instruments; (4) lack of equipment of the necessary instruments; and (5) last but not least, lack of proper instruction to enable the operating engineer to coördinate and interpret the information autographically recorded when such instruments are supplied.

Discussion

Nevin E. Funk[1] opened the discussion of Mr. Uehling's paper as follows: "In Par. 26 the author says: 'If the necessary equipment is provided, any up-to-date operating engineer should by the aid of such equipment and the simplified formulas be able to maintain the highest combustion and absorption efficiency that the structural and operating conditions of his plant (including the quality of the fuel used) will permit, and if maximum combustion and absorption efficiencies are maintained, minimum waste of fuel will necessarily result.'

"That can be done hour by hour or minute by minute by the use of the scheme he has outlined. Of course, it is of some value to know the next day what you have done, but it is far better to arrange the control equipment so that it is possible to know that the coal is burned efficiently at the moment of its burning, but the writer does not believe this scheme has done that.

"The author says: 'If the proper tools are supplied, maintaining absorption efficiency is a simple matter.' That is a very good statement. The writer cannot see, however, that Mr. Uehling has stated the proper tools in this paper. There is an attempt at a statement in another paragraph where the author says: 'in addition to the steam gage and water glass, which are always supplied (because required by law), the necessary instruments, viz., an Orsat, a continuous recording CO_2 meter and indicator, a recording pyrometer and a boiler draft gage have been properly installed.' These are the instruments he needs to check this boiler efficiency scheme. It will be noticed there is no output measurement on the boiler. If the operator does not know the output of the boiler, how does he know the correct draft? The results will be hit or miss. He guesses it by looking at the fire, and if there is more than one boiler, or if there are several men running a bank of boilers, there is a probability that one man may keep a splendid fire above and make the other fellow take the ragged ends, and so it seems that a very important instrument has been left out of Mr. Uehling's statement, that is, a steam-flow meter or a water-flow meter, either one, which shows at what output the boiler is delivering every instant.

"Then, to match up the readings of some of these meters, such as a draft gage, there must be a table on the boiler telling what the draft should be for each output, or some scheme should be used to give a man an indication of his performance during the period of the steam flow.

"These comments have been in a way destructive, but the writer does not want to leave the impression that he feels that this paper is not important, because he thinks it is. He does not believe that the method has given the means of putting in the operator's hands accurate control of good combustion."

A. T. Hutchins[1] presented a written discussion and a curve in which he had plotted gas analyses from the Detroit Edison Co.'s tests, the New York Edison Co.'s tests, and the formula proposed by Mr. Uehling.

F. G. Cutler[2] said that the author had overlooked one phase of the subject, that applied to steel-plant operation, particularly with blast-furnace or by-product gases. With by-product gas the best CO_2 content is around 7 per cent, he said, and with blast-furnace gas it is from 22 to 25 per cent.

---

[1] Operating Engr., Philadelphia Elec. Co., Philadelphia, Pa. Mem. Am. Soc.M.E.

[1] Supt. Steam Plants, Alabama Power Co., Birmingham, Ala. Mem. Am. Soc.M.E.

[2] Ch. of Bur. of Steam Engrg., Tenn. Coal, Iron & R.R. Co., Ensley, Ala. Mem. Am.Soc.M.E.

Steel for Forge Welding

By FRANK N. SPELLER,[1] PITTSBURGH, PA.

In this paper the principal factors—method of manufacture, chemical composition, fluxing quality, susceptibility to heat and welding temperature—affecting the welding quality of steel are discussed and the average results of 80 tests made on forge welds of hammer-welded pipe are compared with the original material. In addition it is stated that tests have demonstrated that both steel not over 0.15 per cent carbon and minimum tensile strength of 47,000 lb. per sq. in. and that not over 0.20 per cent carbon and minimum tensile strength of 52,000 lb. per sq. in., are satisfactory for forge welding of pipe lines, penstocks, tank-car work and similar construction. In conclusion the writer states that the most important considerations to produce uniformly good results in the forge welding of steel, are suitable material, well-trained operators and adequate facilities for the control of operations.

THE welding quality of steel and the strength and reliability of such welds depend on a number of factors, which include principally method of manufacture, composition, susceptibility to heat, fluxing quality, the mechanical appliances for handling and controlling the work, and the skill of the operator. There are so many factors present affecting the results that it is often difficult to determine which of these predominates in any particular case. This paper discusses particularly the characteristics of steel for forge welding, with brief reference to other factors which enter the problem.

MATERIAL AND WORKMANSHIP

Method of Manufacture. Wrought iron is most easily welded, probably on account of the presence of about one and one-half per cent of easily fusible cinder, which enables the metal to be welded at a comparatively low temperature and protects it from injurious oxidation at high temperature. For this reason wrought iron can usually be welded without much difficulty, but on account of the presence of this cinder internal defects such as laminations and blisters are more likely to occur after the metal has been brought up to the welding heat. What we term "soft welding steel" may be made by the bessemer or open-hearth process and should be made especially for this purpose, i.e., it should have, as far as possible, sufficient of the characteristics of wrought iron to readily form a "welding scale" at the lowest possible temperature. Very highly refined open-hearth steels, "ingot iron" or electric steel, are, as a rule, lacking in this respect and so far have not shown as good welding quality as soft welding steel or wrought iron.

Composition. It is well known that comparatively small quantities of nickel, chromium and silicon interfere seriously with welding. Each of these should be under 0.05 per cent. Carbon has a lesser effect and should preferably be low, certainly under 0.30 per cent for any kind of forge welding. The higher the carbon, the lower the melting and burning points of the steel. By the burning point we mean the temperature at which the grain growth has increased to such a degree as to cause actual disintegration and intergranular oxidation of the metal. Sulphur under 0.05 per cent is not harmful and under certain conditions more may be present without injurious results. Phosphorus up to bessemer limits is beneficial to welding.

Self-Fluxing Quality. On heating iron or steel above 1500 deg. fahr. an oxide scale is formed. The relation between the fusibility of the oxide scale to the temperature at which the metal "burns" is one of the most important factors determining suitability of the metal for welding. This scale consists usually of the magnetic oxide of iron (Fe_3O_4) with a certain percentage of "sonims"[1] from the iron (MnO, P_2O_5, SiO_2, etc.) which tend to make the scale more fusible. The method of manufacture and composition of the steel have much to do with the formation of a suitable welding scale.

---

[1] Metallurgical Engineer, National Tube Co. Mem. Am.Soc.M.E.

Abridgment of a paper presented at the Spring Meeting, Atlanta, Ga. May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

[1] Solid non-metallic impurities in steel, H. D. Hibbard, Trans. A.I.M.E., vol. xli, p. 803 (1910).

The range of temperature between the melting point of the scale and the burning point of the metal is about 100 deg. fahr. in good welding steel and distinguishes this class of steel probably more than any other property. In fact, it is this self-fluxing quality which makes possible the commercial welding of iron and steel. Artificial fluxes, such as borax, may be used to lower the melting point of the scale in welding small parts of high-carbon steel, but at present this is not practicable to apply satisfactorily when working on a large scale. The fusion of the scale also affords the operator a definite indication of the welding point, giving him close control over the operation.

Susceptibility of Metal to Heat. When normal wrought iron or steel is heated above the upper critical point (about 1750 deg. fahr. for soft steel) the grain grows at a rate depending on the temperature and time of heating. When a certain grain size is reached, a disintegration of the metal occurs with intergranular oxidation and the metal becomes "burnt." When this occurs, the metal is red-short and cold-short and useless for most purposes. The actual temperature at which iron or steel is burned depends as much on the protective character and fusibility of the welding scale as anything else. High-carbon steels are more susceptible to damage of this kind in welding than the same class of steel of lower carbon, but the carbon is not the only factor, otherwise we might expect highly refined open-hearth steel or "ingot iron" to weld as easily as charcoal iron.

The large granular structure caused by exposure of the metal to welding temperature may be reduced to a fine structure (unless the metal has been excessively overheated) by a certain amount of mechanical forging applied while the metal is cooling or by reheating the metal to about 30 deg. fahr. above the upper critical point, followed by cooling in the air, which with soft steel may be comparatively rapid.

Welding Temperature. To produce intercrystalline union of two pieces of iron it is necessary that the clean surfaces be brought into close contact with a certain pressure. This is possible even at normal temperature with application of sufficient pressure in the case of soft steel, or may easily be done at a temperature slightly above the fusing point of the scale with comparatively little pressure, or at a lower temperature if the fusion point of the scale is lowered by the use of artificial fluxes, such as borax. So that the most favorable temperature for welding depends on the material and mechanical facilities. The usual temperature at which soft steel is found to weld satisfactorily ranges from 2500 to 2600 deg. fahr.

RESULTS OF TESTS

A number of tests of forge welds (80 in all) made on two rings cut from the ends of hammer-welded pipe, compared with the original material taken from the same pipe, about 1/2 in. thick 90 deg. from the weld, gave results which are summarized as follows:

Material Away from Weld—Average transverse tensile test:

Elastic limit, lb. per sq. in.	32150
Ultimate strength, lb. per sq. in.	52790
Elongation in 8 in., per cent	29.7
Reduction, per cent	58.6

Efficiency of Weld—Test pieces machined to uniform thickness:

Average of all tests (80 tests), per cent	92.7
Average at extreme end (40 tests), per cent	90.3
Average 2 in. or more away from end (40 tests), per cent	95.0
Minimum at extreme end, per cent	69.0
Minimum 2 in. or more away from end, per cent	82.3

The above steel before welding ranged in tensile strength from about 47,000 to 62,000 lb. per sq. in.—most of it being under 57,000 lb. and under 0.16 per cent carbon.

SPECIFICATIONS

This brings us to the question of specifications for steel best suited for forge welding. While skillful operators can undoubtedly make a good job of most steels when the carbon does not exceed that of flange quality, it seems desirable, everything considered, to limit the carbon to about 0.15 per cent for important parts where life and valuable property are at stake and a high efficiency of strength of weld is desired.

The present A.S.T.M. specification (A78–21–T) for forge-welding steel (given in an appendix to the complete paper) calls for steel of not over 0.18 per cent carbon having a minimum tensile strength of 50,000 lb. per sq. in. A.S.T.M. Sub-Committee II of Committee A-1 now has under consideration substituting for this two grades of steel having the following chemical and physical properties:

CHEMICAL COMPOSITION	GRADE A	GRADE B
Carbon, per cent[1]	not over 0.15	not over 0.20
Manganese, per cent	0.35 to 0.60	0.35 to 0.60
Phosphorus, per cent	0.04	0.04
Sulphur, per cent	0.05	0.05
PHYSICAL TESTS		
Tensile strength, lb. per sq. in.	not under 47,000	not under 52,000
Yield point, lb. per sq. in.	not under 25,000	0.5 tensile strength
Elongation in 8 in., per cent	not under 26	not under 24

[1] For plates over 3/4 in. thick, 0.02 additional carbon is permissible.

Steel of both grades has been forge-welded and used in large quantities with an assumed weld efficiency of 90 per cent. The tests we have made indicate that this figure is warranted for pipe lines, penstocks, tank-car work and similar construction. A somewhat lower efficiency or higher factor of safety should, of course, be used for boilers and Class A unfired pressure vessels.

BOILER-CODE REQUIREMENTS

With respect to steel for forge welding, Part I, Section I, Par. 186 of the A.S.M.E. Boiler Code requires that:

> The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 28,500 lb. per sq. in., with steel plates having a range in tensile strength of 47,000 to 55,000 lb. per sq. in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

Section III, Par. L-29 reads:

> The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 28,500 lb. per sq. in., with steel plates having a range in tensile strength of 45,000 to 55,000 lb. per sq. in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

The proposed section on unfired pressure vessels with reference to forge weldings, Pars. 5 and 8, reads:

> The ultimate strength of a joint which has been properly welded by the forge process shall be taken as 65 per cent of the tensile strength of the plate.

This weld efficiency seems rather low for Class A vessels and we believe that it should be still higher for Class B vessels.

In Pars. 2 and 3 of Sections I and III, firebox and flange steel are specified *for all parts* of the boiler. There seems to be a conflict in these specifications between the requirements for steel which may be forge-welded, although apparently the intention is to use a steel of lower carbon for this purpose. This would seem to be in line with the best experience, but inasmuch as flange steel has apparently been successfully used for some time in forge-welded boiler construction where part of the stress is carried by riveted straps, there would seem to be no reason for not continuing this practice when the weld is so reinforced.

FINISHING

After the weld is made, internal strains remain in the metal which should be released by annealing. This may be done by heating the piece uniformly to a red heat (about 1500 deg. fahr.) and allowing to cool in the air. Any objectionable amount of distortion which has occurred in the welding operation should be removed, preferably while the piece is at an annealing heat; otherwise it should be reformed and then annealed. Some operators prefer one form of scarfing, others none at all. Some use roller welding machines, but the majority use power hammers.[1] Good welding has been done with coke fire, producer gas, natural gas and water gas, the last being best adapted for forge welding on a large scale.

To produce uniformly a high weld efficiency the most important considerations are suitable material, well-trained operators, and adequate facilities for control of the work.

---

[1] Details of mechanical appliances for hammer welding in modern American plants will be found in articles by E. F. Thum in *Chemical & Metallurgical Engineering*, September 21, 1921, October 19, 1921, and November 16, 1921.

The Evaporation of a Liquid into a Gas

By W. K. Lewis,[1] Cambridge, Mass.

The author investigates the mechanism of the evaporation of a liquid into a gas as applied to such processes as are found in gas scrubbers, humidifiers, dehumidifiers, water coolers, air driers, etc. He establishes a formula for calculating the humidity of air from wet- and dry-bulb thermometer readings, and shows that the coefficient of heat transfer divided by the coefficient of diffusion equals the humid heat of the gas.

A LARGE amount of work has been done on the evaporation of water into air at temperatures below the boiling point. The dynamic equilibrium corresponding to the evaporation of water into air counterbalanced by the flow of heat from the air into the water is the basis of wet-bulb thermometry, the most useful method of determining the humidity of air.[2] In 1886 Desmond Fitzgerald[3] pointed out that the rate of evaporation of water into air is a function of the difference in partial pressure between the moisture in equilibrium with the evaporating water and the actual moisture content of the air in contact with it. It is true that Fitzgerald did not assume the rate of evaporation linearly proportional to this difference, but added a small correction term proportional to the square of the difference. Barrows and Babb[4] made a large number of determinations of evaporation from the surface of Maine lakes, and while their experimental determinations were subject to a large percentage variation, none the less their results substantiate this proportionality. More recently Willis H. Carrier[5] has shown that the rate of water evaporation is, within experimental error, proportional to partial-pressure difference. The following is an analysis of the mechanism of such evaporation.

Preliminary Assumptions

For purposes of formula derivation assume a long tunnel through which unsaturated air is flowing at constant mass velocity. The walls of this tunnel are non-conductors of heat. Along the bottom of the tunnel is placed a mat or wick permanently wet with water supplied from below as evaporation takes place above. The water is furnished to this wick at every point at a temperature exactly equal to that of the water on the upper surface of the wick at that point. There is no motion of the liquid water parallel to the axis of the tunnel. The mass velocity of the air over the water is constant and sufficiently low so that heat generated by friction may be neglected.

The unsaturated air entering this tunnel will become humidified in passing through it owing to the evaporation of water. In consequence, the temperature of the air will fall, and if the tunnel be sufficiently long, the water and air will ultimately come to equilibrium.

Notation

In the formula to be derived, the following notation is used:

A = Area of liquid in contact with gas

H = Absolute humidity of gas, or parts by weight of vapor per part by weight of vapor free gas

h = Surface coefficient of conductivity of heat between gas and liquid, or B.t.u. per unit time per unit surface area per unit temperature difference

k' = Coefficient of diffusion, or parts by weight of vapor diffused per unit time per unit area per unit absolute humidity difference

k = Coefficient of diffusion, or parts by weight of vapor diffused per unit time per unit area per unit vapor pressure difference

p = Partial pressure of vapor

P = Total pressure of vapor and vapor-free gas (i.e., barometer)

θ = Time

t = Temperature

r = Latent heat of vaporization

s = Humid heat, or number of heat units necessary to change the temperature of unit weight of vapor-free gas, *plus the vapor it contains*, one degree

W = Weight of liquid evaporated.

Interaction of Water with Air

Now consider for the moment the conditions at any given point along the length of this tunnel. At this point the temperature, absolute humidity, and pressure of water vapor in the air will be represented by t, H and p. Since the apparatus is continuous in its operation these conditions will remain unchanged at this particular point, but will vary from point to point along the tunnel. The corresponding quantities representing the condition of the liquid water in contact with the air at this particular point are t_w, H_w and p_w.

The mechanism of interaction of the water with the air is as follows: There exists over the water what is equivalent to a stationary film of air, which insulates the water from the main body of the air. Through this air film heat is diffusing from the air into the water and through the same film there is diffusing, in the opposite direction, the water vapor formed by evaporation on the surface of the liquid. This evaporation cools the surface of water, and, since it is available from no other source, heat must be supplied solely by diffusion from the air. The heat of vaporization must therefore be quantitatively compensated by the heat flow through the surface film, and the rate of evaporation is limited by the rate of diffusion of vapor through the same film.

From the foregoing one can immediately write the following equations:

$$-\frac{dW}{A d\theta} = k'(p_w - p) \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

$$\frac{dQ}{A d\theta} = h(t - t_w) \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

$$dQ = -r_w dW \quad \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

Whence

$$p_w - p = \frac{h}{k' r_w}(t - t_w) \quad \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

This last equation is the one normally used for calculating the humidity of air from wet- and dry-bulb thermometer readings. In it, variation in r_w is neglected and the term $h/k'r_w$ is assumed constant. For p in millimeters of mercury and t in deg. cent., it equals 0.5. The equation implicitly assumes that the cooling of the air is differential, i.e., so small in the neighborhood of the point in question that the actual changes in temperature and humidity of the air, t and p (or H), are negligible.

Since

$$p = P\frac{\frac{H}{18}}{\frac{H}{18} + \frac{1}{29}} \quad \ldots\ldots\ldots\ldots\ldots\ldots [5]$$

$$t - t_w = \frac{k' r_w}{h} P\left(\frac{\frac{H_w}{18}}{\frac{H_w}{18} + \frac{1}{29}} - \frac{\frac{H}{18}}{\frac{H}{18} + \frac{1}{29}}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots [6]$$

Where H is small, as is usually the case below 150 deg. fahr., $\frac{H_w}{18}$

---

[1] Head of Dept. of Chem. Engrg., Mass. Inst. of Tech.

[2] Leslie, Nicholson's Journal, vol. 3, p. 461; August, Pogg. Ann., vol. 5, p. 69, 1825; Apjohn, Trans. Royal Irish Acad., vol. 17, p. 275, 1834; Weilenmann, Meteorol. Zeit., vol. 12, pp. 268 and 368, 1877; Maxwell, Zeit. f. Meteorol., vol. 16, p. 177, 1881; O. D. Chowolson, Traité de Physique, vol. 3, part 2, p. 807, 1911.

[3] Journal Am.Soc.C.E., 1886.

[4] U. S. Dept. of Interior, Washington, D. C., Water Supply Bulletin No. 279.

[5] Am. Soc. Refrigerating Engineers' Journal, May, 1916, vol. 2, no. 6, p. 23.

Paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

and $\frac{H}{18}$ are negligible compared with $\frac{1}{29}$, and one may write, as a close approximation,

$$t - t_w = \frac{kr_w}{h}(H_w - H) \quad \text{[7]}$$

where

$$k = 29k' \frac{P}{18}$$

It is obvious that h and k depend on the thickness of the air film and are therefore functions of the velocity of the air. It is, however, equally obvious that if air velocity be increased sufficiently to double the one, the other will double also. The ratio of h/k therefore remains constant, independent of velocity. This explains why the reading of a wet-bulb thermometer is uninfluenced by the velocity of air passing it, provided the velocity is sufficient so that any heat lost by radiation is negligible in comparison with that picked up by conduction.

The Relation $h/k = s$

Now consider the change in humidity and temperature of the air as it moves along the tunnel. Starting at the same point previously considered, the air will drop in temperature by an amount dt and increase in humidity by an amount dH. The heat given up by cooling must correspond to the heat of vaporization of the water picked up, i.e.,

$$-s\,dt = r_w\,dH \quad \text{[8]}$$

whence, assuming constancy of s and r_w,

$$H = -\frac{s}{r_w}t + \text{const.} \quad \text{[9]}$$

Assuming the tunnel indefinitely long, the air will ultimately become saturated at some temperature t_e, and humidity H_e. Since these conditions represent equilibrium between the air and the water, evaporation will cease, and t_e and H_e are therefore the constant, fixed end-points of the process. Inserting these limits,

$$H_e - H = \frac{s}{r_w}(t - t_e).$$

We have now derived two formulas connecting H and t, both applying to this same process of evaporation, i.e.,

$$H_e - H = \frac{s}{r_w}(t - t_e)$$

and

$$H_w - H = \frac{h}{kr_w}(t - t_w)$$

These two expressions must therefore be identical. By the method of undetermined coefficients this can be true only provided the corresponding coefficients are equal, i.e.,

$$\frac{s}{r_w} = \frac{h}{kr_w}, \text{ or } s = \frac{h}{k}$$

and $t_w = t_e$, a constant; and $H_w = H_e$, also constant.

So far the discussion has been limited to water and air. Obviously, however, the same relationships must apply to any liquid and any gas with which its vapor is mixed.

The first of these equations, $h/k = s$, states that the coefficient of heat transfer divided by the coefficient of vapor diffusion through the gas film is constant, and equal to the humid heat of the gas. By means of Formula [1] the ratio h/k can be calculated from the observed wet- and dry-bulb temperatures for any vapor-gas mixture of a known gas humidity. The experimental determinations of wet-bulb temperatures for water-air, water-carbon dioxide, toluol-air and chlorbenzol-air, and calculations for h/k given in Table 1 show that this ratio is in all cases substantially equal to the humid heat of the entering gas, which in this case was identical with the specific heat because the gas which was used was vapor free.

TABLE 1 VALUES OF h/k FOR VARIOUS VAPOR GAS MIXTURES

	h/k calculated from experimental results	Specific heat of gas
Water-air	0.236	0.238
Water carbon dioxide	0.217	0.220
Toluol air	0.238	0.238
Chlorbenzol air	0.218	0.238

We have therefore demonstrated that, granting substantial constancy of s and r_w, and assuming H to be small, the ratio of the coefficient of diffusion of heat to that of any vapor through the gas film on the surface of the liquid is equal to the "humid" heat of the gas. Furthermore, during "adiabatic"[1] evaporation of a liquid into a gas, the liquid being in dynamic equilibrium with the gas, the temperature of the liquid remains unchanged throughout the process and the end-point of the process is reached when the gas has cooled itself to saturation at a temperature identical with that of an ordinary wet-bulb thermometer.[2]

Importance of the Relationship $h/k = s$

The importance of the relationship $h/k = s$ is very great. The term s, the humid heat, may be readily calculated for any case, regardless of whether the problem is primarily one of heat transfer or of diffusion. Hence if the heat-transfer coefficient h has been experimentally determined for a certain type of apparatus operating under definite conditions, the coefficient of diffusion equals h/s, and the capacity of this same apparatus may be predicted when functioning in diffusion processes, e.g., as a gas scrubber. Conversely, if k and s are known for definite conditions, h equals ks; in other words, one can predict the performance of a given apparatus for heat transfer from data upon the same equipment functioning as a scrubber.

These processes of diffusion of heat and of vapor are at the basis of the performance of all such equipment as humidifiers, dehumidifiers, water coolers, gas scrubbers, air driers, light oil stripping columns, and the like. The above relationships make it possible to study the performance of such equipment on a more rational basis than hitherto and to compare the effectiveness of different types of equipment even when the data on the individual types are obtained under widely varying conditions. The Department of Chemical Engineering, Massachusetts Institute of Technology, expects to publish in the near future a series of articles showing various applications of these relations.

Occlusion of Gases in Coal

The great trouble about the analysis of coal and the estimates based upon the analysis is that the analytical processes themselves affect the coal so that the methods of examination are conventional. That concerns the very first quantity determined in any analysis, the moisture, and further, the volatile constituents and the occluded gases. The occluded gases can be determined by pumping off the gas liberated, or by collecting the gas given off in a vacuum, either at ordinary temperature (15 deg. cent. or lower) or at 100 deg. cent. Especially at ordinary temperature the experiments will last many days, and there is evidence that the first liberation of the gas will be followed and accompanied by a reabsorption, and that the establishment of an equilibrium condition will be a slow process depending, among other conditions, on the diffusion of gas from the inner layers up into the first-evacuated surface layers of the coal. Conducting such experiments upon various coals and lignites occurring in New Zealand, A. D. Monro of Canterbury College, Christchurch, found that some of the coals behaved peculiarly. There would be strong spasmodic outbursts of gas, e.g., on the 7th, 22nd, 31th and 36th day, the evolution of gas stopping almost entirely on the intervening days, while in other cases the gas evolution would be much more steady. While the percentage of CO_2 in the gas evolved changed little during the outbursts, the percentage of nitrogen and, to a lesser degree that of oxygen, varied very much. Nitrogen and oxygen generally came off first from the various coals, carbon dioxide and methane more slowly. Most of the methane was liberated only by heating; in mines methane is, of course, slowly evolved without external heating, but the coal may be under considerable pressure and at relatively high temperature *in situ*. Monro suggests that gases are both mechanically retained, and held in solution, probably at considerable pressure; the latter would be more important and would account for the spasmodic outbursts. (*Journal Society of Chemical Industry*, April 29, pp. 129–132T)

---

[1] W. H. Carrier, Journal Am.Soc.M.E., 1912, p. 1321.

[2] Ibid.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Properties of Steam at High Pressures

By G. EICHELBERG

INVESTIGATION into the values of the heat of vaporization of steam. In particular, the author attempts to establish a relation between the exponents in the adiabatic equation, the heat of vaporization, and the specific heats of the steam, and measure indirectly the specific heats of saturated steam by using this relation.

The recent attempts to employ commercially steam pressures of the order of [illegible] atmos. makes it important to consider the behavior of steam at these pressures. Unfortunately, steam tables fail to agree for pressures in excess of 20 atmos. Because of this it was suggested that the measurements as to the heat of vaporization carried out by the German Institution for Physical and Technical Measurements be extended into this region of values, and this was actually done by Schuele in 1921. The results obtained by him were very different from those previously secured by the present author. At about 20 atmos. there is a difference in the values of the heat of vaporization as found by the two investigators of about 6 large calories, and at about 40 atmos. the difference is 19 large calories. Corresponding differences would of course appear also in the values for saturation volumes of steam as these are connected by thermodynamic laws with the values for the heat of vaporization.

It is claimed, however, that the measurements of specific heat in the region of superheat which Schuele had available, extended only up to 8 atmos. On the other hand, Eichelberg bases his values on the Munich measurements of the specific heats of superheated steam. These values were expressed in the form of an equation from which the various magnitudes of state in the region of superheat could be derived, one after another, in accordance with well-known thermodynamic laws. Furthermore, by means of the equation for the specific heats of water (Knoblauch and Winkhaus) and the condition of equilibrium between steam and water, it became possible to obtain the curve of vapor tension and finally all the magnitudes of state in the region of saturation, in particular, the values of the heat of vaporization.

These latter in the region above 10 atmos. have shown material deviations from the values obtained by Schuele and only further experimentation can show which are correct. Meanwhile, and having regard to the measurement of the specific heats of steam, there are two ways to which to proceed in forming an opinion.

The first of these is based on the variation of the heat content in cases of high superheat and requires that at equal temperatures the heat content shall decrease with increase in pressure. Since the specific volume of steam is smaller than it should have been according to the gas law, but with increase of superheat approaches it asymptotically (in other words, since in the equation $v = \frac{RT}{p} - \Delta$ the member Δ has a negative sign and converges toward zero, so that $\Delta > 0$ and $\left(\frac{\partial \Delta}{\partial T}\right)_p < 0$, it follows that—

$$\left(\frac{\partial i}{\partial p}\right)_T = A\left[v - T\left(\frac{\partial v}{\partial T}\right)_p\right] = A\left[-\Delta + T\left(\frac{\partial \Delta}{\partial T}\right)_p\right] . [1]$$

is always negative.

But the heat content i of steam consists of the heat content i' of the liquid, the heat of vaporization r and the heat of superheat i'', and because of this the variation of r may be tested by taking into consideration the requirement that i must decrease at equal temperature with increase in pressure.

In Table 1 i has been computed for $t = 550$ deg. cent. as the sum of the three magnitudes above referred to with the Schuele values for the heat of vaporization. After a brief falling off in the value of i, it appears that from 6 atmos. up (Fig. 1) there is a rise in value, in contradiction to the condition established above. As the Eichelberg values are derived directly from an equation for i and the values of r are calculated therefrom, the contradiction (lines 5 and 6) does not appear in this case.

Up to 10 atmos. there are available satisfactory measurements of the heat of vaporization (Henning) expressed by an equation proposed by Thiesen (line 7). Within the range to which these measurements apply the three sets of values are in good accord. As it is unlikely that there is an error in i'', it follows that one of the two magnitudes is too large; namely, either the heat of vaporization r as found by Schuele, or the heat of superheat i_u at 20 atmos. the value of error being about four large calories.

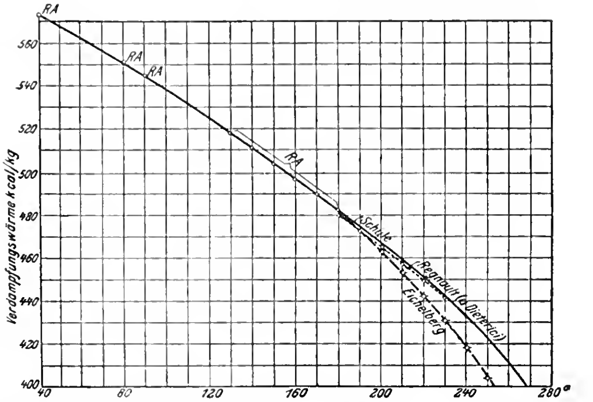


FIG. 1 HEATS OF VAPORIZATION (ORDINATES ARE HEATS OF VAPORIZATION IN LARGE CALORIES PER KILOGRAM; ABSCISSAS ARE TEMPERATURES IN DEG. CENT.)

To ascribe such an error to the value of the heat of superheat would mean, however, that the c_p curve for $p = 20$ atmos., which has been found by careful experiments, must be so displaced as to fall under the present curve for $p = 18$ atmos. without displacing at the same time the corresponding curve for $p = 8$ atmos. This again would mean that in the neighborhood of the limit of saturation the values for c_p at 20 atmos. must be located at least 10 per cent lower, somewhere as indicated by the broken line in Fig. 2. Notwithstanding the difficulty of measuring c_p, however, one would

TABLE 1 HEATS OF VAPORIZATION AND HEAT CONTENTS

p (atmospheres) =	2	4	6	8	10	12	14	16	18	20
1 Heat content of water i'	119.9	143.9	159.4	171.4	181.1	189.9	197.3	201.1	210.2	215.9
2 Heat of superheat i_u (550 deg. cent.)	211.0	202.6	197.8	194.5	192.0	190.4	188.9	187.8	187.0	186.5
3 Heat of vaporization r according to Schuele	525.7	508.7	498.0	489.7	482.6	476.9	471.4	466.6	461.8	457.4
4 Heat content at 550 deg. cent. with r according to Schuele	856.6	855.2	855.2	855.6	856.0	857.1	857.6	858.5	859.0	859.8
5 Heat content at 550 deg. cent. according to Eichelberg	856.8	856.4	856.0	855.6	855.2	854.9	854.5	854.1	853.7	853.3
6 Heat of vaporization r according to Eichelberg	525.9	509.9	498.8	489.7	481.8	474.7	468.3	462.2	456.5	450.9
7 Heat of vaporization r according to Thiesen	525.6	509.7	498.4	489.6	481.9	(475.3)	(469.2)	(463.7)	(458.6)	(453.8)

not expect to find such an error in the classical Munich measurements, which would lead to the belief that the Schuele heats of vaporization obtained by extrapolation based on insufficient experimental values are too high even for 20 atmos. In this connection the author states that Professor Knoblauch, one of those in charge of the Munich tests, assured him that it is inconceivable that the curve for 20 atmos. could, as shown in Fig. 2, be shifted so to appear below the curve for 18 atmos.

The second method of procedure mentioned by the author is of great interest, though not equally compelling. It is based on the slight variations (observed many times before) of the exponent of the adiabatic equation.

The exponent K_s = constant in the adiabatic equation $pv^K = C$ is

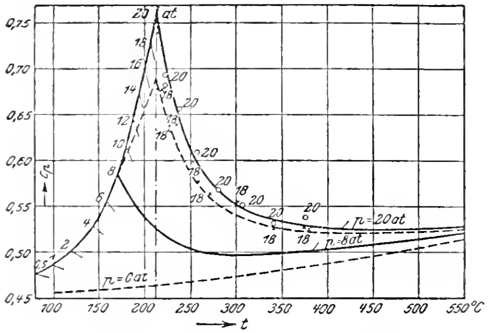


Fig. 2 Specific Heats c_p (At. = Atmospheres; Abscissas in Deg. Cent.)

the product of the exponent of the isothermal equation K_T = constant and the ratio c_p/c_v of the specific heats. It is identical with these latter only in the case of ideal gases, where $K_T = 1$. In the case of steam K_T beginning with the value 1 for $p = 0$, it decreases as we move along the limit of saturation, and at the critical point where $\left(\frac{\partial v}{\partial p}\right) = \infty$ it reaches the value—

$$K_T = -\frac{v}{p\left(\frac{\partial v}{\partial p}\right)_T} = 0$$

Since at the same point $\frac{c_p}{c_v} = \infty$, the value of K_T which it assumes at that critical point is indeterminate.

Numerical solution of the equation for c_p gives Table 2 and Fig. 3, which between them indicate that K_s has a nearly constant value of 1.3. This value has long been used for steam. A similar constancy of value has been observed with respect to the exponent n in the equation T = constant p^n, and this relation permits the following insight into the courses of variation of the heat of vaporization. From the relation

TABLE 2 EXPONENTS OF THE ISOTHERMAL AND ADIABATIC EQUATIONS (ALONG THE LIMIT OF SATURATION)

	K_T	$\frac{c_p}{c_v}$	K_s
$p = 2$	0.977	1.342	1.311
$p = 6$	0.947	1.382	1.310
$p = 10$	0.919	1.420	1.307
$p = 14$	0.891	1.466	1.305
$p = 20$	0.849	1.535	1.303

$$\frac{r}{T} = s'' - s' \qquad [2]$$

when

$$ds = \frac{c_p}{T}\,dT - A\left(\frac{\partial v}{\partial T}\right)_p dp \qquad [3]$$

it follows that

$$\frac{d\left(\frac{r}{T}\right)}{dT} = \frac{c_p}{T} - A\left(\frac{\partial v}{\partial T}\right)\frac{dp_s}{dT} - \frac{c_{fl}}{T} \qquad [4]$$

provided c_{fl} denotes the specific heat of water along the limit of saturation, and all the other magnitudes in the equation likewise refer to the limit of saturation. On the other hand, however, the exponent n may be expressed as follows:

$$n = \frac{Ap}{c_p}\left(\frac{\partial v}{\partial T}\right)_p \qquad [5]$$

If now, from Equations [4] and [5] we eliminate the expression $\left(\frac{\partial v}{\partial T}\right)_p$ which is difficult to determine, we obtain—

$$c_p'' = \frac{T\frac{d\left(\frac{r}{T}\right)}{dT} + c_{fl}}{1 - n\frac{T}{p}\frac{dp_s}{dT}} \qquad [6]$$

or

$$n = \left[1 - \frac{T\frac{d\left(\frac{r}{T}\right)}{dT} + c_{fl}}{c_p''}\right]\frac{1}{\frac{T}{p}\frac{dp_s}{dT}} \qquad [7]$$

In this thermodynamically well-founded equation the following

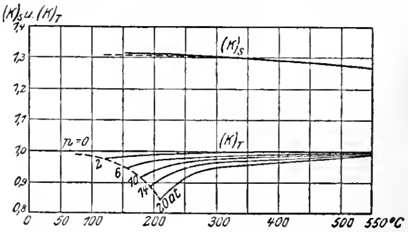


Fig. 3 Specific Heats c_p (At. = Atmospheres; Abscissas in Deg. Cent.)

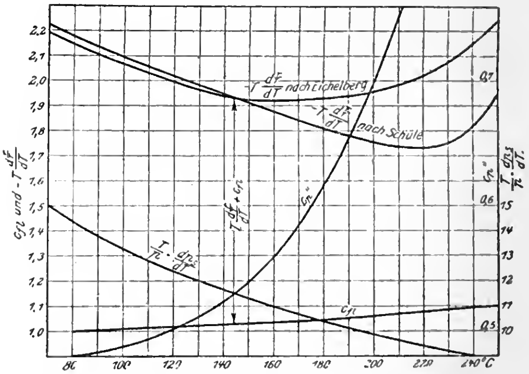


Fig. 4 Auxiliary Curves for Determining the Exponent n (*Und* = and; *nach* = according to.)

magnitudes may be considered as known with a great degree of reliability: $\frac{dp_s}{dT}$, the tangent of the steam-pressure curve up to the critical point; c_{fl}, the specific heat along the limit of liquefaction (up to about 300 deg. cent.), and likewise c_p'', the specific heat at constant pressure at the limit (up to 20 atmos.).

The magnitude $\frac{d\left(\frac{r}{T}\right)}{dT}$, or the inclination of the r curve, is subject to discussion, and with this in view the course of variation of n as found from Equation [7] may be examined.

Table 3 and Fig. 4 furnish the auxiliary magnitudes necessary to compute n; likewise from Fig. 4 the numerator $T\frac{d\left(\frac{r}{T}\right)}{dT} - c_{fl}$

TABLE 3 DETERMINATION OF EXPONENT n

	t_s (deg. cent.) =	80	100	120	140	160	180	200	210
1	c_p	1.00	1.01	1.02	1.02	1.03	1.05	1.06	1.07
2	c''_p	0.48	0.49	0.50	0.52	0.56	0.615	0.70	0.75
3	$\frac{T}{p}\,\frac{dp_s}{dT}$	14.4	13.3	12.4	11.7	11.0	10.4	9.9	9.65
4	$T\,\frac{d\left(\frac{r}{T}\right)}{dT}$ according to Eichelberg	−2.13	−2.07	−2.00	−1.94	−1.92	−1.93	−1.955	−1.98
5	$T\,\frac{d\left(\frac{r}{T}\right)}{dT}$ according to Schuele	−2.17	−2.09	−2.01	−1.94	−1.87	−1.80	−1.76	−1.73
6	Exponent n according to Eichelberg	0.236	0.237	0.238	0.237	0.235	0.234	0.231	0.229
7	Exponent n according to Schuele	0.239	0.240	0.240	0.237	0.227	0.214	0.202	0.195

may be read off as the distance between the two curves. The exponent n (lines 6 and 7 in Table 3) is plotted in Fig. 4 on a large scale. For purposes of comparison the exponent $\frac{K_s - 1}{K_s}$ as given by Table 2 is also plotted in broken lines.

The values of the exponent n computed by means of the values of r obtained by Eichelberg coincide on the whole with the $\frac{K_s - 1}{K_s}$ values, which was to be expected, as K_s and r are both derived from the same c_p equation. All the values of n lie between 0.23 and 0.24, which is in good agreement with the values determined by Hirn and Cazin in exhaust tests, namely, $n = 0.236$.

On the other hand, Schuele's values of r lead to an exponent which lies within the same limits up to 150 deg. cent., but which at 140 deg. deviates from the original direction and at about 210 deg. cent. (which corresponds to about 20 atmos.) falls under 0.200, which would correspond to an exponent $K_s = 1.25$. All observations on steam as well as other vapors would, however, indicate the possibility of only a slight variation of the exponent. If the exponent be assumed to have a value between 0.23 and 0.24 for pressures of the order of 20 atmos. and if this should be confirmed by test, it would be obviously necessary to recognize that values of r which give contradictory results are incorrect. Since Equation [7] appears to be rational, and the error cannot be looked for in the other magnitudes besides r involved in the equation, the same statement would apply for c_p'' with the indicated values of r: it would be incorrect to the extent of 0.2 large calories, or, say, 30 per cent.

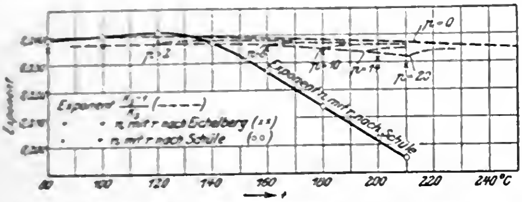


Fig. 5 Exponent n in the Adiabatic Equation $T = p^n$
(*mit r nach* = with the values of r as determined by.)

Finally, attention may be called to the fact that the comparatively sharp inflection in the course of variation of the heats of vaporization as shown in Fig. 4 is per se quite natural, as has been already recognized by Schuele. If, for purposes of comparison, one should plot the heats of vaporization r of various materials with the values of T/T_{crit} the curves obtained thereby would in many instances show an approximate proportionality. In Fig. 6 such a comparison is made for water, carbon dioxide, and ammonia. The latter two curves follow quite closely Eichelberg's r curve which, however, does not mean anything beyond proving once more that Eichelberg's r curve for steam has a rational basis. Such an analogy of curves, on the one hand, does not constitute a positive proof any more than does a comparison of the exponents of the adiabatic equations, at least so long as nothing more certain is known about these latter. On the other hand, however, according to the first criterion indicated above, it is certain that the values of the heat of vaporization extrapolated by Schuele are in conflict with the Munich measurements of specific heats of superheated steam between 10 and 20 atmos.

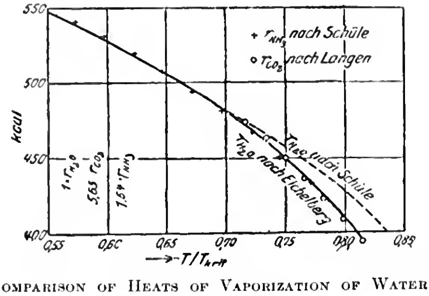


Fig. 6 Comparison of Heats of Vaporization of Water, Carbon Dioxide and Ammonia
(*K cal* = large calories; *nach* = according to.)

It would be very desirable to have this matter cleared up by further experiments. Much would be achieved if only the exponents of the adiabatic equation could be measured at 20 atmos. pressure and saturation, which could be done either by the Hirn and Cazin method or by measuring the velocity of sound in the corresponding medium. For the region above 20 atmos. the precise measurement of r would be of particular interest, together with the measurement of the exponent n or K_s, since then by means of Equation [6] one could obtain very reliable values of the specific heats c_p along the limiting curve which it has been impossible hitherto to obtain by any other method of measurement. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, no. 12, Mar. 25, 1922, pp. 275–277, 6 figs., *tA*)

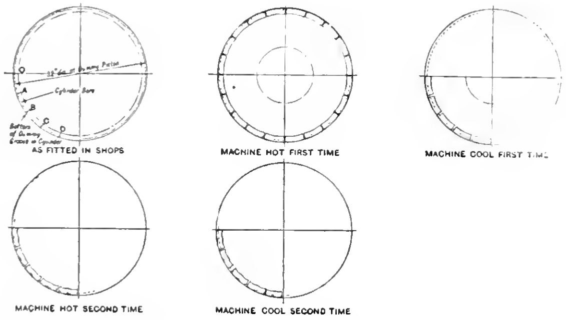
Developments in Power-Station Design

According to a report issued by the Electricity Commissioners (England), electric power is generated very cheaply in the north of England and the most economical steam generating station is that at Carville-on-Tyne. The design of this station involved the solutions of a number of new problems, because of the abnormal steam conditions chosen and a speed of 2400 r.p.m. with 10,000-kw. alternators, which at the time of the design of the station (1915) was unusual. The steam conditions specified were a steam pressure of 200 lb. per sq. in. at the stop valve and a total temperature of 650 deg. fahr. with the additional specification that the steam turbines should be capable of withstanding continuously a temperature of 700 deg. fahr.

The difficulties which had to be overcome in order to operate the turbines at an initial steam pressure of 650 deg. to 750 deg. fahr. were found to be due almost entirely to unequal heating and cooling when starting up and shutting down, and these difficulties were aggravated by the unequal coefficient of expansion of the materials used. On starting up a Parsons turbine from the cold condition, the shroud strip on the blading heats up more quickly than anything else and by its expansion spreads the blades fanwise, the greatest bending stresses being produced at the roots of the outermost blades of a segment or unit. On shutting down the machine, the shrouding strip cools down first, and owing to its contraction the blades are bent in the reverse direction. The greater the circumferential length of the blade segments, the more serious is the effect produced, and if this dilation is sufficiently great, ultimate fracture of the blades at the root is the inevitable result.

In the first of the five 10,000-kw. sets installed in the Carville station, "end-tightened" blade segments composed of manganese

copper and about 6 in. long were used in the high-pressure cast-steel cylinder. The difference in the coefficient of expansion between the dummy packing or the blading material and that of the cylinder and shaft led to trouble, and the sequence of events is shown in Fig. 1. The top left-hand diagram shows a ring of brass strip dummy packing originally calked in at the ordinary temperature of the surroundings in 6-in. segments. On starting up the turbine the brass expanded more than the casing, with the result that the strip was forced out of the groove at the weakest points, namely, at the butt joints *A*, *B*, *C*, etc., the effect being shown in the diagram, Fig. 1. On shutting down the turbine the brass strip cooled more rapidly than the casing, and owing to the larger coefficient of expansion contracted to a greater extent, and definite gaps were left between the segments, as shown in the third diagram. The next time the turbine was started, however, the brass strip again heated up first and expanded more than the casing, and appeared to become so firmly wedged in the grooves that free expansion was restricted, with the result that hogging took place in the middle of the segments, as shown in the bottom left-hand diagram; while on cooling down the brass strip contracted freely and the gaps were widened still more, as shown in the next diagram.



AS FITTED IN SHOPS MACHINE HOT FIRST TIME MACHINE COOL FIRST TIME

MACHINE HOT SECOND TIME MACHINE COOL SECOND TIME

Fig. 1 Diagram Showing the Effects of Heating and Cooling in Steam Turbines

The ultimate effect of these results was the formation of large gaps between the segments, creeping of the segments in their grooves, so that in some cases they were butted close together with a corresponding large gap elsewhere, and general displacement out of the grooves. The cylinder blading behaved in a similar manner, while in the case of the rotating blade rings on the shaft the butted ends of the segments were forced outward, and the blades at the ends became loose. All these troubles were, however, largely overcome by the simple expedient of inserting both blade units and dummy packing strips in short lengths. In the case of the blading the segments were made about $1^1/_2$ times the length of the blades and they were also brazed up solid at the roots, which were accurately faced at the ends, so that creeping was made impossible. The shrouding strip was kept the same length as the blade units, but small gaps were left between adjacent pieces. Dummy piston-packing strip was inserted in lengths of about 1 in., and proved to be entirely satisfactory. During the construction of the later machines for the Carville station further improvements were made.

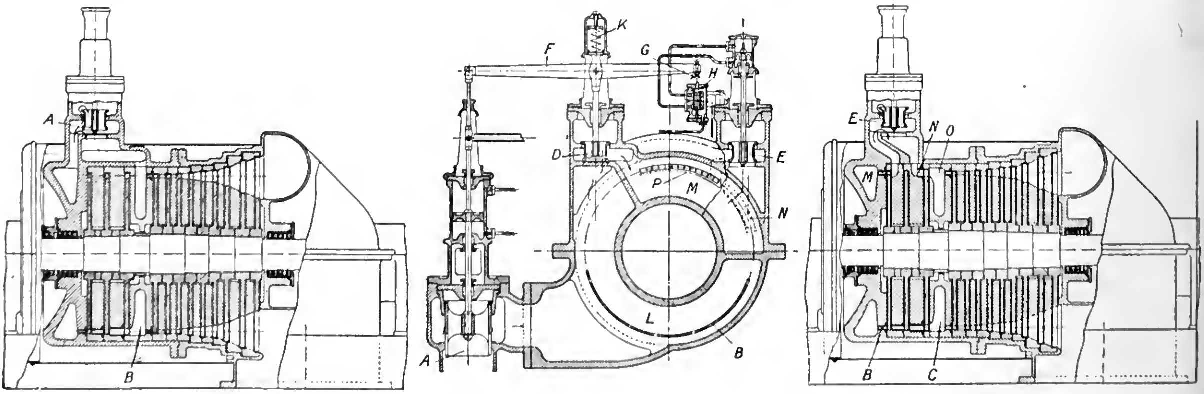


Fig. 2 Original Type of Oerlikon Turbine, and Fig. 3, New Type of Oerlikon Turbine

Steel blade material was adopted, and the individual "lock root" type of blading was introduced into the shafts, each blade unit consisting of a blade and spacing section riveted and brazed together, the root being heavily serrated on both sides. The blade units were then assembled in grooves with parallel sides and with correspondingly heavy serrations, the last blades of each row being inserted through a lantern space, which was finally closed by a serrated steel locking piece calked in position with copper calking pieces. After being assembled into a complete blade ring in the shaft, the shroud strip was brazed on to the blade tenons in short lengths, the adjacent ends slightly overlapping so that in service flexibility is permitted without increasing the steam-leakage area. In the latest Parsons turbines the blade units are produced in one piece, a blade root and a spacing section being combined by a special process which does not involve expensive milling out of the solid nor casting the blades into the roots. The experience obtained at Carville has enabled perfect "end-tightened" reaction blading to be produced, and it is claimed to be quite suitable for the high steam temperatures which are now coming into use.

The success of the first Carville unit was such that several other similar sets were built. Recently two 10,000-kw. tandem machines of similar design, but without water-cooled rotors, and running at 3000 r.p.m. were installed and are run under the same steam conditions as those at Carville, and several other sets are either being installed or are under construction. It is of interest to note that while originally the specified steam temperature was 650 deg. fahr., this temperature was subsequently increased to 706 deg. fahr. owing to the efficiency of the superheaters and the absence of trouble with the turbines. The turbines are of the Parsons type.

The experience with these turbines has shown that when the electrical conditions permit, it is now easier and better to build a 15,000-kw. set for 3000 r.p.m. than for 1500 r.p.m.

One of the most recent turbine improvements is due to the Oerlikon Company, which has introduced a special method of admitting extra steam during times of overload. Steam turbines are usually required to deal with an overload of, say, 25 per cent for a specified period, which may range from one-half to two hours, and, generally speaking, the steam consumption while this overload is being carried exceeds that which is experienced while the machine is running at the normal full load for which it has been designed. The method of admitting the additional steam varies to a great extent in different makes of turbines. In the Oerlikon turbine, which has pressure stages, it was originally customary to introduce the overload steam into the second or one of the following stages, as shown in Fig. 2. Steam passed from the steam chest through the high-pressure section into the intermediate steam chamber

B, and from there into the low-pressure portion of the turbine, where there is full peripheral admission; while in the high-pressure portion there is only partial admission. At all loads up to full load the overload valve *A* remains closed, but when the load exceeds the full normal value the valve opens and admits steam to the low-pressure portion. A table is given in the paper which shows the increase in the steam consumption under overload conditions.

With the boiler plant available it was not possible to maintain the same steam conditions at all loads, the temperature of the steam in both the tests being higher during the overload tests than it was when the machines were running at other loads; but in arriving at the percentage increases given due allowance was made for that fact. Up to full load the steam consumption per kilowatt-hour decreases as the load increases, but after full load has been reached the consumption rises. Similarly, the efficiency of the turbo-generator increases up to full load and drops on overload. The steam consumption on overload is not of great importance when the overloads are infrequent and are of short duration, but in view of the fluctuations of load on the supply system, a turbine of the type shown—Fig. 2—would not, the makers contend, usually be worked at full load, as the variations in the load on the system would involve the by-pass valve being opened at fairly frequent intervals. Variations in steam pressure and vacuum have also to be taken into account, and the normal load under working conditions would hardly exceed 90 per cent of the full load. With the Oerlikon Company's patented arrangement for the admission of steam into turbines, however, the heat drop during the overload period can be entirely utilized. The steam passes from the main inlet valve into the throttle valve *A*—see Fig. 3—and the quantity of steam admitted to the turbine varies according to the load. The steam chest, as the drawing shows, occupies only a portion of the circumference, and the bank of nozzles *B* is designed to deal with the quantity of steam which the turbine requires for full load. This steam passes through the high-pressure part of the machine, which consists of three pressure stages, and flows into the intermediate steam chamber *C*, and from there into the low-pressure wheels, where there is full peripheral admission; while in the high-pressure part there is only partial admission. In the first and third stage of the turbine there is a separate bank of nozzles for the passage of the overload steam. As soon as the turbine is subjected to an overload and the normal supply of steam is no longer sufficient to enable the turbine to develop the output required, the two overload valves *D* and *E* open automatically. The central lever *F*, which is fitted with an adjustable screw *G*, opens the valve *E* by pressing on a pilot valve *H*, which causes the valve *E* to open by supplying oil under pressure to a piston. When the pilot valve has reached its lowest position the control lever *F* pivots about the screw *G*, and the overload valve *D*, which is normally held down by the spring *K*, is lifted. The additional steam passes from the steam chest *L* through the valve *D* into the steam chamber *M*, and from there it passes into the nozzle segments *P* and into the first turbine wheel. It is then led through the overload valve *E* to the nozzle segments *N* in the third stage of the turbine, and from there into the third set of wheels, where its energy is utilized. In the intermediate chamber *O* it joins the main supply of steam and flows through the low-pressure portion of the turbine.

The results obtained with this system of supplying extra overload steam to turbines have met all expectations. The fundamental difference between the old and new arrangements lies in the fact that in the latter case the efficiency steadily rises up to an overload of 140 per cent. Tests made on a 1500-kw. machine have also confirmed this result, and with this new arrangement for admitting overload steam it is not only possible to run the turbine at its full capacity, but also run it at overload for the full period as determined by the heating of the generator. In the case of back-pressure turbines working on overload the advantages of the new system of admitting overload steam are even greater than those which are obtained when the system is applied to ordinary turbines, as the total heat drop is smaller. All the Oerlikon turbines are now provided with this improved arrangement, and some of them are coupled to generators which are capable of carrying the overload continuously. (Serial article in *The Engineer*, vol. 133, no. 3459, Apr. 14, 1922, pp. 406–409, illustrated, *dgA*)

Short Abstracts of the Month

CONVEYING MACHINERY

Steel-Band Conveyors. Description of steel-band conveyors of the rolled linkless type as built by a German concern (Sandviken). This band is very thin (0.8 to 0.9 mm. or 0.031 to 0.035 in.) and consequently flexible. At the same time it is sufficiently stiff laterally to permit of spreading the material over a great width. The surface of the band is hardened to reduce wear. The end sheaves and supporting rollers may be made smaller than the width of the band; hence they may be made of large diameter, thus reducing the cost and power consumption.

The upper working strand of the band may be guided either on rollers or on slides. The lower strand is always supported on rollers. Graphite is usually used as a lubricant. Some data as to design are given in the original article. As regards drive, the steel-band conveyor does not essentially differ from other types. The speed of the band may vary from 60 to 90 m. (196 to 295 ft.) per min., depending upon the capacity.

It is claimed that such a steel band does not easily rust and that it is suitable for transport of wet material, such as clay, beet-root shavings, pulp, etc. When such sticky material is handled a special band cleaner is suspended above the lower strand near the end sheaf, pressing against the latter by means of springs. The original article illustrates the charging arrangements and also a unit used in a steel plant for transporting granulated blast-furnace slag and ore. (*Engineering Progress*, vol. 3, no. 5, pp. 109–110, 13 figs., *d*)

COMBUSTION ENGINES (See Marine Engineering)

ENGINEERING MATERIALS (See also Welding)

Synthetic and Electric-Furnace Cast Iron

Electric Cast Iron. Abstracts of four papers presented at a meeting of the American Electrochemical Society in Baltimore, April 27, 1922, and which cover the historical, economic, metallurgical and "sane" phases of the subject.

Geo. K. Elliott presented a paper on Cast Iron as Produced in Electric Furnaces. The first use of the electric furnace for gray cast iron in regular production seems to have been made by the Lunkenheimer Co., Cincinnati, Ohio, in the summer of 1917, the cupola being utilized in the melting period and the electric furnaces for refining.

The primary factor justifying the employment of the electric furnace as the second step in a duplexing process lies in its ability to refine and superheat the metal, two things which cannot be done in the cupola. On cast iron the electric furnace is capable of delivering without too great attention metal superheated to any degree, reduced in sulphur as required, deoxidized, and with carbon, silicon and manganese adjusted to the desired standards (this applies especially to the furnace with basic bottom). Phosphorus cannot be altered in cast iron by the electric furnace in commercial practice. The electric furnace is at its best when coupled with the chemical laboratory in an intimate manner.

The advantages of superheating lie in the increased fluidity of the iron. Greater fluidity not only permits the use of low-phosphorus iron, but in other metals assures solid castings through freedom from blow holes, shrink holes, slag inclusions and the like. Superheated metal increases the effectiveness of risers by lengthening the period of fluidity, which is their only period of activity as feeders, and thereby obviates to a large degree the internal shrinkage that comes from fluid contraction of the metal. Abetted by superhot metal the efficiency of the ordinary riser becomes surprising.

Jas. L. Cawthorn in a paper on Synthetic Cast Iron discussed methods of production of cast iron from machine-shop scrap. He stated that when this is melted in either an acid or basic electric furnace with 75 lb. of good coke per ton, it will come down with about 2.5 per cent carbon and well deoxidized. Melting under a carbide slag in a basic furnace does not change the carbon, man-

ganese or phosphorus, but reduces silicon practically to zero and sulphur to half. Acid-furnace melting without special slag, which is cheaper and simpler, brings down metal unchanged in sulphur and phosphorus; about 50 per cent of the manganese goes out in the slag and a little silicon may be picked up from the lining. If more carbon is needed it can be added by stirring it into hot, clean metal; for example, by poling, and the author described a useful test depending on the hardness of the test bar.

W. E. Moore gave a paper on History of Electric Cast-Iron Melting. The paper is, however, a good deal broader than its title.

It is stated that electric iron can be kept uniform in hardness and strength and under exact control for the particular application desired. The iron runs 50 to 90 per cent stronger than either cupola gray-iron castings or air-furnace malleable castings. Further, since electric iron may be rendered fluid by superheat, it is unnecessary to keep the phosphorus content high, low phosphorus adding to the resistance of the castings to shock.

In a case where the most careful cupola practice made bottle-machine molds which would hold their polish for four hours only, similar electric-furnace iron molds lasted from three to four times as long.

Table 1 was presented as giving the operating costs of iron furnaces. The figures of this table were, however, seriously questioned in the discussion. The electric furnace is said to offer superior metal for making white-iron castings to be malleableized or for making chilled castings, such as crusher wearing plates, chilled wheels, chilled rolls, etc. For electric iron castings charcoal pig may be eliminated entirely, with better results than before.

TABLE 1 OPERATING COSTS OF IRON FURNACES

	Cupola melting		3-Ton leectric furnace
Borings, 1500 lb. at $4			$ 3 00
Foundry pig, 1000 lb. at $20	$10.00		
Machinery scrap, 1000 lb. at $14	7.00	500 lb.	3.50
Per ton mixture average	$17.00		6 50
Melting loss, 8 per cent	1.36	4 per cent	0.68
	18.36		7.18
Coke, 1/6 ton at $8	1.33	50 lb.	0.20
Blower power and slags	0.50		
Additions			0.20
Power, 400 kw-hr. at 1½ cents per kw-br.			6.00
Electrodes, 10 lb. carbon at 6.5 cents			0.66
Refractory repairs	0.50		0.20
Labor	1.25		0.80
Total cost of iron "at spout"	$21.94		$15.24

In a paper entitled Synthetic and Electric Pig Iron Sanely Considered, Robt. Turnbull claimed that the manufacture of synthetic pig iron is a logical operation for iron foundries having electric furnaces and making either gray-iron or steel castings. In countries where coke is expensive, pig iron from scrap in an electric furnace may prove cheaper than electric-furnace production from ore.

The question of cost of production of cast iron in an electric furnace raised a lively discussion. E. L. Crosby told of a foundry in Detroit which could buy borings at $8 per ton and use them for 100 per cent of the charge. The current consumption was 600 kw-hr. per ton under eight-hour operation, or 500 to 525 kw-hr. per ton for sixteen-hour operation. With current at 1.8 cents per kilowatt-hour, molten iron from borings cost $23.60 per ton, whereas cupola iron made right alongside cost $25.00 per ton, the number of rejections of castings being far less with electric iron than with cupola iron. On the other hand, the claim put forward by W. E. Moore that electric iron can be made at $15 per ton was vigorously opposed by several speakers.

As part of the discussion Dr. Richard Moldenke read a translated abstract of an article from a German publication (*Giesserei-Zeitung*) describing the practice of a German foundry using the cupola-electric furnace duplexing process, and giving an itemized cost of operation in German units. (American Electrochemical Society papers abstracted through *The Iron Age*, vol. 109, no. 18, pp. 1203–1205, and *Chemical and Metallurgical Engineering*, vol. 26, no. 18, pp. 820–822, *gc*)

Cobalt-Tungsten Alloys, Karl Kreitz. Data of extensive experiments with alloys of these two metals, as a result of which experiments it was found that the alloys may be divided into five groups as follows: Those containing up to 40 per cent of tungsten have a mixed crystal structure; from 40 to 45 per cent tungsten, a eutectic matrix with primary mixed crystals; from 45 to 70 per cent tungsten the mixed crystals disappear and the crystals of a cobalt-tungsten combination take their place; from 70 to 80 per cent tungsten the alloys have an unstable structure, indicating the appearance of excess of tungsten; finally, alloys containing more than 80 per cent of tungsten, consisting of a homogeneous matrix embodying primary crystals, or possibly mixed crystals with a high content of tungsten.

From the investigation it would appear that only alloys containing about 10 per cent of tungsten may have a practical importance, for example, for use as a material for metal-cutting tools. The Brinell hardness varied from 185 to 282 with the increase of tungsten from 0 to 97 per cent, the variation being quite gradual. On the other hand, however, the increase of tungsten reduced the ability of the alloy to resist corrosion when in contact with sea water. (*Metall und Erz*, vol. 19, no. 6, Mar. 22, 1922, pp. 137–140, 1 fig., *e*).

Y Alloy (Aluminum-Copper-Nickel-Magnesium). Data on an alloy described in a recent report to the Alloys Research Committee of the British Institution of Mechanical Engineers, entitled Some Alloys of Aluminum.

The alloy contains about 4 per cent copper, 2 per cent nickel, 1.5 per cent magnesium and remainder aluminum. When properly cast and heat-treated it has a strength of 47,000 lb. per sq. in., and when rolled and heat-treated 54,500 lb. per sq. in., with an elongation of 24 per cent in 2 in.

The original article gives instructions as to the casting of this alloy. Its physical properties may be materially improved by heat treating. Chill castings are given a 6-hr. anneal at 530 deg. cent., then quenched in boiling water and aged. This treatment increases the tensile strength from 28,000 lb. to about 47,000 lb. per sq. in. with 6.5 per cent elongation in 2 in.

Data on correct forging and rolling practice and physical properties of rolled Y alloy after heat treatment are given in the original article. One of the remarkable properties of this alloy is its great resistance to corrosion, which is greater than that of high-strength aluminum alloys. (*Chemical and Metallurgical Engineering*, vol. 26, no. 17, Apr. 26, 1922, pp. 785–787, 6 figs., *de*)

FOUNDRY

Making Castings Without Feeding Heads. Abstracts of two articles, one in a British and the other an American publication. The first article reports the work of E. Ronceray, a French foundryman, who delivered a lecture at a meeting of the London section of the Institute of British Foundrymen, April 16, 1922.

The principle involved in the pouring of castings by this method is to run them from their thinnest section, so that the metal will freeze almost simultaneously throughout the mass of the casting, and to run the metal at such a rate that freezing will take place within as short a time as possible after the completion of the pour, thus reducing to the practical minimum the amount of liquid contraction in the period after the mold has been poured. By these means a casting can be poured with a runner or runners of relatively extremely small area, the total weight of the metal not employed in the actual casting being reduced to an almost insignificant amount compared with the weight of the casting. With the rate of pouring thus controlled, the metal first poured, as it cools and contracts, is said to feed itself from the metal poured afterward while pouring is still in progress.

It is claimed that with this method of casting not only a greater part of the melting scrap is eliminated but also sounder castings and a smaller proportion of wasters is produced. (*The Metal Industry* (London), vol. 20, no. 18, May 5, 1922, p. 417, *dp*)

Another instance of casting without a riser is described from American practice, with reference to the experience of the author in 1916 in connection with casting copper bands in sand. After some trouble a successful attempt was made to cast large copper bands weighing 30 lb. with a gate weighing only 1.75 lb. without using either risers or chills. The bands cast by this system are said to be clean and solid. To do this the copper was poled till brought to a good tough pitch. It was then poured at about 2500 deg. fahr. and just hot enough so that the head would not swell. At another time

similar castings were made by the author of 98 per cent copper and 2 per cent nickel mixture in sand without risers or chills. (Casting Copper Without a Riser, by Nelson F. Flanagan, *The Metal Industry* (New York), vol. 20, no. 5, May 1922, p. 182, 1 fig., *dp*)

HYDRAULICS (See Pumps)

INTERNAL-COMBUSTION ENGINEERING

Schuele's Tests of a Holzwarth Gas Turbine

Thyssen-Holzwarth Oil and Gas Turbines, Prof. W. Schuele. Tests made by Professor Schuele with the Holzwarth gas and oil turbine have led him to the conclusion that so far only that turbine satisfies the conditions imposed by the operating functions and work in modern plants. It is claimed that a thermodynamic efficiency of 45 per cent is attained with the Holzwarth process at a compression ratio of three as against a ratio of twelve in the piston gas engine. It is really the efficiency of compression that goes far to determine the comparative overall efficiencies of the gas turbine and reciprocating engine.

Another important consideration is the temperature condition in the unit. In the Holzwarth turbine the time during which the high temperatures prevail is short and is followed by a period of low temperature, which makes the Holzwarth explosion turbine as safe as a piston engine. It is said that the combustion turbine cannot operate without this rhythmical change of temperatures.

As compared with the steam turbine the gas turbine is remarkable from the fact that it requires but one stage for its drop of pressure from 230 lb. to atmospheric pressure, a ratio of sixteen. In the steam turbine the jet works uniformly, while in explosion turbines it works like a shot with decreasing jet velocity. Fortunately, this does not matter much, as is shown by Figs. 1 and 2. In Fig. 1 *BHC* represents the *p*-*v* diagram of the Holzwarth turbine working with a compression pressure of 2.2 atmos. and an explosion pressure of 17.3 atmos. abs. While the pressure decreases during the expansion from 17.3 atmos. abs. to 7.3 atmos. abs., the part of the energy marked with vertical lines has been transformed into kinetic energy and only the small balance below *MN* is left.

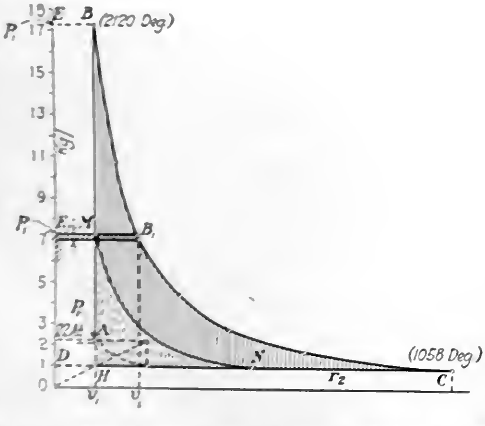


Fig. 1 Pressure-Volume Diagram of the Holzwarth Explosion Turbine

Fig. 2 shows that the jet velocity decreases slowly until about 90 per cent of the total energy is transformed into kinetic energy. During transformation of the last 10 per cent, however, which is not of much importance, the jet velocity decreases at a more rapid rate, and the efficiency of the one-stage turbine is therefore not much lower than that of a similar steam-turbine wheel. The shocks which the wheel blades have to stand in the Holzwarth turbine are, of course, much greater than with steam turbines.

Schuele made tests with a vertical 1000-hp. experimental gas turbine and found an efficiency of 25 per cent with the engine developing 1200 hp.

In this connection attention may be called to an article entitled Thermodynamic Bases for Determining Efficiency to be Expected from Gas Turbines, by H. Schmolke, abstracted from a German publication in Mechanical Engineering, March, 1922, pp. 187–190. This article is also largely based on the experience with the Holzwarth turbine and tests of Prof. Schuele. (Chapter from a German book translated by Hans Holzwarth, the inventor of the turbine, and published in *Motorship*, vol. 7, no. 5, May, 1922, pp. 351–53, 9 figs., *d*)

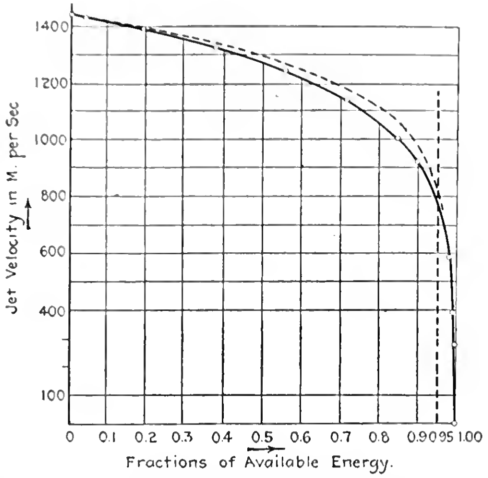


Fig. 2 Variation of Jet Velocity in the Holzwarth Explosion Turbine

MACHINE DESIGN AND PARTS (See Power Transmission)

MACHINE TOOLS

Abbreviations for Machine Designers

Methods of Machine-Tool Design, A. L. De Leeuw, Mem. Am.Soc.M.E. Among the things discussed in this article are a set of symbols (Fig. 4) which the author used as a sort of designer's shorthand. They are merely simplified, one might say skeletonized, indications of various machine parts and might be useful for preliminary sketches. Fig. 3 shows an arrangement of a gear mechanism represented by means of these symbols. There is a pulley with friction clutch, the clutch being keyed to a shaft. To this same shaft is keyed a pair of sliding gears which can mesh with two stationary gears on another shaft, and to this second shaft is keyed a bevel gear driving another bevel gear on a third shaft on which is keyed a worm driving a worm wheel. (*American Machinist*, vol. 56, no. 17, Apr. 27, 1922, pp. 617–620, 3 figs., *p*)

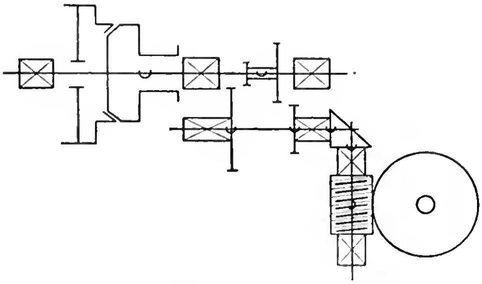


Fig. 3 A Mechanism Indicated by Symbols

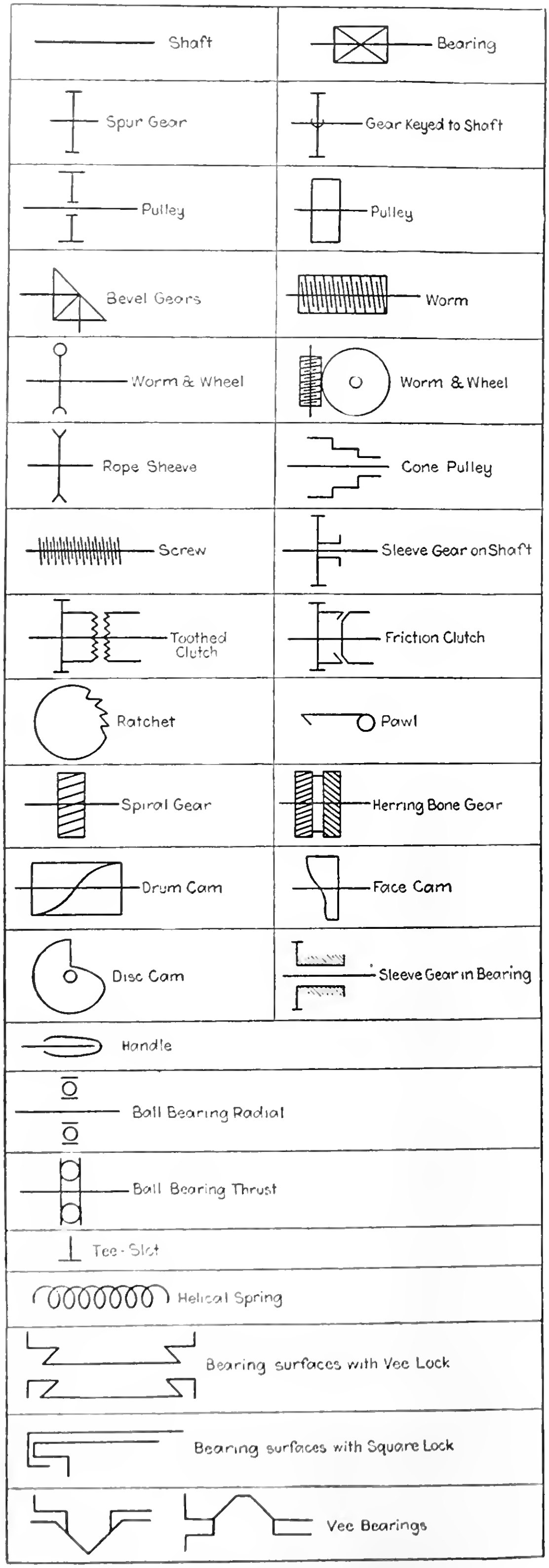


Fig. 4 Designer's Shorthand Symbols

MARINE ENGINEERING

Voyage Around the World of Motorship "William Penn." On March 19 the *William Penn* completed her maiden voyage around the world of 28,500 miles. She is the first large American motorship suitable for deep-sea cargo trade. On her return to New York the propelling machinery was found to be in perfect condition, requiring no repairs. The exhaust and inlet valves of the main engines were changed only once, which was at the middle of the voyage. All work on the main engines was done by the engineer personnel when in port and all similar work on the auxiliary engines and machinery was done while under way at sea. There was no involuntary stopping of the vessel at any time throughout the voyage.

The two main engines are six-cylinder, $29^1/_8$ in. by $45^1/_4$ in. They were originally designed to run at 115 r.p.m. and deliver together 4500 i.hp., but because of the full form of the *William Penn* the power was cut down by reducing the revolutions to 108, corresponding to an output of 4200 i.hp. and a speed of 11.5 knots. In addition there are three auxiliary Diesel engines each direct-coupled to a 65-kw. generator for supplying current to the various electrically driven engine-room and deck machinery. At sea only one of the auxiliary engines was required and carried a load of about 55 kw.

The mean sea speed from New York to London was 11.01 knots with a mean fuel consumption of 13.06 tons per day (exclusive of donkey boiler). The longest non-stop run was from Singapore to Suez, 4943 nautical miles, taking nearly 18 days with a mean sea speed of 11.48 knots and mean total consumption of main and auxiliary engines of 13.41 tons per day, equivalent to a consumption per indicated horsepower of 0.3025 lb.

The original article gives a comparison between the *William Penn* and the electrically driven ship *Eclipse*, which, while not entirely strict, appears to be in favor of the motorship. It is also pointed out that there are several sister ships of the *William Penn* equipped with either steam turbines or reciprocating engines which have been laid up for the past year or more due to their inability to operate at a profit, while the *William Penn* sailed in April for the Far East again, carrying chiefly heavy or dead-weight cargo consisting mostly of structural steel and loaded down to the full-draft marks. With this class of cargo she is able to carry about 1000 tons more than an equivalent steamer, this amount representing the additional fuel and fresh water which the steamer has to carry.

On the way out the vessel encountered severe storms, and it became necessary to slow down to prevent losing the deck cargo. On the return trip the vessel was not fully loaded, although the cargo was of a bulky nature, consisting of hemp, copra, rattans, tapioca, coffee, etc. (*Marine Engineering and Shipping Age*, vol. 27, no. 5, May, 1922, pp. 313–314, 1 fig., *dc*)

MEASURING INSTRUMENTS

The Rotameter. Description of a new device for measuring the rate of flow of any gas or liquid through a pipe per unit of time. This device, the rotameter, consists essentially of a vertical transparent tube with a bore tapering toward the lower end and within which there is a circular, top-shaped float. The stream of gas or liquid flowing through the tube lifts this float, and the quantity passing through is directly read from an accurately calibrated scale fixed to or engraved on the tube. The accuracy of the apparatus lies in the peculiar construction of the float which is kept in rapid rotation by the steam of gas or liquid flowing past it. The float does not touch the walls of the tube and the instrument is assumed to be frictionless. The rotational movement of the float is much more sensitive to disturbance than the vertical movement and there is a continuous check upon the accuracy and proper functioning of the instrument. After long use the float and tube may become fouled and when a certain degree of fouling is reached the float will cease to rotate, thus giving warning that the instrument requires cleaning. It is stated, however, that the rotation ceases long before the accuracy of the vertical motion of the float, and consequently of the readings, is appreciably affected. (*Iron and Coal Trades Review*, vol. 104, no. 2826, Apr. 28, 1922, p. 612, 1 fig., *d*)

POWER-PLANT ENGINEERING (See also Railroad Engineering)

British Steam-Turbine Drive for Textile Mills

A Steam-Turbine Mechanical Drive for Textile Mills. Description of a unit designed by the Metropolitan-Vickers Electrical Co., Ltd., Manchester, England. The intention is to employ machines in sizes varying from about 800 to 2000 b.hp., which is a range that should cover the requirements of textile mills. The condenser is located immediately below the turbine exhaust, but the height from basement to ceiling is only 15 ft.

As regards efficiencies, it is stated that for a turbine of 1500 hp. the makers are prepared to guarantee that the steam consumption will not exceed 10 lb. per b.hp-hr. with steam at 180 lb. pressure, superheated 180 deg. fahr. and a vacuum of 28.5 in. This is equivalent to, say, 9 lb. per i.hp-hr. for a steam engine.

The condenser pumps are to be driven by ropes from the main turbine and a small steam engine is provided for driving them until the turbine is up to speed, after which the engine is cut out by means of a clutch. Where electricity is available for starting purposes, a small motor could be used instead of the steam engine.

Where there is a demand for steam at a pressure of 20 or 30 lb. for heating, drying, boiling, etc., the use of a turbine is economical as it takes very little more heat to raise steam to a pressure of 180 lb. than it does to raise low-pressure steam to 30 or even 60 lb. for heating. On the other hand, steam in expanding from 180 lb. to, say, 30 lb. can be made to do a great deal of useful work in passing through the turbine.

Where the whole of the exhaust from the turbine can be utilized irrespective of the load on the generator, a back-pressure turbine is usually installed; but the instances in which this type of turbine can be employed are limited, since it generally happens that the demand for heating steam is irregular and does not coincide with the demand for power. In other words, whereas with a back-pressure turbine there is a direct connection between the amount of steam available for heating purposes and the work which can be done by the turbine, there are other and more numerous schemes of power plant in regard to which the amount of power required and the demand for heating steam bear no relation to each other. A turbine is therefore required which will give either heating steam or electric power independently, and as the demand for either varies. These requirements are met by the reducing-pressure turbine, which consists of a back-pressure turbine and a low-pressure turbine arranged within one casing and having one shaft. The chief merit of this combination is that it possesses the advantages of an ordinary high-pressure turbine, in that low-pressure stages are provided, through which all surplus steam which has not been discharged into the heating mains can be economically expanded to condenser pressure.

It is of the utmost importance from the point of view of economy that the heating-steam pressure to be maintained by the turbine should be reduced to the minimum pressure which will suffice for the particular heating process under consideration. In the great majority of heating schemes the important point to bear in mind is that the energy dissipated in the process of heating is derived from the latent heat of the steam and not from the sensible heat. When this principle is grasped it will be seen that the back pressure against which the turbine is required to work should be as little as possible above the pressure which corresponds to the temperature required at the point where heating takes place. The loss of energy—and, therefore, of fuel—which results from raising the pressure in the heating mains above the necessary minimum is out of all proportion to any small increase obtained in the heating capacity of the steam.

The article compares the steam turbine and the reciprocating steam engine from several viewpoints, such as steam consumption, mechanical losses, radiation losses, etc., the comparison being on the whole in favor of the steam turbine.

A typical Metropolitan-Vickers reducing-pressure turbine is shown in diagrammatic form in the original article. In this illustration the steam chest and valve gear are shown attached to the top half of the cylinder. This is merely for the sake of facilitating an inspection of their functions. (*Mechanical World*, vol. 71, no. 1843, Apr. 28, 1922, pp. 307–309, 4 figs., *dc*)

POWER TRANSMISSION

Causes of Vibration and Chattering in Geared Drives

Nodal Arrangement of Geared Drives, Dr. J. H. Smith. In power-transmission systems consisting of shafts and toothed wheels it was often found that the gearing chattered. With the introduction of gear wheels running at high speeds the chattering conditions became very pronounced in certain cases. In certain motor cars there are ranges of speed in which it is impossible to secure quiet running without the aid of special appliances; in electric tram-car systems the phenomenon of rail corrugation appears and leads to serious trouble, but the most serious trouble is met with in the geared drives of turbine-propelled ships. The difference in the three cases apparently arises from the difference in size of the rotating masses employed.

Conditions are often particularly bad in double-reduction-gear systems. Occasionally a double-geared ship is produced which appears to give complete satisfaction, while occasionally a roarer is turned out which is found to be unsatisfactory even at half speed.

Various methods have been suggested for the reduction or elimination of chattering and its concomitant phenomena, such as increase in the amount of oil; reduction in pitch of teeth; shortening or lengthening of teeth; increase in the width of the teeth; and finally, adding flywheels and elastic couplings at various points of the drive. The author attempted to carry out a more or less complete mathematical investigation of the causes that led to the chattering. It is believed that the results of this investigation will point out the only possible solution of the problem.

The mathematical part of the paper is not suitable for abstracting and only some of the conclusions arrived at can be reported here.

In the first place, the author established the fact that there is a certain critical speed and defines it as a speed of revolution such that the amplitude of the fluctuating tooth-pressure torque is equal to the transmitted torque. At this speed parting of the teeth will occur. As the speed of the drive is gradually increased, the external periodic action will gradually search out the critical speeds of the system, and if any continuous running is allowed at any one of these synchronizing conditions, dangerous oscillations and chattering may occur. If the equation defining these conditions has (as it may have) a large number of roots lying within the range of the speeds of revolution of the various shafts, there will be a large number of critical speeds.

From a further investigation of the subject the author arrives at the conclusion that the effect of adding either a single mass or an elastic connection to a simple system of gears will increase the number of degrees of freedom of the system, and hence increase greatly the number of critical speeds.

In investigating the effect of tooth-form irregularities it is found that the searching periodic irregularities may be looked upon as a series of fundamentals for frequencies equal to the speeds of various shafts corresponding to inaccuracy in the centering of the wheels, together with a series of harmonics which it would be rather difficult to define, but which, in the upper limit, have periodicities corresponding to the number of contacts per minute. The author states that he knows of the case of a periodic variation in the thickness of the teeth every twelve teeth in a newly cut primary wheel. Periodic variations of tooth thickness are often observed in the worn gear wheels of motor cars.

It does not seem feasible at present to determine analytically the critical speeds arising from irregularities of teeth, as we have no information on the values of these periodic irregularities. If the degree of accuracy of gear cutting were known, the problem could be solved in the same way as that employed by the author for the effect of periodic torques. As this cannot be done, he attempts to solve it in a different way, and comes to the following statement of conditions best adapted for avoidance of the critical speeds which may arise from high-periodicity irregularities of the teeth of gear wheels in elastic-shaft geared drives.

The shafts must be made as flexible as possible and the ratio of the moment of inertia of the mass attached to any shaft to its attendant wheel must be as large as possible.

In the case of the low-periodicity irregularities arising from

varieties of pitch, inaccuracy of centering, etc., the only possible means of avoiding critical speeds may be stated as follows:

The system adopted must be such that it possesses the least number of possible free vibrations and the periodicity of these free vibrations must be as low as possible so as to be outside the range of all disturbances.

In order to simplify a proposed elastic-shaft geared drive, with the object of securing an arrangement which shall have the least number of possible critical speeds, and therefore the least chance of coincidence of any of these with any impressed periodic actions arising either from the action of unknown internal irregularity or known and unknown external periodic disturbances, a certain amount of ingenuity is required. No common line of procedure can be chosen which will be suitable for the most general arrangement. When designing a drive one may have to study the peculiarities of the known disturbing elements, and in some cases it may be necessary to split these elements into their component parts. In all such cases the component parts will consist of a fundamental and a series of harmonics having periodicities that are simple multiples of the periodicities of the main feature of the disturbance. Such considerations will lead to the formation of a family of periodicities. An arrangement of the drive will then have to be made of such a nature that the possible critical speeds are so placed that synchronism does not occur between any one of them and any member of the family of the impressed periodicities. General considerations on a question such as this are of course always difficult to deal with, but after carefully considering the possible variations of the numerous elements with which we are concerned in elastic-shaft geared drives, the author is led to the opinion that the required reductions are best secured by: (1) Simplifying the system; (2) tuning the system; (3) making the elasticities and masses of certain shafts dynamically similar; (4) adjusting the phases of the disturbance; (5) attempting the elimination of high periodicity disturbances by lowering the pitch of the possible free vibrations of the system; (6) arranging the periodicities of the disturbance in a definite and simple family; and (7) reducing the moments of inertia of the wheels of the attendant train to the least possible value.

The difference in behavior of single-reduction and double-reduction systems would appear to be partly explained as arising from the simple nature of the former. In a single-reduction arrangement there are only one-half the number of tooth connections, and hence, roughly speaking, only one-half the number of possible critical speeds and smaller critical-speed ranges than in the corresponding double-reduction arrangement. With the present haphazard method of designing them, the single-reduction arrangement has a far better chance of success than the corresponding double-reduction type. It should not be necessary to dwell on this aspect of the question; the mathematics given in the paper should make it quite clear, for example, that any arrangement having two or more masses attached at different points to any shaft must either be cut out, or precautions must be taken to bind the masses together so that they behave practically as one solid mass. The suggested use of a flywheel on the propeller shaft is without doubt a mistake; it would increase the degrees of freedom of the system and hence the number of possible critical speeds. Any change in the moments of inertia of the propeller or of the shaft dimensions would not increase the number of possible critical speeds, and is therefore not objectionable. It may be observed also that all elastic shafts in the gear box must be cut out; that is, the driver and drive wheels mounted on any shaft must be bound as rigidly together as possible. In short, our systems must be reduced to a one-mass shaft system, and if this is done we have simplified the system in a general way as far as it is possible.

It is often possible to make a group of shafts, together with their attached masses and transmitted torques, dynamically similar, and in such cases the behavior of all the shafts in the group becomes identical and they can be treated as one individual shaft. In this way the number of tooth connections is reduced from the number appearing in the group of shafts to the number appearing in one shaft, and hence the critical ranges will be the same for all members of the group. The simplest conditions to be satisfied in such a reduction are first that the shafts of the group are tuned to the same free periodicity; second, that the masses mounted on the shafts are identical; and third, that the torques transmitted by the shafts are the same. The simplification dealt with here will be of importance when the external disturbing periodic couples can be reduced to one couple action on one shaft.

In certain cases the phase of the disturbing periodic couples will be known with a fair degree of accuracy, and hence by an adjustment of various shafts it will be possible to arrange that these couples cancel each other when taken in pairs. In such arrangements the shafts considered will have to be tuned to the same periodicity and assembled in an appropriate manner. As an example of this, it might be stated that the simplest nodal arrangement which could be devised, if the elimination of the fluctuating torque arising from propeller-blade disturbance is the important consideration, would consist of twin propeller shafts connected to one gear box and suitably assembled.

The author suspects that in many cases angular oscillations have been occurring in turbine rotors, and have been so pronounced as to give rise to appreciable fluctuating couples. If such periodic torques are possible it would appear that they can only be tuning down the possible free vibrations of the system in question to the lowest pitch.

As a general conclusion on simplification the author states that the tuning or nodalizing of any gear drive is the most direct and important dynamical means of attacking the problem when it is proposed to reduce the number and magnitude of the possible critical-speed ranges.

In order to illustrate the use of the equations and conclusions deduced analytically, the author deals in a broad way with two simple problems in which the arrangement of gears and elastic shafts consists of two prime-mover shafts geared to one propeller shaft, which is the common form of arrangement used in ship propulsion. He also gives what he calls a critical-speed diagram. This part, though interesting, cannot be abstracted owing to the lack of space. (Paper before The Institution of Naval Architects (British), read April 6, 1922, and abstracted through *Engineering*, vol. 113, nos. 2936 and 2937, Apr. 7 and 14, 1922, pp. 438–440 and 467–469, 1 fig., *tmA*)

PUMPS

Pipe Friction and Pump Efficiency. Discussion of a paper by W. Brazenall read previously before the Mining Institute of Scotland. The speakers point out the great losses of money in collieries through the use of inefficient pumping installations. The *Iron and Coal Trades Review*, vol. 104, no. 2826, Apr. 28, 1922, p. 611, *p*)

New Vacuum Pump, H. Vigneron. While the new pump is built on the same basic principle as the Gaede vacuum pump, using an eccentric rotation of a heavy cylinder in a hollow cylindrical chamber, it is capable of producing a vacuum equal to 0.0001 mm. of mercury and of doing this in one unit, i.e., without the intervention of an auxiliary pump.

The original article describes and illustrates the details of this pump. In tests made in exhausting a container having a volume of 13 liters (3.43 gal.) the pump running at 225 r.p.m. produced the following vacuums: at the end of 30 min. a pressure of 0.00786 mm. of mercury; at the end of one hour 0.00119 mm., and at the end of two hours 0.00092 mm. of mercury. (*La Nature*, no. 2504, Apr. 1, 1922, pp. 197–199, 3 figs., *d*)

RAILROAD ENGINEERING

Superheater Flue-Hole Liners. The author advocates copper liners in the firebox tubeplates of superheater boilers as a means of combating the difficulties arising from deterioration of tube holes and the constant leakage produced thereby. He describes in some details the manufacture of liners and their fitting into the tubeplate as well as the tools used.

As an example of the value of these liners is cited the case of a heavy passenger engine used on the main line between London and Carlisle with superheater tube holes of the firebox tubeplate $4^{3}/_{8}$ in. in diameter. There was, however, constant trouble with leaky tubes, necessitating frequent rolling and rerolling which resulted in rapid deterioration of the plate, so that in February, 1915, after one year

and ten months' service, it became necessary to fit a new firebox tubeplate. This new plate lasted for a year and eight months and the engine had to be returned to the shops for repairs in December, 1916. By this date smoke-tube-hole liners had been introduced and eleven of them were fitted in the tubeplate of the boiler. After a run of approximately 71,000 miles the engine was again in for repairs in December, 1917, that is, after two years and eight months' time, and the condition of the tubeplate was such that it was decided to take these eleven liners out and equip the plate with a full set of twenty-four. The new plate remained in service until September, 1919; that is, the liner-equipped plate had a life $2^1/_2$ times that of the former plate not so equipped. These liners have also done good service in engines fitted with steel fireboxes and have been successfully applied to the repair of cracked tubeplates. (*The Railway Engineer*, vol. 43, no. 507, April, 1922, pp. 134–135, 12 figs., *d*)

Locomotive Types from a Transportation Viewpoint, J. F. Porterfield. The items going to make up the cost of freight-train operation, except crew wages, do not materially decrease with the increase of locomotive capacity. From various estimates the increased cost of maintaining the large 2-10-2 type compared with the cost of the 2-8-2 or Mikado type, works out at about 20 per cent with a decrease of about 10 per cent in mileage, these items with the increased cost of ownership being about equal to the saving in crew wages.

There is a useful field for the large locomotive where grades exceed 0.5 per cent, and particularly where the preponderance of traffic is in the heavier commodities not requiring preferential movement. On train districts with easier grades where the traffic is fairly well divided between the heavier and lighter commodities the Mikado-type locomotive is the proper type to use. The Mikado type is also better adopted to movement of high-class freight. All of these statements are supported by the author by various calculations.

On the whole, he comes to the conclusion that because of the increased cost of maintenance and of ownership and the decrease in efficiency of the extremely large types of locomotives, careful study and consideration should be given to the grade and traffic conditions, the train frequency or road capacity, the terminal expense required to reduce or increase trains, and other operating conditions before making an investment in locomotives of the larger types. Consideration should also be given to increasing the hauling capacity and productive time or mileage of the existing types, as well as reducing the fuel cost of their operation. (Paper before the Western Railway Club, Apr. 17, 1922, abstracted through *Railway Review*, vol. 70, no. 16, Apr. 22, 1922, pp. 565–566, 1 fig., *pc*)

Flexible-Pipe Feedwater Connections Between Engine and Tender. The connections were made on consolidation-type locomotives on the Bangor and Aroostook. At first there was a single large pipe line on the center line of the locomotive through which both injectors were fed, but this type of connection met with the objection that a failure of the pipe would entirely cut off the feedwater supply and cause a complete engine failure. Because of this the arrangement was changed so as to provide a separate connection for each injector.

At the tender end the connections are attached to plates riveted to the bottom of the tank, and the upper joints are each connected by a short nipple to one of the tank wells. This arrangement with the connections apply directly to the tank instead of to the tender frame is intended to eliminate the possibility of leakage, resulting from slight shifting of the tank.

Connections of this type with feed lines 2 in. in diameter have been in service for several months during the past winter, during which time the locomotives have averaged about 30,000 miles with no maintenance required to the feedwater line. The severe climatic conditions prevailing during the winter months on this line require almost constant use of the heaters when the injectors are not working, and it is estimated that the same service would have required at least one and probably two renewals of the ordinary hose connections. (*Railway Age*, vol. 72, no. 18, May 6, 1922, p. 1070, 1 fig., *d*)

Springs and Draft-Gear Design Data for Freight Cars

Springs, Draft Gears and Other Problems in Car Design, Prof. Louis E. Endsley. In the design of a freight car there are two distinct problems to be taken into consideration. One is the direct vertical load, and the other is the shock or pressure produced between two cars whenever they come together at varying speeds.

None of the parts above the springs should receive shocks from a direct vertical load, and by shocks is meant here that force which is produced by the springs going solid.

The author believes that springs should be designed with a greater capacity than is now done is some instances, and the capacity of springs should not be less than 200 per cent of the normal weight of the car and lading, with the car standing still, and 250 per cent would probably be even better.

In tests made by the author on the Pennsylvania Railroad in 1914, he found that with 200 per cent spring capacity in trips of the experimental car between Pittsburgh and Alliance many solid impact blows were delivered between the bolster and the side frame. Another set of springs which were 300 per cent of the normal load never went solid and there was only one impact recorded that was over 225 per cent of the normal load.

The use of springs of greater capacity would not only protect the car better but would also reduce materially the breakage of springs. The parts of the car which are below the springs, namely, the side frames, need extra weight in them. In tests which the author made to determine the effect of the impact blow upon the side frame after the springs went solid, he found that it takes only a little more energy than that necessary to close the springs to cause some very excessive forces.

Draft-gear problems with modern solid steel cars are not considered to have been entirely solved. They would have been, however, if a draft gear had been used in each car that would never go solid without a pressure above the coupler and still strength but this is not a fact, as we have never yet been able to keep our switching speeds below the impact point.

The old wooden underframe for freight cars was in a better condition to withstand stresses than the modern steel underframe, because it gave two inches as compared with the give of one inch for the steel frame. On the other hand, however, railroads are now willing to permit an increase in draft-gear travel.

Steps should be taken to keep the draft-gear capacity up so that we can keep in the service longer the old and medium-weight cars. If our old cars have an impact capacity of only 600,000 or 700,000 lb., and we design cars with a new underframe that has a capacity of over 1,000,000 lb. and these cars come in contact, without an adequate draft gear in each of them, there is not much doubt which one of the cars is going out of commission. As long as we keep together two cars of equal strength they will stand a great many impact blows in the switching after the draft gear goes solid, but when they come into contact with cars of greater capacity the old cars will go out of commission very fast; while if we should design the new cars with a draft gear and arrangement that would take care of a reasonable switching speed, we would keep in service many cars which are now going out of service. Today we have draft gears which will take care of switching speeds between $3^1/_2$ and 5 miles an hour when new, but unless they are kept under repairs, the speed at which they will protect the car will be reduced considerably. (Abstract of an address before the recent meeting of the Virginia Section of The American Society of Mechanical Engineers. *Railway Review*, vol. 70, no. 17, Apr. 29, 1922, pp. 591–594.)

ROLLING MILLS

Power Required to Roll Wrought-Iron Bars, Edwin L. Fletcher. Results of tests in reducing 3-in. billets to $^1/_2$-in. round, of particular interest because of the comparative scarcity of published information on rolling wrought iron, where the conditions are somewhat different from those obtaining in the rolling of steel.

The heat loss between the roughing mill and the merchant mill is much more serious in rolling wrought iron than in rolling steel,

and proper timing at this point may easily cut the scrap loss in half.

Under modern conditions the spacing between roughing and merchant mills may be as high as 32 ft. centers and the billets weigh from 100 to 135 lb. The original article gives data as to power consumed over a number of days of rolling of the product of eight puddling furnaces for wrought-iron bars to meet the requirements of railroad shops and chain makers. (*The Iron Age*, vol. 109, no. 17, Apr. 27, 1922, p. 1144, *e*)

SHIPBUILDING (See Power Transmission)

SPECIAL PROCESSES

Anderson Process for the Hot Rolling of Gears

The Hot Rolling of Gears, Reginald Trautschold. Description of a process devised more than ten years ago by H. N. Anderson, Mem. Am.Soc.M.E., and now practiced by the Anderson Rolled Gear Company.

In previous attempts at hot rolling of gears only one of the operating shafts of the rolling apparatus was positively driven, which produced a slip between the die roll and the blank, with the resulting distortion of the teeth of the molded gear and lack of accuracy in tooth spacing.

Mr. Anderson conceived the idea of positively driving both shafts and accurately synchronizing their rotation by means of suitable timing gears, and it was found that the gears were such that no finishing of the teeth was necessary. He was awarded for this development the John Scott Legacy Medal by the Franklin Institute in 1915.

In the actual process of rolling gears the blank heated to a temperature of from 2000 to 2100 deg. fahr. is mounted on the work arbor of the rolling machine and securely clamped in place by means of a powerful auto-manipulator. The arbors carrying the die roll and the heated blank are actuated by suitable heavy timing gears and the die and blank are rolled together in synchronized contact under a rolling pressure of from 10 to 20 tons. At the start of the rolling the die is clear of the blank, but advances gradually until the teeth of the die have penetrated the blank their full depth. As the rolling is done as a rule at speeds varying from 400 to 700 r.p.m., the advance of the die roll per revolution is very slight. This insures a thorough kneading and working down of the metal of the blank and permits easy flow of the metal as it is displaced and built up by the die.

During the rolling operation the die is cooled by a stream of water directed against its face at a point opposite to that in contact with the blank. As the entire rolling consumes less than 15 sec., this cooling prevents the temperature of the die from rising above that easily bearable by the hand. The chilling effect of the cold, wet die roll on the hot blank causes a rapid contraction of the latter and loosening of the forging scale as it is formed. The loosened scale is then thrown free by the centrifugal force due to the high speed of rotation of the blank. Because of this in the finished gear the teeth are not only perfect in shape but are highly polished on all contact surfaces.

In order to attain the highest degree of precision in the form of the teeth molded, machines designed for the production of the most accurate gears are equipped with additional mechanism for frequently and automatically reversing the rotation of the die and blank. This frequent reversing or oscillation, at somewhat reduced speeds, varying from 80 to 200 r.p.m., is maintained during the forming of the molded teeth and until the die is within 0.01 in. of full penetration. The action then automatically reverts to high-speed direct rolling for the planishing effect. The oscillating methods tend to effect displacement and building up to a somewhat more equal and constant degree on both sides of the teeth than if rolling in one direction is maintained, thereby producing a more perfectly symmetrical tooth form.

Herringbone gears may be produced as accurately and cheaply as the other types by using a compound die roll. For the production of all types of bevel gearing the crown-gear form of tooth is used and in many cases the crown-gear type of die roll. If, however, the gear to be rolled is to be of a given number of teeth of a certain pitch, such as the standard pitches now in general use, its diameter is also definitely fixed. As the diameter of a crown-type die roll is established by the length of the conical element of the gear to be rolled, it is apparent that the circumference of the crown-gear die roll may not be commensurably proportional to that of the blank. The crown-gear die roll would not, therefore, accommodate a full number of teeth of the given pitch, but this may be overcome by the use of a flat bevel die roll, shortening the diameter of the die until it is commensurably proportional to that of the gear blank.

All die-roll faces are somewhat narrower than those of the gear blanks, thus producing gears partly or wholly shrouded. Consequently, if it is desired to strengthen the weaker member of a pair of gears, the shroud may be left on, either entirely or partly, or the shrouds on the two gears may be so proportioned as to equalize the strength of the two and greatly increase that of the combination. The increase in strength cannot well be definitely established, but considering also the greater inherent strength of rolled teeth, it is probably a conservative assumption that shrouded gears can be proportioned and rolled which possess double the strength of ordinary cut gears of the same pitch.

The greater inherent strength of rolled gears is due to the effect on the structure of the metal of rolling at high temperature and under high pressure. This pressure and the thorough kneading action of the die teeth while the metal is in a plastic state, in addition to building up and compressing the metal into the formed teeth, gradually breaks up the normal coarser crystalline structure and produces a dense, thoroughly worked metal of almost fibrous characteristics. The minute crystals are rearranged in a truss formation following the periphery of the finished gear, thus tying the teeth to the body of the gear and equalizing the structural strains. In fact, the reduction of internal structural strains is so marked that no distortion whatever occurs in subsequent heat treatment of the gears and it has even been found unnecessary to use any clamps for the purpose of holding the gear true when quenching.

The modified metal structure also materially increases the hareness and wearing qualities of the gear teeth and assures a mord uniform result from case-hardening or other heat treatment. Exacting laboratory tests, confirmed by service tests under the most severe operating conditions, have shown an average superiority for rolled gears of 25 per cent in strength and 20 per cent in hardness, as shown in the tables.

	Machine-cut gears	Hot-rolled gears
Normal Condition:		
Yield point	6470 lb.	7918 lb.
Ultimate strength	12250 lb.	13645 lb.
Hardness	22	26
Case-Hardened:		
Yield point	13529 lb.	14750 lb.
Ultimate strength	17250 lb.	19130 lb.
Hardness	87	85
Depth of case	0.027 in.	0.035 in.

It is stated that the gear-rolling method is more economical than the usual machining process.

The problem of ultimate perfection of the process thus became primarily one of developing a system of die rolls which would form perfect and efficient gears with a high degree of accuracy at low cost and which could be redressed when necessary without affecting the precision of form of the molded teeth. The perfection of such a system of dies and their adaptation to use on a practical and efficient machine operating on the principle evolved have now made feasible the commercial production of gears by a true molding process. (*Blast Furnace and Steel Plant*, vol. 10, no. 5, pp. 270–273, 2 figs., *dA*)

TEXTILE MILLS (See Power-Plant Engineering)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Coal. THE IGNITION TEMPERATURE OF COAL. See *Fuels, Gas, Tar and Coke A9-22.*

Electrolysis A1-22. ELECTRODEPOSITION OF IRON. In view of the extended use of electrodeposition of iron for many industrial purposes the Department of Scientific and Industrial Research, Westminster, London, S. W. 1, has considered it advisable to issue the present bulletin which embodies the results of research carried out by W. E. Hughes, with the assistance of grants made by the Department.

The contents of the report are arranged under the following headings:

Division 1: Descriptive. (*a*) General note on the description of the deposits; (*b*) Series I, on the effect of temperature; (*c*) Series II, on the effect of current density; (*d*) Series III, on the effect of mechanical movement.

Division 2: Theoretical. (*a*) The crystallization of substances in general; (*b*) application to electrodeposited metal; a consideration of the results of the experiments of the Series I, II, and III. Some remarks on deposits (1) from other iron solutions; (2) of other metals. General conclusions; (*c*) workshop application.

Appendix. Bibliography comprising references to publications on: (*a*) the electrodeposition of iron and phenomena connected therewith; (*b*), the properties of electroltyic iron; (*c*), works of reference relating to the electrodeposition of iron.

The bibliography will be of use to those desiring general information upon the subject, as well as to research workers. The report is copiously illustrated by microphotographs. Copies of the report may be obtained by addressing His Majesty's Stationery Office for the Department of Scientific and Industrial Research, Imperial House, Kingsway, London, W. C. 2. Price per copy 6s. 6d. (By mail, 6s. 8½ d.)

Expansion A1-22. THERMAL EXPANSION OF A FEW STEELS. Scientific Paper No. 433 of the Bureau of Standards on this subject was prepared by Wilmer Souder and Peter Hidnert. Thermal-expansion data on 28 samples of iron and steel are given. One sample of vacuum electrolytic iron and one of gray cast iron are included. A specimen of hardened steel has been tested to show the dimensional changes incident to heat treatment or drawing. Twenty-two curves and a 2-page table are used to summarize the results.

The average expansion of the specimen of electrolytic iron is 12.0×10^{-6} for the range 25 to 100 deg. cent.

For 25 steels:

11.2×10^{-6} for the range 25 to 100 deg. cent.

14.2×10^{-6} for the range 25 to 600 deg. cent.

Above the critical region the values usually jump to approximately 23×10^{-6}.

The values on cooling are not very different from those on heating; the transformation regions are displaced as usual.

The contraction and expansion reversals within the critical regions vary from a few microns per meter, if any at all, for a 3.7 per cent silicon steel, to almost 2000 microns per meter for a 1.2 per cent chrome steel (C. 0.35; Cr., 1.17; V. 0.14).

The critical region was found to extend over a temperature interval of from less than 6 deg. cent. for electrolytic iron to something over 100 deg. cent. for a special 1.1 per cent manganese steel. These differences in dimensional changes and extent of critical region are suggested as a means for determining the tendency toward cracking or warping when parts of specimens are quenched at unequal rates. This rate is always different, depending upon the size, shape, etc. The specimen of cast iron showed irregularities and considerable permanent growth upon heating, the growth being especially rapid at temperatures above 650 deg. cent.

A brief review of some of the previous work on expansion is included. Copies may be obtained by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents per copy.

Forest Products A1-22. TECHNICAL NOTES. For the past three years and more the Forest Products Laboratory of the U. S. Forest Service has issued technical data sheets (8×10½ in.) which cover a variety of subjects of special interest to the manufacturer, dealer and user of lumber, wood and wood products.

Many of these Technical Notes are of interest to mechanical engineers. A few of the subjects are therefore listed below by way of illustration. A-3, How to Make Factory Roof Timbers Last Longer; B-3, Metal Strapping on Wooden Boxes; B-9, Preparation of Stock for Bending; B-10, The Nailing of Boxes; 92, When to Heat Wood Before Gluing; 98, Fuel Value of Wood; 101, Comparative Value of Timber Cut from Live and Dead Trees; 105, What Is Dry Rot? 106, Making Wood Fire-Resistant with Paint; 110, Saving Mine Timbers from Decay; 130, Tie Renewals in Relation to Average Life; 134, The Crate Corner; 149, Strength of Screw Fastenings in Plywood; 121, Automatic Control of Humidity in Shops; and 122, Comparison of Five Different Types of Glue.

Fuels, Gas, Tar and Coke A9-22. THE IGNITION TEMPERATURE OF COAL. Bulletin No. 128 of the University of Illinois Engineering Experiment Station, just issued, is a careful study of this subject by Ray W. Arms.

In his introduction he states that there is no definite temperature at which coal bursts into flame. The phenomenon of flame from coal is due to the combustion of volatile matter driven off from the coal, the character of such matter varying under different conditions; hence the temperature at which the coal flames varies widely and is dependent upon surrounding conditions, and therefore the flaming temperature of a coal does not serve as an indication of the ignition point. Strictly speaking, it is the true ignition point, but since it varies so widely its evaluation is meaningless.

The first purpose of this investigation, therefore, was to establish some definite point along the line of this process of heating which could be called the ignition temperature. In the effort to locate such a temperature heating curves were drawn to show the rate at which the coal increased in temperature when assisted by an outside source of heat. After a study of these curves the point at which the coal assumed a uniform glow was chosen as the most logical ignition temperature, not only because this point was found to be rather definite in the heating curve, but also because it could be checked in various types of apparatus by different means of temperature measurement and control, and by different operators.

Mr. Arms' five conclusions are:

1 The "ignition temperature" of coal means nothing unless it is applied to some definite point in the process of heating the coal, which can easily be determined and duplicated.

2 The temperature at which the coal glows seems to be the most logical point to choose as the ignition temperature. It is easily observed, can be duplicated with a fair degree of accuracy, and marks the beginning of visible combustion.

3 The glow point is probably affected by the oxygen content of the coal, and perhaps by other agencies made active by weathering.

4 The glow point is not affected by ash, moisture, size of particles, slight variations from the normal air supply, or rate of heating.

5 There is no indication at present that the glow point bears any direct relation to the liability to fire while in storage. Perhaps if a series of tests were made on the glow points of freshly mined coal new information would be brought to light which would lead to the discovery of some more definite relation between glow point and the firing qualities of the coal.

Internal-Combustion Engines A1-22. THE BACKGROUND OF DETONATION. This is the subject of Technical Note No. 93 recently prepared by the National Advisory Committee for Aeronautics. It has for its object the discussion of a phase of this question which so far has received but little attention. The effect of the temperature and pressure of the charge before combustion is especially considered, as it is believed that a careful study of this "background" can throw considerable light on results that have been obtained in investigations of detonation both at the Bureau and elsewhere.

The circumstances under which detonation occurs are described, and the effects of varying conditions in the engine are discussed. The work of Harry R. Ricardo in England receives a great deal of attention, and it is believed that additional facts have been deduced from the data which he obtained.

It is shown that compression and explosion pressures, scavenging, and the operation of the ignition system all play a prominent part in the phenomenon of detonation. The influence of changes in fuel characteristics is believed to lie outside the province of this paper and is not taken up in any detail.

Preignition and detonation are conceded to be entirely independent phenomena, and it is shown that overheating troubles are more likely to be from preignition than from detonation. Curves and diagrams illustrating various phases of the subject are presented, and the whole forms a valuable contribution to the study of the internal-combustion engine. Those desiring copies should write directly to the above-named committee at 2722 Navy Building, Washington, D. C.

Iron and Steel A2-22. THERMAL EXPANSION OF A FEW STEELS. See *Expansion A1-22.*

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Automotive Vehicles and Equipment B2-22. Power Loss in Automobile Tires. The rubber laboratory of the Bureau of Standards is equipped with a special dynamometer for determining, among other things, the power loss in automobile tires. A great many of the standard makes of tires have been tested on this dynamometer, and valuable data are being obtained concerning the percentage of the power of an automobile engine which is absorbed by the tires under various conditions.

Some interesting figures have already been secured as a result of this work. For instance, an average 4-in. fabric tire, under conditions of normal load and air pressure, will absorb approximately 0.90 hp. due to rolling resistance at a speed of 25 miles per hour. Under the same conditions, the power loss in a 4-in. cord tire is approximately 0.60 hp., while a 5-in. cord tire represents a loss of 1.20 hp. The extent to which different parts of the tire contribute to the power loss has also been investigated. It is estimated that from 80 to 85 per cent of this loss is in the carcass, the tread contributes 10 to 15 per cent, and the tube probably less than 5 per cent.

Boilers B1-22. Specifications for Refractories. See *Refractories B1-22.*

Corrosion B3-22. Resistance of Chromium Steels to Atmospheric Corrosion. For resisting corrosion by water and air, a considerable amount of chromium in a steel is necessary, and alloys of this general type were found much more resistant than were those of low chromium content. These latter steels, however, were found much more resistant than the simple carbon steel or "pure" iron. Hardening the chromium steel by heat treatment retarded corrosion by water and air as it did in the acid tests. This was true, in particular, for the steels of high chromium content, while variations in heat treatment produced very little difference in resistance to corrosion in specimens lower in chromium. Adhering patches of oxide scale upon the surface were found to have a very noticeable effect in accelerating the rate of attack of the chromium steels.

The alloy containing a high percentage of nickel, as well as chromium, found to be attacked the least by acid, also proved much more resistant to atmospheric corrosion than most of the chromium steels tested, although it was far surpassed by certain of the high-chromium materials.

In most cases corrosion of the chromium steels consisted in an attack at small isolated spots rather than in a general tarnishing and coating of the surface. This, in view of the fact that adhering particles of scale accelerate the corrosive attack of a steel to a very marked degree, suggests that the presence of inclusions or other defects within the material may be responsible in large measure for the character of the resulting surface pattern.

The character of the service should govern the type of "non-corrodible" steel to use. For example, if resistance to severe acid attack is the principal requirement, a high-chromium steel is the least suitable of all the materials tested. However, most classes of service require fairly satisfactory performance under a variety of conditions. Thus, for example, cutlery steel must withstand *both* acid and atmospheric corrosion as well as possess certain necessary mechanical properties, "forgeability," hardness, etc. No single type of non-corrodible steel appears to be suitable for each and every purpose which may arise. Address Dr. S. W. Stratton, Director, Bureau of Standards, Department of Commerce, Washington, D. C.

Non-Ferrous Metals B1-22. Spectroscopic Analysis of Bronzes. An examination of five bronzes for impurities for the purpose of establishing the spectrographic method for quantitative estimation of small amounts of aluminum and silicon which are detrimental in bronze or brass castings has been recently undertaken by the Bureau of Standards. A progress report on this practical application of spectrum analysis was presented at the Nonferrous Metals Committee Meeting on April 24.

Refractories B1-22. Specifications for Refractories. At the last meeting of the Bureau of Standards Advisory Committee on specifications for refractories, it became evident that additional investigation would be necessary to determine what test requirements are most effective in drawing the line between satisfactory and unsatisfactory brick for furnace linings in stoker-fired boilers. As a result preparations are being made to conduct an extended series of tests, including a 72-hour reheating test at 1450 deg. cent. A prominent consulting engineer is coöperating with the Bureau in this work and in addition to gathering information as to the suitability of different brands of brick, is arranging to have a quantity of samples representing about 20 brands shipped to the Bureau of Standards by the users.

Rubber and Allied Substances B1-22. Power Loss in Automobile Tires. See *Automotive Vehicles and Equipment B2-22.*

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Forest Products F1-22. Preservation of Mine Timber. This bibliography, prepared by R. R. Hornor for the Bureau of Mines, consists of six closely typewritten pages 8×10½ in. in size. It is known as Serial No. 2343 and may be obtained by addressing H. Foster Bain, Director, Department of the Interior, Bureau of Mines, Washington, D. C.

Petroleum and Allied Substances F3-22. A List of Recent Articles. This bibliography lists under eleven headings the literature on this subject which was published during the months of March and April. The compiler is E. H. Burroughs, Bibliographer of the Bureau of Mines. It is one of the Bureau's Reports of Investigations, Serial No. 2348.

Wood Products (other than Cellulose and Paper) F1-22. Preservation of Mine Timber. See *Forest Products F1-22.*

Second Revision of A.S.M.E. Boiler Code, 1922

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the Society in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be cordially invited to attend and present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

The revisions which have met the approval of the Boiler Code Committee are here published. It is the request of the Committee that these revisions be fully and freely discussed so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

The revisions here published are limited to the paragraphs appearing in the 1918 Edition of the A.S.M.E. Boiler Code, and the paragraph numbers refer to the paragraphs of similar number in that edition. For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

Par. 9 Revised:

9 Cross pipes connecting the steam and water drums of water-tube boilers, headers, cross boxes and all pressure parts of the boiler proper over 2-in. pipe size, or equivalent cross-sectional area, shall be of wrought steel, or cast steel of Class B grade, as designated in the Specifications for Steel Castings, when the maximum allowable working pressure exceeds 160 lb. per sq. in. THE USE OF BESSEMER STEEL IS PROHIBITED FOR THE PRESSURE PARTS OF BOILERS. Malleable iron may also be used when the maximum allowable

Note: Matter deleted, in smaller type; matter added, in small capitals.

working pressure does not exceed 200 lb. per sq. in., provided the form and size of the internal cross-section perpendicular to the longest dimension of the box, is such that it will fall within a 7 in. by 7 in. rectangle.

Par. 12 Revised:

12 Cast iron shall not be used for nozzles or flanges attached directly to the boiler for any pressure or temperature. CAST IRON SHALL NOT BE USED [nor] for boiler and superheater mountings such as connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 deg. fahr.

Par. 20 Revised:

20 The minimum thicknesses of tube sheets for FIRE-TUBE [horizontal return tubular] boilers, shall be as follows:

When the diameter of tube sheet is

42 In. or under	Over 42 in. to 54 in.	Over 54 in. to 72 in.	Over 72 in.
$^3/_8$ in.	$^7/_{16}$ in.	$^1/_2$ in.	$^9/_{16}$ in.

Par. 25 Revised:

25 *Chemical Composition.* The steel shall conform to the following requirements as to chemical composition:

		Flange	Firebox
Carbon		Plates $^3/_4$ in. thick and under—NOT OVER [illegible] 0.25 per cent Plates over $^3/_4$ in. thick—NOT OVER [illegible] 0.30 per cent	
Manganese		0.30–0.60 per cent	0.30–0.50 per cent
Phosphorus	Acid.	Not over 0.05 per cent	Not over 0.04 per cent
	Basic.	Not over 0.04 per cent	Not over 0.035 per cent
Sulphur		Not over 0.05 per cent	Not over 0.04 per cent

Par. 29 Revised:

29 *Modifications in Elongation.* *a* For material over $^{11}/_{16}$ in. in thickness: From the figure representing the percentage of elongation required as determined in accordance with Par. 28 *a*, there shall be deducted an amount equal to four times the difference between the ordered thickness in inches and $\frac{3}{4}$ [$^{11}/_{16}$] in., except that the minimum elongation required shall in no case be less than 20 per cent.

b For material $^1/_4$ in. in thickness, the elongation shall be measured on a gage length of 6 in.

Par. 36 Revised:

36 *Marking.* *a* Each shell plate shall be legibly stamped by the manufacturer with the melt or slab number, name of manufacturer, grade and the minimum tensile strength of the stipulated range as specified in Par. 28, in TWO [three] places, [two of] which shall be located NOT LESS THAN [at diagonal corners about] 12 in. from the edge [and one about the center] of the plate, or at TWO [a] points selected and designated by the purchaser so that AT LEAST ONE [the] stamp shall be plainly visible when the boiler is completed.

b Each head shall be legibly stamped by the manufacturer in two places, about 12 in. from the edge, with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength of the stipulated range as specified in Par. 28, in such manner that the stamp is plainly visible when the boiler is completed.

c Each butt strap shall be legibly stamped by the manufacturer in two places on the center line about 12 in. from the ends with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength of the stipulated range as specified in Par. 28.

d The melt or slab number shall be legibly stamped on each test specimen.

Add the Following to Par. 36:

e IT IS PERMISSIBLE TO TRANSFER, WITHOUT IMITATION, THE MARKINGS ON THE PLATE UNDER AUTHORITY OF AN AUTHORIZED INSPECTOR IN CHARGE; SAID INSPECTOR TO PUT HIS PRIVATE MARK AFTER THE TRANSFERRED STAMP.

f IF, DURING FABRICATION IN THE BOILER SHOP, REMOVAL OF BOTH GROUPS OF THE PLATE MANUFACTURER'S STAMPS CANNOT BE AVOIDED BECAUSE OF THE CUTTING OR PUNCHING OF NECESSARY HOLES IN THE PLATES, ONE GROUP OF SUCH STAMPS MAY BE TRANSFERRED TO A PERMANENT POSITION BY RESTAMPING UNDER THE SUPERVISION OF AN AUTHORIZED STATE, MUNICIPAL OR INSURANCE COMPANY INSPECTOR. WHEN STAMPS ARE TRANSFERRED THE PLATE MANUFACTURER'S NAME SHALL NOT BE IMITATED. THE INSPECTOR SHALL PUT HIS PRIVATE STAMP BESIDE THE TRANSFERRED GROUP AND A RECORD OF THE TRANSFER AND THE INSPECTOR'S STAMP SHALL BE NOTED ON THE DATA SHEET. A GROUP OF STAMPS CONSISTS OF THE MANUFACTURER'S NAME, MANUFACTURER'S TEST IDENTIFICATION NUMBER, GRADE AND TENSILE STRENGTH.

Par. 48 Revised:

IV PERMISSIBLE VARIATIONS IN GAGE

48 The gage of each bar shall not vary more than 0.01 in. from that specified.

Par. 180 Add following paragraph:

THE FACTOR OF SAFETY USED IN DETERMINING THE MAXIMUM ALLOWABLE WORKING PRESSURE CALCULATED ON THE CONDITIONS ACTUALLY OBTAINED IN SERVICE SHALL NOT BE LESS THAN 5.

Par. 182 Revised:

182 The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

a If $\frac{P}{[\mathrm{D}]\mathrm{d}}$ is 4 or less, the minimum value shall be $2[\mathrm{D}]\mathrm{d}$;

b If $\frac{P}{[\mathrm{D}]\mathrm{d}}$ is over 4, the minimum value shall be:

$$2[\mathrm{D}]\mathrm{d} + 0.1\,(P - 4[\mathrm{D}]\mathrm{d})$$

where

P = pitch of rivets in outer row where a rivet in the inner row comes midway between two rivets in the outer row, in.

P = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between two rivets in the outer row, in. (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced.)

$[\mathrm{D}]\mathrm{d}$ = diameter of the rivet holes in.

Par. 194 Revised:

194 *Domes.* THE REQUIREMENTS OF PARS. 187 AND 188 SHALL APPLY TO RIVETED LONGITUDINAL JOINTS OF DOMES EXCEPT THAT FOR DOMES 24 IN. AND LESS IN DIAMETER FOR PRESSURES EXCEEDING 100 LB., THE LONGITUDINAL JOINTS MAY BE LAP-RIVETED IF THE FACTOR OF SAFETY IS NOT LESS THAN 8. [The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction, irrespective of pressure. When the maximum allowable working pressure exceeds 100 lb. per sq. in., the flange of a dome 24 in. or over in diameter shall be double-riveted to the boiler shell.]

THE FLANGE OF A DOME 24 IN. OR OVER IN DIAMETER SHALL BE DOUBLE-RIVETED TO THE BOILER SHELL. WHERE THE FLANGE OF THE DOME IS USED FOR REINFORCING OR ATTACHING IT TO THE SHELL, THE DIAMETER OF THE DOME SHALL NOT EXCEED ONE-HALF THE DIAMETER OF THE SHELL OR BARREL OF THE BOILER. [The longitudinal joint of a dome less than 24 in. in diameter may be of the lap type, and its flange may be single-riveted to the boiler shell provided the maximum allowable working pressure on such a dome is computed with a factor of safety of not less than 8.]

The dome may be located on the barrel or over the fire-box on traction, portable or stationary boilers of the locomotive type up to and including 48 in. barrel diameter. For larger barrel diameters, the dome shall be placed on the barrel.

Flanges of domes shall be formed with a corner radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plate for plates over 1 in. in thickness.

Par. 201 Revised:

201 *Structural Reinforcements.* When channel irons or other members are securely riveted to the boiler heads for attaching through stays, the transverse stress on such members shall not exceed 12,500 lb. per sq. in. In computing the stress, the section modulus of the member shall be used without addition for the strength of the plate. The spacing of the rivets over the supported surface shall be DETERMINED BY THE FORMULA IN PAR. 199 USING 135 FOR THE VALUE OF C [in conformity with that specified for staybolts.]

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of these rivets attaching

the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

PAR. 205 REVISED

205 The distance from the edge of a staybolt hole to a straight line tangent to the edges of the rivet holes may be substituted for p for staybolts adjacent to the riveted edges bounding a stayed surface. When the edge of a FLAT stayed plate is flanged AND RIVETED, THE DISTANCE FROM THE CENTER OF THE OUTERMOST STAYS TO THE INSIDE OF THE SUPPORTING FLANGE SHALL NOT EXCEED THE PITCH OF THE STAYS, p, PLUS THE INSIDE RADIUS OF THE FLANGE [p shall be measured from the inner surface of the flange, at about the line of rivets to the edge of the staybolts or to the projected edge of the staybolts.]

PAR. 206 REVISED:

206 The MAXIMUM PITCH p AS GIVEN IN PAR. 199 [distance between the edges of the staybolt holes] may be INCREASED BY THE STAYBOLT HOLE DIAMETER WHERE [substituted for p for] staybolts ARE adjacent to a furnace door or other boiler fitting, tube hole, handhole or other opening.

PAR. 212*c* REVISED:

c A FURNACE FOR A VERTICAL FIRE-TUBE BOILER, 38 IN. OR LESS IN OUTSIDE DIAMETER, WHICH REQUIRES STAYING, SHALL HAVE THE FURNACE SHEET SUPPORTED BY ONE ROW OF STAYBOLTS, OR MORE, THE CIRCUMFERENTIAL PITCH NOT TO EXCEED 1.05 TIMES THAT GIVEN BY THE FORMULA IN PAR. 199 AND IN TABLE 4.

THE LONGITUDINAL PITCH BETWEEN THE STAYBOLTS, OR BETWEEN THE NEAREST ROW OF STAYBOLTS AND THE ROW OF RIVETS AT THE JOINTS BETWEEN THE FURNACE SHEET AND THE TUBE SHEET OR THE FURNACE SHEET AND MUD RING, SHALL NOT EXCEED THAT GIVEN BY THE FOLLOWING FORMULA:

$$\mathrm{L} = \frac{(220 \times \mathrm{T}^2)^2}{(\mathrm{P} \times \mathrm{R})}$$

EXCEPT WHEN THIS VALUE IS LESS THAN THE CIRCUMFERENTIAL PITCH, IN WHICH CASE THE LONGITUDINAL PITCH MAY BE AS GREAT AS THE ALLOWABLE CIRCUMFERENTIAL PITCH

where

L = LONGITUDINAL PITCH OF STAYBOLTS
T = THICKNESS OF FURNACE SHEET IN SIXTEENTHS OF AN INCH
P = MAXIMUM ALLOWABLE WORKING PRESSURE IN LB. PER SQ. IN.
R = OUTSIDE RADIUS OF FURNACE, IN INCHES.

THE STRESS PER SQUARE INCH IN THE STAYBOLTS SHALL NOT EXCEED 7500 LB. AND SHALL BE DETERMINED IN THE WAY SPECIFIED IN PAR. 212*d*.

PAR. 212*d* INSERT NEW SECTION AS FOLLOWS:

d FOR FURNACES OVER 38 IN. IN OUTSIDE DIAMETER OF VERTICAL FIRE-TUBE BOILERS AND OTHER TYPES OF FURNACES AND COMBUSTION CHAMBERS NOT COVERED BY SPECIAL RULES IN THIS CODE, WHICH HAVE CURVED SHEETS SUBJECT TO EXTERNAL PRESSURE, THAT IS, PRESSURE ON THE CONVEX SIDE, THE STAYING, BOTH CIRCUMFERENTIAL AND LONGITUDINAL, SHALL BE PROVIDED FOR IN ACCORDANCE WITH THE FOLLOWING FORMULA:

$$\mathrm{P} = \frac{\mathrm{CT}^2}{p^2} + 250\,\frac{\mathrm{T}}{\mathrm{R}}$$

WHERE p AND THE VALUE OF C ARE AS GIVEN IN PAR. 199, p SHALL NOT EXCEED 2T, AND p^2 SHALL NOT EXCEED 0 008CTR.

THE STRESS PER SQ. IN. IN STAYBOLTS SHALL NOT EXCEED 7500 LB., BASED ON A TOTAL STRESS OBTAINED BY MULTIPLYING THE PRODUCT OF THE CIRCUMFERENTIAL AND LONGITUDINAL PITCHES BY $\left(\mathrm{P} - 250\,\frac{\mathrm{T}}{\mathrm{R}}\right)$.

PAR. 217 REVISED:

217 The net area to be stayed in a segment of a head may be determined by the following formula:

$$\frac{4(\mathrm{H} - d - 2)^2}{3}\sqrt{\frac{2\,(\mathrm{R} - d)}{(\mathrm{H} - d - 2)} - 0.608} = \text{area to be stayed, sq. in.}$$

where

H = distance from tubes to shell, in.
d = distance DETERMINED [given] by formula in Par. 214.
R = radius of boiler head, in.

PAR. 243 IN THE CONSTANT C FOR MORISON FURNACES, CHANGE TO READ AS FOLLOWS:

C = 15,600 a constant for *Morison furnaces*, when corrugations are not MORE [less] than 8 in. from center to center and the radius of the outer corrugations is not more than one-half that of the suspension curve.

PAR. 247 REVISED:

247 Where NO RULES ARE GIVEN AND it is impossible to calculate with a reasonable degree of accuracy the strength of a boiler structure or any part thereof, a full-sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test. IN SUCH A STEEL-PLATE OR CAST-STEEL STRUCTURE, THE PRESSURE CORRESPONDING TO THE YIELD POINT SHALL BE ACCURATELY DETERMINED AND THE MAXIMUM ALLOWABLE WORKING PRESSURE SHALL NOT EXCEED THAT OBTAINED BY DIVIDING THIS PRESSURE BY 2.5. SUCH STRUCTURES WHEN OF CAST IRON SHALL BE TESTED TO THE BURSTING POINT.

PAR. 250 REVISED:

250 A fire-tube boiler WITH TUBES UNDER 5 IN. DIAMETER shall have [both ends of] the tubes [substantially] rolled and beaded, or rolled and welded at the firebox or combustion-chamber end, AND ROLLED AND BEADED AT THE OTHER END. IN THE CASE OF TUBES UNDER $1^1/_4$ IN. DIAMETER, THE TUBES MAY BE EXPANDED BY THE PROSSER METHOD IN PLACE OF ROLLING. IN THE CASE OF TUBES 5 IN. IN DIAMETER AND OVER, THE TUBES SHALL BE SECURED BY RIVETING OR OTHER APPROVED METHOD AT BOTH ENDS.

PAR. 252 REVISED:

252 The ends of all tubes, suspension tubes and nipples of water-tube boilers and superheaters shall project through the tube sheets or headers not less than $^1/_4$ in. nor more than $^1/_2$ in. before flaring. WHERE THE TUBES ENTER AT AN ANGLE, THE MAXIMUM LIMIT OF $^1/_2$ IN. SHALL APPLY ONLY AT THE POINT OF LEAST PROJECTION.

PAR. 253 REVISED:

253 *Drilling of Holes.* All rivet holes and staybolt holes and holes in braces and lugs shall be drilled [full size] or they may be punched not to exceed $^1/_4$ in. less than full diameter for material over $^5/_{16}$ in. AND NOT EXCEEDING $\frac{5}{8}$ IN. in thickness, and $^1/_8$ in. less than full diameter for material not exceeding $^5/_{16}$ in. in thickness [and then drilled or reamed to full diameter.] FOR FINISHING THE RIVET HOLES, THE plates, butt straps, braces, heads and lugs shall be firmly bolted in position by tack bolts for FINAL drilling or reaming TO FULL DIAMETER [all rivet holes in boiler plates except those used for the tack bolts.] THE FINISHED HOLES MUST BE TRUE, CLEAN AND CONCENTRIC. HOLES SHALL NOT BE PUNCHED IN PLATE OVER $\frac{5}{8}$ IN. THICKNESS.

PAR. 259 REVISED:

259 A manhole reinforcing ring when used, shall be of steel or wrought-iron, and shall be at least as thick as the shell plate THICKNESS REQUIRED BY PAR. 180.

PAR. 260 REVISED:

260 Manhole frames on shells or drums when used, shall have the proper curvature, and on boilers over 48 in. in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. 21. The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength (REQUIRED BY PAR. 180) of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other opening.

PAR. 268 REVISED:

268 *Threaded Openings.* ALL PIPE THREADS SHALL CONFORM TO THE AMERICAN PIPE STANDARD AND ALL [a pipe] connections 1 in. in diameter or over shall have not less than the number of threads given in Table 8.

If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 100 lb. per sq. in., A NOZZLE OR SADDLE FLANGE [connection] riveted to the boiler to receive a flanged fitting shall be used for all pipe openings over 3 in. pipe size.

Par. 299 Revised.

299 [Nozzles and] *Fittings.* Flanged cast iron pipe fittings used for boilers, [parts,] for pressures up to and including 160 lb. per sq. in., shall conform to the American Standard given in Table [s] 16 of the Appendix, FOR PRESSURES UP TO 50 LB. and Table 17 FOR ALL HIGHER PRESSURES AND FOR STEAM, FEED AND BLOW-OFF PIPES UP TO THE STOP VALVE, except that the face of the flange of a safety valve as well as that of a safety valve nozzle, may be flat and without the raised face.

(Note. Balance of paragraph remains unchanged.)

Par. 307 Revised

307 *Blow-off Piping.* A surface blow-off shall not exceed 1½ in. pipe size and the internal and external pipes, when used, shall form a continuous passage, but with clearance between their ends and arranged so that the removal of either will not disturb the other. A properly designed brass or steel bushing SIMILAR TO OR EQUIVALENT OF THOSE [as] shown in Fig. 22, or a flanged connection, shall be used.

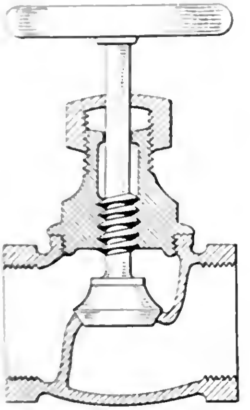


Fig. 22½: Type of Globe Valve

Par. 308 Revised:

308 Each boiler shall have a bottom blow-off pipe, fitted with a valve or cock, in direct connection with the lowest water space practicable; the minimum size of pipe and fittings shall be 1 in. and the maximum size shall be 2½ in. STRAIGHTWAY GLOBE VALVES OF THE ORDINARY TYPE AS SHOWN IN FIG. 22½, OR VALVES OF SUCH TYPE THAT DAMS OR POCKETS CAN EXIST FOR THE COLLECTION OF SEDIMENT, SHALL NOT BE USED ON SUCH CONNECTIONS. [Globe valves shall not be used on such connections.]

Par. 314 Revised:

314 *Feed Piping.* The feed pipe of a boiler shall have an INTERNAL DIAMETER NOT LESS THAN ¾ IN. [open end or ends inside of the boiler.]

Par. 325 Revised:

325 Lugs or brackets, when used to support a boiler of any type, shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. 15 and 16. WHERE IT IS IMPRACTICAL TO USE RIVETS, STUDS WITH NOT LESS THAN 10 THREADS PER INCH MAY BE USED. IN COMPUTING THE SHEARING STRESSES, THE AREA AT THE BOTTOM OF THE THREAD SHALL BE USED. [For traction or portable boilers, studs with pipe threads may be used.]

Fig. 32 Revised:

A Change dimension line to center of stayrod.
D Change dimension line to center of staybolt.
F Change dimension line to center of door ring rivet.
H Give eighth sketch in drawing the designation "H."

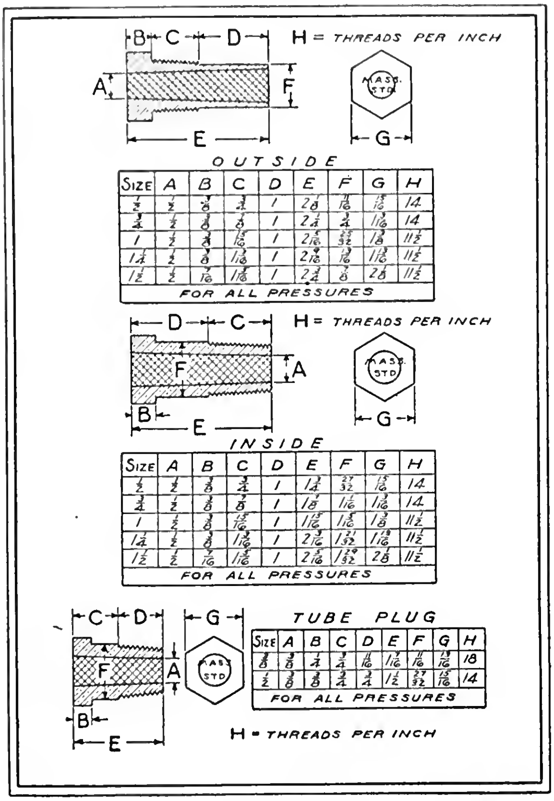
Par. 423 Change Second Section to Read as Follows:

A bevel-seated 3½ in. valve WITH [is marked by the manufacturer] 0.11 in. lift HAS A [and] discharge capacity AT [for] 400 lb. pressure OF [=] 4840 lb.; hence two such valves would be required.

Par. 424 Change Second Section to Read as Follows:

A bevel-seated 2½ in. valve WITH [is marked by the manufacturer] 0.08 in. lift HAS A [and] discharge capacity AT [for] 275 lb. pressure OF [=] 6350 lb.; hence two such valves would be required.

Fusible Plugs.



OUTSIDE

Size	A	B	C	D	E	F	G	H
1/2	1/2	3/8	3/4	1	2 1/8	11/16	15/16	14
3/4	1/2	3/8	7/8	1	2 1/4	3/4	1 3/16	14
1	1/2	3/8	15/16	1	2 5/16	25/32	1 3/8	11 1/2
1 1/4	1/2	3/8	1 3/16	1	2 9/16	13/16	1 13/16	11 1/2
1 1/2	1/2	7/16	1 7/16	1	2 3/4	7/8	2 1/8	11 1/2
FOR ALL PRESSURES								

INSIDE

Size	A	B	C	D	E	F	G	H
1/2	1/2	3/8	3/4	1	1 1/4	27/32	15/16	14
3/4	1/2	3/8	7/8	1	1 7/8	1 1/16	1 3/16	14
1	1/2	3/8	15/16	1	1 15/16	1 5/16	1 3/8	11 1/2
1 1/4	1/2	3/8	1 3/16	1	2 3/16	1 21/32	1 13/16	11 1/2
1 1/2	1/2	7/16	1 5/16	1	2 5/16	1 29/32	2 1/8	11 1/2
FOR ALL PRESSURES								

TUBE PLUG

Size	A	B	C	D	E	F	G	H
3/8	3/8	1/4	3/4	11/16	1 7/16	11/16	13/16	18
1/2	3/8	3/8	3/4	3/4	1 1/2	27/32	15/16	14
FOR ALL PRESSURES								

Fig. 33½ Acceptable Forms of Fusible Plugs

Par. 425 Change Second Section to Read as Follows:

A bevel-seated 2 in. valve WITH [is marked by the manufacturer] 0.07 in. lift HAS A [and] discharge capacity AT [for] 150 lb. pressure OF [=] 2500 lb.; hence one such valve would be required.

Table 16 Change Title to Read as Follows:

AMERICAN STANDARD 125-LB. WORKING PRESSURE PER SQ. IN. STANDARD CAST-IRON FLANGE FITTINGS, STRAIGHT SIZES (SEE FIG. 33).

Table 17 Change Title to Read as Follows:

AMERICAN STANDARD, 250-LB. WORKING PRESSURE PER SQ. IN., EXTRA HEAVY CAST-IRON FLANGE FITTINGS, STRAIGHT SIZES (SEE FIG. 33).

Par. 428 Revised:

428 Fusible plugs, if used, shall be filled with tin with a melting point between 400 and 500 deg. fahr., and shall be renewed once each year. WHERE THE BOILERS ARE TO BE OPERATED AT WORKING PRESSURES IN EXCESS OF 225 LB. PER SQ. IN. GAGE, THE USE OF FUSIBLE PLUGS IS NOT ADVISABLE.

Interesting Discussion at Atlanta Sessions

American Welding Society Assists in A.S.M.E. Spring Meeting Session on Welded Pressure Vessels—Professional Divisions on Fuels, Machine Shop, Management, Materials Handling, Power and Textile Coöperate in Program

SIX of the A.S.M.E. Professional Divisions coöperated in providing the technical sessions at the Atlanta Spring Meeting. The papers were all in hand by March 15 and this insured the printing and issue of the papers two weeks before the meeting. The resulting carefully prepared discussion added greatly to the interest and value of the technical sessions.

In accordance with the procedure of the past few years, a running account of the discussion is given in this issue of MECHANICAL ENGINEERING. Complete discussion will appear in the Transactions of the Society.

TEXTILE-MACHINERY SESSIONS

UNDER the auspices of the Textile and Machine-Shop Practice Divisions sessions were held on Tuesday and Wednesday mornings, May 9 and 10. At the first meeting two papers were presented: Cotton-Ginning Machinery, by S. E. Gillespie, and Maintenance of Textile Machinery, by E. H. Marble. On Wednesday three papers: Weaving Machinery, by L. B. Jenckes; Extraction of Oil from Vegetable Matter, by Jos. Davidson, and Modern Shop Practice in the Building of Revolving Flat Cards, by F. E. Banfield, Jr., were considered. All of these papers have been recently published in MECHANICAL ENGINEERING. H. M. Latham presided on both occasions.

In discussing Mr. Gillespie's paper, W. E. Caldwell[1] stated that the usual operating troubles encountered by cotton ginners are due to the too frequent use of set screws and clamped joints by the gin manufacturers instead of keys, to overloaded belts produced by the use of small pulleys and low belt speeds, and finally, to fans and their piping arrangement. The margin of safety on peripheral speed of fans in modern practice is too low. Air-blast gins have apparently been developed to accommodate the fans now on the market, whereas a fan should be designed to better meet the requirements of ginning systems. A fan somewhat on the order of the cupola blower, which has a better pressure-volume characteristic than the usual volume fan, as well as greater efficiency, might be advantageously employed, although the efficiency is relatively unimportant considering the low annual load factor of ginning plants. He asked whether the belt distributor had any real advantages over the pneumatic elevator, considering power saving, greater simplicity, ease of operation and saving of time between bales.

In another written discussion of this paper, A. W. Merkel[2] compared the single- and double-rib huller gins and presented figures on the power requirements of air-blast and brush gins. He also pointed out that while cotton gins are classed as agricultural implements, which as a class usually do not demand close machine work, the ribs, saws and space blocks which separate the saws, are parts necessitating accurate machining.

After the reading of the paper by Mr. Marble, the discussion was opened by R. A. Packard[3] who stated that the time must soon come when the lubrication of textile bearings will be done on a more efficient basis and while ball bearings on textile machinery are filling a great need today, the question as to whether they should supplant babbitt or brass friction metals is still unsettled.

W. H. Holby[4] discussed the subject from the ball-bearing manufacturer's viewpoint and in summing up his comments claimed that ball bearings require very little attention; that they effect a considerable saving in horsepower, varying with the application and type of machine; that savings in lubrication and maintenance costs are often sufficient to justify the entire expense of ball-bearing equipment, and that ball bearings improve the quality of the textile product.

The incorrectness of the idea that ball bearings are the cure for all operating troubles was then set forth by A. F. MacIntyre,[5] who advocated a specific remedy determined for and applied to each case rather than a general one for all ills.

Speaking from the viewpoint of the textile-machinery manufacturer, F. E. Banfield, Jr.,[6] said that there were certain bearings well suited for the application of ball bearings while others were not. On cards, ball bearings are not desirable since the properly designed plain bearing is simpler and will give less trouble in the long run. The average mill management puts too little importance on the subject of lubrication, whereas the life of a textile machine depends almost wholly upon the life of its bearings. Mr. Banfield placed roller bearings in the category of ball bearings, but considered them better suited for lineshafts, trucks, cranes or bearings subject to heavy loads and severe working conditions.

SECOND SESSION

The Wednesday session was opened by the presiding officer, Mr. Latham, who read abstracts from Mr. Jenckes' paper and described slides shown in connection therewith. In the discussion, C. H. Fish[7] questioned whether velvets are woven double and cut, since then, strictly speaking, it is not velvet but some type of plush. The distinct difference between the two is that plush is cut with a knife and not necessarily woven double and cut from the loom, while velvet, being much finer fabric, is cut as it is woven.

Mr. Davidson supplemented his paper with a detailed account of the development, operation and construction of his high-pressure yielding-plunger pump which gives a greater efficiency in oil extraction and saving in press cloth than with the hydraulic method. The discussion which followed centered around the cotton seed and the use and extraction of its oil on a commercial basis. The author stated that to every 1500 lb. of unginned cotton there was 1000 lb. of seed and the cotton-seed oil industry is secondary to the textile business in the cotton districts. From 1000 lb. of cotton seed 150 lb. of crude oil is obtained, and with the refining loss 6 to 10 per cent the net amount of refined oil is about 130 lb.

After explaining that picking or removing seed, leaf and other foreign matter from ginned cotton is the first process through which cotton is put in the mill and that carding is simply a further cleaning process to take out any short fly or staple which is undesirable in the making of a good yarn, Mr. Banfield presented his paper. He covered his subject very thoroughly and showed numerous slides. In the discussion, Mr. Fish called attention to the omission of mention of the old American drop card which was in use in this country prior to the production of revolving flat cards.

MATERIALS HANDLING SESSION

THE Materials Handling Division held its session on Tuesday morning, May 9, with R. M. Gates presiding. Only one paper, that entitled Material Handling Equipment as Used in the Iron and Steel Industry, by F. L. Leach, was scheduled. As the author is in India the paper was presented by F. L. Estep,[8] a former associate. The paper will be published in a future number of MECHANICAL ENGINEERING.

Mr. Estep read the entire paper and interspersed detailed ex-

---

[1] United Electric Light & Power Co., New York. Jun. Mem. Am.Soc. M.E.

[2] Supt., Continental Gin Co., Atlanta, Ga. Mem. Am.Soc.M.E.

[3] Supt. Power & Shops, Ludlow Mfg. Association, Ludlow, Mass. Mem. Am.Soc.M.E.

[4] Dist. Mgr., SKF Industries, Inc., Atlanta, Ga. Jun. Mem. Am.Soc. M.E.

[5] Agent, Fulton Bag & Cotton Mills, Atlanta, Ga. Mem. Am.Soc.M.E.

[6] Supt., Saco-Lowell Shops, Newton Upper Falls, Mass. Mem. Am.Soc.M.E.

[7] Cons. Engr., Boston, Mass. Mem. Am.Soc.M.E.

[8] Chief Engr. and Partner, Perin & Marshall, New York. Mem. Am.Soc.M.E.

planations of interesting features. He called attention to the soaking-pit crane and the charging machine. In the combination rail and structural mill described in the paper where the rolling of rails is one problem and the rolling of shapes another, he pointed out the equipment arrangement in complete units of angle table, cut-off, throw-off, skid table, gag straightener, double enders and double drillers. The mechanical doubler, which does the work more accurately than manual labor and has thereby been instrumental in reducing the cost of ten-sheet metal, received special comment.

Discussion Questions Answered

In answering questions raised in the discussion Mr. Estep said that he doubted if a machine could be invented to open the packs, since this is a problem of 75 per cent rolling and 25 per cent heat and the human element was needed. In a steel plant the wages are on a tonnage basis and therefore all equipment should be designed and constructed to meet the practical requirements of the workers and not to meet theoretical conditions. Handling and moving is a large item in the cost of manufacturing steel and steps are being taken to reduce it.

Stafford Montgomery[9] asked about economical methods for conveying and storing large quantities of many sizes of light tubes in the finished condition between drawing operations, also whether steam locomotives can be economically eliminated from the yard proper of a steel company and electrical power used. In reply Mr Estep stated that three or four methods can be applied in the handling of tubes between departments and storage between operations. A tube mill, as a rule, does not have overhead cranes in a big building but monorails can be installed which will quickly carry a good tonnage of hot or cold material. Or if it is cold tonnage, it can be handled with a magnet and a monorail. In regard to the question of steam against electricity, he said that the overhead-trolley system would interfere with the plant operation and a third-rail system, nine times out of ten, would be too expensive. Difficulties in the way of maintaining and safeguarding would offset the saving in operating economies.

E. L. Shaner[10] was of the opinion that the handling equipment in iron and steel plants could be divided into two classes, the largest of which is comprised of heavy and intricate machinery that requires the attention of engineers who specialize in that equipment. On the other hand, there are many operations which require simple mechanisms and hand labor, and the reduction of handling costs on these operations is of great interest to iron, steel, electrical and metallurgical engineers.

FIRST GENERAL SESSION

At the First General Session of the Spring Meeting, Edward R. Fish[11] presented in the absence of the author a paper on The Accuracy of Boiler Tests, by Alfred Cotton,[12] and C. C. Trump[13] a paper on Using Exhaust Energy in Reciprocating Engines which appeared in the June issue of Mechanical Engineering. Interest in the second paper was stimulated by the presence of Dr. Johann S. Stumpf, co-author of the paper and originator of the uniflow engine, who had investigated the principles set forth in the paper. The discussion of Mr. Cotton's paper appears directly after his paper in this issue, page 430. Earl F. Scott, of Atlanta, Manager of the Society, presided at this session.

Mr. Trump presented his paper with the aid of lantern slides which illustrated the important points he wished to bring out, and then introduced Dr. Johann Stumpf. Dr. Stumpf spoke of the uniflow locomotive which Mr. Trump had mentioned in presenting the slides. The uniflow locomotive, he said, had been in successful operation for a year. He described how he had changed completely the exhaust as usually designed, and told in considerable detail of the effect of an exhaust port designed to remove steam from the cylinder in the time available. He also spoke of the application he was making of this principle to a 6-cylinder automobile gas engine.

J. S. Coon[14] mentioned the hydraulic-ram analogy; and C. E. Coolidge[14a] told how the power of the Liberty motor had been increased by lengthening the exhaust pipe. J. T. Wikle[15] asked about the possibility of muffling a gas engine equipped with such an exhaust pipe. Mr. Trump pointed out that the exhaust pipe of such a design was in effect a muffler, and, in reply to a question by Roland B. Hall,[16] said that the gain in power of an ordinary steam engine had not been decided upon, as so far the only actual example in operation was that of the locomotive. The success with the locomotive pointed to gains in power at heavy load of over 10 per cent and at light loads of 3 per cent.

In answer to a question by Mr. Scott, Dr. Stumpf said that the greatest possibilities for gain lay with the gas engine rather than the steam engine, because the exhaust loss was larger.

In answer to a question about the gas turbine, Dr. Stumpf said that he considered the subject a serious one, and that he had the "most sincere pity for engineers who have to get up a gas turbine."

In answer to a question by Mr. Weaver, Mr. Trump said that the design of the exhaust nozzle was similar to the design of the turbine nozzle. It is simply to produce the velocity under the conditions of difference of pressure which exist during the exhaust period, this difference changing from instant to instant. In a multiple-cylinder engine the velocity can be used to produce a suction on another cylinder, but this is impossible in single-cylinder engines.

Donald B. Prentice[17] wrote that the paper suggested a fertile field of research for college laboratories.

FUEL SESSION

At the Fuel Session of the Spring Meeting three papers were presented: Reduction of Fuel Waste in the Steel Industry, by F. G. Cutler;[18] Boiler-Room Performance and Practice at Colfax Station, Duquesne Light Company, by C. W. E. Clarke,[19] and The Control of Boiler Operation, by E. A. Uehling.[20] Mr. Fred R. Low presided at the session. The first two of these papers have appeared in recent issues of Mechanical Engineering; Mr. Uehling's paper is published in this issue. A brief abstract of the discussion at the meeting follows.

Discussion of Mr. Cutler's Paper

Following the presentation of the paper by the author, a written discussion by F. J. Crolius[21] was read. He said that the author's suggestion of a method of balancing elements so that the smallest amount of added fuels will be consumed was an excellent one, but that there is at present no steel plant designed or operating with this objective in view. Fuels have always been an incident in production, he said, and conclusions based on present-day practice were of small value. He showed that, using figures of the best present-day practice, there is a deficit in the heat balance, although it is quite fair to assume that an ideal plant, designed with heat and power conservation in view, might be operated without firing additional fuel.

The author's suggestion of better-designed heating furnaces, while excellent for a projected plant, he said, was difficult to accomplish and hardly justified in the matter of investment. There was no question that heating furnaces, as usually operated, violated combustion laws, although these losses were small compared with others. Much might be done, he said, toward improving the conditions of operation which could result in saving heat.

---

[9] Cons. Engr., Detroit Engineering Co., Detroit, Mich. Jun. Mem. Am.Soc.M.E.

[10] Engineering Editor, *Iron Trade Review*, Cleveland, O. Assoc-Mem. Am.Soc.M.E.

[11] V. P., Heine Boiler Co., St. Louis, Mo. Mem. Am.Soc.M.E.

[12] Research Engr., Heine Boiler Co., St. Louis, Mo. Mem. Am.Soc.M.E.

[13] V. P., Humphreys Gas Pump Co., Syracuse, N. Y. Assoc-Mem. Am.Soc.M.E.

[14] Prof. of M.E., Supt. of Shops, Georgia School of Technology, Atlanta, Ga. Mem. Am.Soc.M.E.

[14a] Georgia School of Technology, Mem. Am.Soc.M.E.

[15] Purchasing Agt., M.E., Fulton Bag and Cotton Mills, Atlanta, Ga. Mem. Am.Soc.M.E.

[16] Cons. Engr., Hall Engineering Service, Chicago, Ill. Assoc-Mem. Am.Soc.M.E.

[17] Prof. of M.E., Lafayette College, Easton, Pa. Assoc-Mem. Am.Soc.M.E.

[18] Ch. Bureau of Steam Engr., Tenn. Coal, Iron & R. R. Co., Ensley, Alabama. Mem. Am.Soc.M.E.

[19] Dwight P. Robinson & Co., New York, N. Y. Mem. Am.Soc.M.E.

[20] Milwaukee, Wis. Life Mem. Am.Soc.M.E.

[21] Carnegie Steel Co., Homestead Steel Works, Munhall, Pa.

R. S. Sage[22] and E. Pragst[23] presented a written discussion in which they said that apparently those primarily interested in the power and blowing plants of the steel industry are confronted with two entirely different classes of problems: one in plants where there is available an excess of gas, etc., above power and blowing requirement, so that the design of these machines need not be influenced by the question of plant thermal economy, and the other in plants where there is a shortage of by-product fuel or would be unless high thermal economy is possible. The writers then mentioned some of the advancements made in generating-station design which had direct bearing on steel plants belonging to this second class.

F. L. Estep[24] wrote that conditions in steel plants were far from being ideal, and that one of the outstanding features of the subject was that there was generally more to be gained by proper operation of existing equipment than by the installation of additional equipment. He criticized some of the author's figures which he thought were somewhat out of line with blast-furnace practice in general throughout the country. He thought an efficiency of 65 per cent more generally obtained than one of 60 per cent, that 1250 deg. was too high a hot-blast temperature, and that the assumption of 55 cu. ft. of air per lb. of coke left little margin for leakage. In the author's table of horsepower, the figures for total gas and total boiler horsepower seemed higher than in ordinary practice. He believed that net tons of coke consumed was a better basis than tons of iron produced for figuring expected horsepower. He thought the subject a very timely one and one which had not been discussed sufficiently.

Walter N. Flanagan[25] wrote that the use of blast-furnace gas was the keystone of power economy in the steel plant, as it was easier to maintain high efficiency when burning blast-furnace gas than when burning coal. A good burner was essential to efficient combustion, and a good gas cleaner was another source of saving. Dry-cleaning methods offered the greatest savings, he said, because the sensible heat in 400-deg. gas was worth $22,000 per furnace per year in equivalent coal. Coke breeze screened out of the blast furnaces was being used successfully in plants. When burned in underfeed stokers, coke would produce slightly more than half as much steam per pound as good coal.

W. Trinks[26] wrote that there was danger that the conclusions drawn from the author's paper might be generalized and that readers might gain the impression that an economical blast furnace and steel plant could operate without coal and still use steam blowing equipment. The coke consumption of 2500 lb. assumed by the author was high for northern plants, he said, where 1800 lb. per ton of pig iron was a more reasonable figure. The effect of such a reduction in coke consumption was to decrease both the quantity and the heat value of the gas. As regards open-hearth furnace practice, he said, northern plants were using approximately equal quantities of hot pig iron and scrap, so that a ton of pig iron would certainly produce at least 1.5 tons of steel, which would result in a greater heat demand. The total effects would show a net deficiency of over 17 million B.t.u. per ton of pig iron, which must be supplied by the burning of coal. As the matter stands today, he wrote, he knew of no low-coke-ratio plant with blooming and finishing mills in which the blast-furnace and coke-plant fuel sufficed for the whole plant, unless gas blowing engines were used.

The author replied to the discussion as follows: "Mr. Crolius apparently overlooked the intention of this method of comparison of blast furnaces. He goes into some detail in showing that one plant will vary from another, and how this difference will be caused, depending on the type of equipment used.

"That is one view of the comparison, it is true, but there is no reason why the same plant cannot be compared day by day by the method suggested in the paper.

"He also stated that he did not believe it would be advisable to improve existing heating furnaces. In that respect I beg to differ very strongly with Mr. Crolius, as we have found that it is very necessary to improve the existing heating furnaces.

"Mr. Trinks brings out a formula in which he shows that the heat available from the gas per ton of iron varies materially with the coke consumption and is less than that given in the paper. The only difference between the figures is that the author uses 2500 lb. and Mr. Trinks 1800 lb. of coke per ton of pig iron. The author believes that the average lies between these figures and that 2500 lb. is closer to the average coke consumption of all furnaces in operation.

"Mr. Trinks also mentions the fact that in some open hearths a large percentage of scrap is used. This may be true for the particular furnaces that he has in mind, but if this ratio is maintained, practically one-third of the pig-iron steel would have to go back into scrap in order to make some more open-hearth steel.

"In regard to the point raised by Mr. Estep as to the omission of the allowance for leakage, the author's position is that leakage bears the same relation to inefficiency in either gas or coal, and it does not make any difference to the whole gas-furnace plant whether the gas inefficiency is in the boilers or stoves; or in throwing it away in the top of the furnace. The whole question resolves itself into how much can be got out of the surplus gas. We all differ in our assumptions. The figure of 55 cu. ft. per lb. of coke includes an allowance of probably 10 per cent of the theoretical figure, which is between 50 and 55 in most cases, and 55 includes a percentage for leakage."

Discussion of Mr. Clarke's Paper

Nevin E. Funk[27] opened the discussion of Mr. Clarke's paper by stating that one of the basic principles of power-plant design was that the simplest control consistent with best results should be obtained. This led him to criticize the use of two motor drives on the clinker crusher. He was convinced, from his own experience, that best results were obtained by continuous operation of the rolls, the speed varying with stoker speed. It was possible, he said, to eliminate the necessity of using water in the clinker-crusher pits. He said that the pits in the Colfax plant were too shallow to operate without water, and that the V-shaped sides acted as the buttress for an arch across which clinker would flux and hang unless cooled by water.

He asked if there might not be a possibility of error in the figures for the efficiencies of No. 8 boiler in September and No. 5 boiler in January and February. If such efficiencies could be maintained for a while, he asked, why not all the time with careful operation?

He spoke of the low superheat mentioned by the author and offered as an explanation the suggestion that in a low-set boiler secondary combustion might play a considerable part. With the advent of the more efficiently designed furnace, the heat available at the superheater, as well as the heat transfer rate, would be reduced, and more surface or a rearrangement of gas passages would be necessary to obtain the results expected.

B. N. Broido[28] said that the performance of the boilers at Colfax was of interest because of the large number of 1500- and 2000-hp. boilers now being installed or under consideration. The design of boilers had changed very little, he said, in the last few years, and it seemed that all efforts were being concentrated in the improvement of accessories. He discussed the subject of superheaters in considerable detail.

T. E. Keating[29] said that the paper showed what could be accomplished with modern high boilers and underfeed stokers without the aid of such heat reclaiming apparatus as economizers and air preheaters. He pointed out that the figures represented operating performance and should not be compared with a boiler test, in the common interpretation of the term. He discussed the combustible in the ash and the relation between mechanical and thermal conditions in stoker operation. He showed that time required for boilers to reach the point of maximum efficiency had

---

[22] Power and Mining Engrg. Dept., General Electric Co., Schenectady, N. Y.

[22] Power and Mining Engrg. Dept., General Electric Co., Schenectady, N. Y.

[24] Chief Engr. and Partner, Perin & Marshall, New York, N. Y. Mem. Am.Soc.M.E.

[25] Ohio Works, Carnegie Steel Co., Youngstown, Ohio. Assoc-Mem. Am. Soc. M. E.

[26] Professor of M.E., Carnegie Inst. of Tech., Pittsburgh, Pa. Mem. Am. Soc. M.E.

[27] Operating Engr., Philadelphia Elec. Co., Philadelphia, Pa. Mem. Am.Soc.M.E.

[28] Devel. Engr., Locomotive Superheater Co., New York, N. Y. Mem. Am.Soc.M.E.

[29] Gen. Mgr., Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mem. Am.Soc.M.E.

been reduced from over seven to under two days, and the effect this had on average monthly efficiency.

D. Robert Yarnall[30] discussed the measurement of hot boiler feedwater, saying that his experience had showed him that the V-notch-weir method of measurement was extremely dependable, because it was accurate at low as well as at high rates of flow, because it compensated automatically for variations in temperature and because of the hydrometer action of the float which operates the recording mechanism.

The author replied to the discussion in part as follows: "In reference to the comments of Mr. Funk about the double drivers on clinker grinders, these grinders are about 30 feet wide, and at the time of designing them it was thought best to drive both sides. The clinker operation resulting from this design has justified the designers' ideas on that subject.

"As to the speed of the rolls, we never have been able to run the rolls slowly enough Running the rolls even as slowly as four revolutions an hour is quite fast. The rate of speed of the clinker grinder depends entirely on the ash bed over it. If it is ground at too great a speed, the clinker grinder is burned out. We expected to make an improvement in the use of water in the pits. It has been found absolutely necessary to maintain flowing water in the pits to avoid losses in efficiency and other troubles due to clinkers.

"To touch again on the comparative efficiency of boilers No. 5 and No. 8, we have had an actual difference in this plant of over 10 per cent between adjacent boilers. When ferretted out, we find a certain type of ram, which is less efficient than another, and when we consider these high efficiencies we find many things to consider in stoker temperature. The boilers are not identical, neither are the efficiencies identical. In any boiler plant the size of this, two or three per cent difference in efficiency can be found in the boilers if operated at the ratings given. The man who is running a particular boiler has something to do with this difference. We have never found any of the meters on the boilers with an inaccuracy of over one per cent. The average difference in accurate value of the meters by actual test has been about 0.07 and never over 1 per cent.

"The superheat is low in the original boilers, due to heat absorption through the machine prior to the superheater.

"As to the lowering of oxygen in the barometric heater, we are trying some experiments of putting a slight vacuum on the barometric head, to see what can be done in the way of dilution which will remove the air, and also in heating the feed tank where most of the absorption takes place.

"At the time the plant was built coal was selling at $2.35 at Pittsburgh. We realized that the price of coal was going up, so that $3.50 was the rate assumed for a period of ten years. At that rate, and with the construction costs prevailing at that time, the economizers would begin to pay for themselves when coal reached $7.00 a ton.

"There were two questions regarding oxygen elimination. The oxygen elimination in that heat-balance system involves two factors, which are more accidental than otherwise. It is perfectly natural that there would be a lower value than the theoretical in a cycle in operation.

"Another feature is the time element which is necessary for absorption. We have no special means for oxygen elimination other than what occurs due to the heating, which drives out the oxygen. We are now trying some means of infiltration which will lower the heat further.

"In answer to Mr. Hutchins' comments on the maximum boiler rating, these boilers operate normally from 130 to 210 per cent of rating during the day of 24 hours. We have run them on test as high as 313 per cent for four or eight hours, but the average would be around 175 per cent.

"For February, March and April the total output of the plant was estimated at 97,575,100 kw-hr., and the load factor was 77.5 per cent. This station is operating on the base load as much as possible and the B.t.u. rate per kw-hr. average output, for the months of February, March and April, was 18,713.

"In answer to Mr. Trinks' comment as to air and coal control, some persons think that coal and air can be controlled automatically. It cannot be done. The air is controlled automatically, and the coal by hand.

"In answer to Mr. Bailey's comment regarding the overheating of the superheaters, in the new location it would be impossible to overheat the superheater by any change which did not bring about additional stresses over and above those of the cycle for which the superheater is planned, and if there was an element causing an increase in temperature it would cause overheating in the metal.

"As to Mr. Carter's question on the measurement of flue gases, we use mercurial pyrometers for these readings. We have tried others, but not with satisfactory results.

"In answer to Mr. Davis' question, the baffles are the standard B. & W. baffles, brick-backed, with cast-iron supports. We are going to try these baffles on some additional boilers. We use only the cast-iron baffles. We do not use any poured baffles."

SECOND GENERAL SESSION

At the Second General Session of the Spring Meeting, held on the morning of May 10, four papers were presented: Centrifugal Castings, by Leon Cammen; The Muscle Shoals Plant and the Nitrogen Supply, by Major J. K. Clement, presented by George A. Orrok; Heat Losses from Bare and Covered Wrought-Iron Pipe at Temperatures up to 800 Degrees Fahrenheit, by Russell H. Heilman, and the Evaporation of a Liquid into a Gas, by W. K. Lewis. Major Clement's paper appeared in the June issue of Mechanical Engineering. The papers by Mr. Heilman and Professor Lewis are published in this issue, while Mr. Cammen's paper will appear in an early number. W. S. Finlay, Jr., Manager of the Society, presided. A brief account of the discussion follows.

Discussion of Mr. Cammen's Paper

W. M. Corse wrote that engineers should be interested in centrifugal casting because commercially it was so practical. The speed of production far exceeded that of ordinary sand molding, he said, and the quality of the product was superior.

James B. Ladd[31] regretted that the author had not emphasized the extreme difficulty of making successfully castings by the centrifugal process. He felt that no engineer should undertake to develop the process without knowledge of these difficulties. It should be noted, he said, that a commercially perfected centrifugal process not only produced a product competitive in cost and quality with like products by other processes, but usually the centrifugal product was of superior quality.

Discussion of Major Clement's Paper

In the discussion which followed his presentation of Major Clement's paper, Mr. Orrok[32] said that his experience had shown that water-power plants would pay interest whenever the cost was less than $120 per kilowatt of machinery installed. He had known of plants costing as high as $500 per kilowatt. These plants had begun to pay interest only after the original investment had been written off, that is, after the original stockholders had lost their money. Since the increase in the price of coal, it was possible, he said, to pay as high as $200 per kilowatt and compete with steam plants, but $400 per kilowatt could not be invested with profit. Muscle Shoals, he said, was a very costly water-power development. At the present time no one could say what the cost of the plant would be, but it was his opinion that it would be in the neighborhood of $400 per kilowatt.

W. S. Finlay, Jr.,[33] chairman of the meeting, spoke of the necessity of keeping the Muscle Shoals plant so that it might be available in case of war.

Mr. Orrok said that the South was full of by-product industries, but he had heard no discussion of ammonium sulphate. Ammonium sulphate, he said, was pretty well known; it was produced regularly and at present commanded ready sale. Other nitrogenous compounds in the by-products from the distillation of coal, cyanides, are almost invariably thrown away. He did not have personal knowledge of one plant in which there was an attempt made to save the cyanides. An amount of cyanide is allowed to escape today in the United States equivalent to double

---

[30] Yarnall-Waring Co., Philadelphia, Pa. Mem. Am.Soc.M.E.

[31] Cons. Engr., Philadelphia, Pa. Mem. Am.Soc.M.E.

[32] Cons. Engr., New York, N. Y. Mem. Am.Soc.M.E.

[33] V. P., American Waterworks & Electric Co., New York, N. Y. Mem. Am.Soc.M.E.

the output of the Muscle Shoals plant in fixed nitrogen, but commercially it is not worth saving.

There is one other point of view that should be remembered in connection with the Muscle Shoals plant. That plant was designed three or four years ago. Today it is practically ancient history. The process has developed so much that if the plant were to be used it would have to be reconstructed. If the plant waits another four years it will probably have to be rebuilt entirely, and by 1930 fixed nitrogen will probably be made in a very differently designed plant.

Dr. Stumpf spoke of the plant built in Germany during the war for the manufacture of nitrogen products. Since the end of the war it had been reconverted in an astonishingly short period for the manufacture of fertilizers.

The discussion of Mr. Heilman's paper appears directly after his paper in this issue, page 437.

The paper on The Evaporation of a Liquid into a Gas was presented by title. Written discussion was presented for record in the Transactions of the Society.

MANAGEMENT SESSION

On Thursday morning, May 11, the Management Session was held under the auspices of the Management Division with L. P. Alford, Vice-President of the Society, in the chair.

After the Committee on Management Terminology, which is made up of representatives from the Society of Industrial Engineers, Industrial Relations Association of America, National Association of Cost Accountants, Taylor Society, American Institute of Accountants, and the Management Division, rendered its report, the two papers, Management Applied to Textile Plants, by George S. Harris, and The Southern Worker—His History and Character, by Frank H. Neely, were presented. The former was published in the June issue and the latter in the May issue of Mechanical Engineering.

Both papers were discussed together. J. A. McPherson[34] believed that a good part of the success of the southern mills was due to the close contact of the management with the employees, while in a written discussion, Charles H. Eames[35] predicted that the management of the textile mills of this country will continue to be more and more in the hands of broadly trained manufacturers who are essentially textile engineers. He termed managerial ability as an amalgamation of natural intelligence, educational training, personality and experience.

C. M. Bigelow[36] believed that the success of a mill was greatly dependent upon a properly maintained mechanical department, having an adequate storage of repair parts, mechanical supplies, etc., and a gang of repair men who could promptly handle emergency repairs, but whose overhead cost would be absorbed by continuous work along routine repairs, machining of repair parts, etc. Mr. Bigelow differed with the author and considered that too much emphasis is put on the technical ability of the department heads and not enough on their purely managerial responsibilities.

In a written discussion Frank B. Gilbreth[37] stressed the points that there is one best way for performing any operation and that the various conditions in the textile mills have not been properly studied in general in order to produce superintendents by which one best way may be discovered and put into effect.

In the last of four written discussions read by Prof. Eaton Webber of the Georgia School of Technology, E. A. Lucey[38] advocated a study of conditions and individual training of the workers by a specialist. Although this training is expensive, it pays for itself from the start and later dividends by establishing a better understanding between the management and the employees. Also after this instruction in the best way to do the work, the difference in the amount of work done between the poorest and the best workers should not be over 15 to 20 per cent.

Frederick McDonald[39] called attention to the recently published book entitled Waste in Industry, which placed 50 to 80 per cent of the waste on management and charged the latter with responsibility for improvement. He also urged the training of the mental equipment of workers and a realization that management is not only the problem of the men at the head of the organization, but of every individual who directs some one under him as well.

C. H. Fish[40] pictured the transition during the past twenty years in the nationality of the labor in the northern cotton mills and the utter impossibility of treating the present-day conglomeration of nationalities and classes in the same way as the southern worker. Also since the northern mills were built first, the southern manufacturer has avoided their mistakes and shortcomings.

In the closures, Mr. Harris pointed out the need of standardization before the American manufacturer could compete in foreign markets and the wonderful opportunity before the Society to accomplish the task through its officers and committees. Mr. Neely was opposed to involving workers, who were usually of inferior mental capacity, in the responsibilities of management, but considered it very much better to develop the managerial control.

POWER SESSION

At the Power Session held on Thursday morning, May 11, D. W. Mead presiding, three papers were presented, namely: Economics of Water-Power Development, by C. A. Mees; Power Development in the Southeast, by Chas. G. Adsit, and Hydroelectric Power-Plant Design, by John A. Sirnit. Mr. Mees' paper appears in this issue. Mr. Adsit's paper was published in the May issue of Mechanical Engineering and Mr. Sirnit's paper will appear in an early number.

In a written discussion of Mr. Mees' paper L. A. Magraw[41] pointed out that steam-power plants could be developed in units as the demand grew while water-power plants are constructed complete in the beginning with the result that often heavy losses are sustained by the latter during the early period of operation when the load is considerably less than the capacity of the plant. Regulatory bodies have not given the proper consideration to these deficits and instead of determining the allowed revenue upon replacement cost, new, less depreciation, have attempted to determine the cost in prewar times plus the additions since that time. Then from this historical value of the property is deducted the accrued depreciation arrived at by comparing the physical condition of the plant at the time of the rate inquiry with a similar plant new. This is simply an arbitrary way of reducing the value of the property for rate-making purposes and has no relation to the market and economic conditions in the territory, which should fix the rates.

A. A. McLeod[42] in referring to written instructions for employees, said in his experience that the way to get the best service is to aid the employee in every possible way to discover the fact that he has a brain and then he will use it.

Geo. A. Orrok[43] considered it unfortunate that Mr. Mees adheres to the idea of primary and secondary power. Primary power cannot be sold or used as no one today has a 100 per cent load factor. Those having to do with pulp making or metallurgical projects may have an 85 or 87 per cent load factor, but most plants must be content with a 50 per cent load factor and this is not primary power or even secondary power. Mr. Orrok stated that kilowatt-hours and not kilowatt-years are the units of sale of power.

Chairman Mead emphasized the importance of the economic advisability and justification of any water-power project. These must be established before the project is built.

In closing Mr. Mees called attention to the value of written instructions not only to employees but also to the person preparing the instructions. He decried the use of any other unit but the kilowatt hour for the sale of power, but he reiterated the fact that

---

[34] Ch. Engr., Plan and Construction Dept., J. E. Sirrine & Co., Greenville S. C. Mem. Am.Soc.M.E.

[35] Pres., Lowell Textile School, Lowell, Mass.

[36] Ch. Engr., Cooley & Marvin Co., Boston, Mass. Mem. Am.Soc.M.E.

[37] Pres., Frank B. Gilbreth, Inc., Montclair, N. J. Mem. Am.Soc.M.E.

[38] Pres., H. L. Gantt Corp., New York, N. Y. Mem. Am.Soc.M.E.

[39] Mgr., D. McDonald & Co., Albany, N. Y. Mem. Am.Soc.M.E.

[40] Cons. Engr., Boston, Mass. Mem. Am.Soc.M.E.

[41] Genl. Mgr. and Treas., Central Georgia Power Co., Macon, Ga. Mem. Am.Soc.M.E.

[42] Engrg. Supt., Florida Phosphate Min. Corp., Barlow, Fla. Mem. Am.Soc.M.E.

[43] Cons. Engr., New York, N. Y. Mem. Am.Soc.M.E.

there are two classes of power: one that must be available at any and all times, and the other in which there is some latitude in delivery.

Hydroelectric Power Development

In connection with the presentation of his paper, Chas. G. Adsit showed some airplane views of the water-power development and a moving picture of a portion of the construction of the Burton Dam. This is a cyclopean dam with gravity section, 1220 ft. long and about 125 ft. high. Its reservoir has a shore line of about 63 miles and contains 5,500,000,000 cu. ft. of water. This water now falls 608 ft. and delivers about 55,000,000 kw-hr. but will eventually fall 1220 ft. Another reservoir with a 24 mile shore line contains 1,400,000,000 cu. ft. and on present development has 15,000,000 kw-hr. capacity. The Tallulah Falls diversion dam is 360 ft. long and 116 ft. high and is built on a radius of 900 ft. A tunnel, 12 by 14 ft., runs a mile and a half through a mountain with a fall of 12 ft. and ends in penstocks that drop to the Tallulah Falls plant of 108,000 hp. capacity. A new development under construction at Tugelo will have a dam 150 ft. high and in the plant will be four 20,000-hp. turbines and four 12,500-kw. generators.

In the discussion which followed Oscar G. Thurlow[41] pointed out the valuable location of the Muscle Shoals hydroelectric power project for serving a region which, compared with other sections of the Southeast, has suffered in its industrial development because of lack of power. There is a market now available for the disposal of the primary power and a chemical plant to use a great part of the secondary power, so that with a general distribution of the Muscle Shoals power an industrial advance in this region would naturally follow.

F. P. Cummings[42] gave the details of the emergency in 1921 which the power companies of Tennessee, Georgia and the Carolinas were only able to meet through the interconnecting of the systems, and finally how the leasing for one year of the 60,000-kw. Government power plant at Sheffield, Ala. has insured power service to many industries that might otherwise have been compelled to curtail their production during the low-water period, and provided power services for industrial expansion in this territory.

Prof. C. S. Brown[43] decried the power that was being lost every day at Muscle Shoals because of its incomplete development and Mr. Orrok commented on the mean flow of the Tennessee River and the total fall of water available there.

Mr. Adsit, in his closure, reiterated the statement in his paper that Muscle Shoals is good for about 100,000 hp. in primary power and an undeterminable amount of secondary power, and said that the minimum flow of the Tennessee River is probably around 5500 second-feet.

The last paper of the session was given by Mr. Sirnit, who described his subject as an improvement in the design of an hydroelectric power plant which will not only give more kilowatts but kilowatt-hours without any additional cost. By ingenious application of the kinetic energy of the water, action similar to an ejector is obtained, and the normal tail water is raised at the same time the head on the machine is increased. The details of tests of models of the Thurlow suppressor then followed and in conclusion a description of the development now under construction incorporating the idea.

Mr. Adsit commended this new application of the idea and believed that engineers would eagerly await the operation of the plant.

SYMPOSIUM ON WELDING

THIS symposium was arranged under the joint auspices of the A.S.M.E. Boiler Code Committee and the American Welding Society to supplement the public hearing on the proposed code for unfired pressure vessels held at the Annual Meeting last December. Four papers were selected for presentation. These papers were: Strength of Electrically Welded Pressure Containers, by R. J. Roark; Some Principles of the Construction of Unfired Pressure Vessels, by S. W. Miller; Steel for Forge Welding, by F. N. Speller; and Tests on Welded Cylinders, by E. A. Fessenden and E. J. Bradford. The dire need of a code was indicated by the numerous communications, acknowledging meeting announcements sent to interested manufacturers and individuals, which urged action. Mr. Roark's paper was published in the April issue, and Mr. Miller's in the June issue; Mr. Speller's is printed in this issue of Mechanical Engineering and the fourth will appear in a later number.

Edward R. Fish, who presided at the session, is Chairman of the A.S.M.E. Boiler Code Sub-Committee on Air Tanks and Pressure Vessels. In his opening remarks he reviewed the status of welding pressure vessels.

The discussion at this session was of such general interest and so much new material was submitted that a more complete treatment of the discussion will be presented in the August issue of Mechanical Engineering than is customary with meeting discussions.

Stainless Steel

Below is given a brief list of references of Stainless Steel supplied to Mechanical Engineering by the Engineering Societies Library as data that might prove of value to its readers:

Chromium Steels and Iron. 1921. Leslie Aitchison. *Engineering*, v. 112, pp. 805–807.

Stainless Steel. 1920. Leslie Aitchison. *Engineering and Industrial Management*, v. 3, pp. 114–117.

Stainless Steel. 1921. Leslie Aitchison. *Engineering Steels*, pp. 209–214.

Heat Treatment of a High-Chromium Steel. 1920. H. J. French and Yoshite Yamanchi. *Chemical and Metallurgical Engineering*, pp. 13–16.

Corrosion of Steel Alloys, Introductory Address on. 1916. Sir Robert Hadfield. *Transactions* of Faraday Society. v. 11, pp. 183–197.

Steels Used in Aero Work. 1917. W. H. Hatfield. *Automotive Engineering*, v. 7, pp. 169–174, 209–212, 226–228.

Stainless Steel. 1921. Elwood Haynes. Paper read before American Iron and Steel Institute.

Steelite and Stainless Steel. 1921. Elwood Haynes. Engineering Society of Western Pennsylvania, v. 35, pp. 467–74; discussion, pp. 475–82.

L'Acier Stainless. 1922. H. Hubert. *Révue Universelle des Mines:* 6th series; v. 13, pp. 19–28.

Stainless Steel, Its Treatment, Properties and Applications. 1920. W. H. Marble. Transactions, American Society for Steel Treating, v. 1, pp. 170–177. Discussion, pp. 178–179.

Stainless Steel. 1920. J. H. G. Monypenny. *Journal Society of Chemical Industry*, v. 39, pp. 390R–391R.

Physical Qualities of High Chrome Steel. 1919. L. R. Seidell and G. J. Horvitz. *Iron Age*, v. 103, pp. 291–294.

High-Chromium Steel for Exhaust Valves. 1919. Iron and Steel Committee of Society of Automotive Engineers. *Journal S. A. E.*, v. 5, pp. 262–263.

High-Chromium Steel. 1920. Standards Committees, Society of Automotive Engineers. *Journal, S. A. E.*, v. 6, pp. 58–60.

Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel and Aluminum. 1922. W. H. Souder and Peter Hidnert. Scientific Paper, Bureau of Standards, no. 426.

Stainless Steel and Its Properties. 1921. *Engineer*, v. 132, pp. 504–505.

Stainless Steel for Turbines. 1921. *Electrician*, v. 87, pp. 540–541.

Stainless Steel, Its Properties and Uses. 1921. Brown Bayley's Steel Works, Sheffield, England.*

The Story of Stainless Steel. 1919. *Iron Age*, v. 104, p. 294.

Krupp's Rustless Steels. 1920. B. Strauss and E. Maurer. *Kruppische Monatshefte*, v. 1, pp. 129–46.

The Uses of Stainless Steel. 1921. *Engineer*, v. 131, pp. 598–599. Discussion, pp. 663–664.

Experiments of Stainless Steel as the Exhaust Valves of Internal-Combustion Engines. 1921. Seiiti Yamashita. *Journal of the Society of Mechanical Engineers*, Tokyo, Japan. In Japanese.

---

* Not in Engineering Societies Library.

[41] Ch. Engr., Alabama Power Co., Birmingham Ala. Mem. Am.Soc.M.E.

[42] Operating Supt., Alabama Power Co., Birmingham Ala. Mem. Am.Soc.M.E.

[43] Professor of M.E., Vanderbilt University, Nashville, Tenn. Mem. Am.Soc.M.E.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields. The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie
Ralph E. Flanders John T. Wilkin
O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions

The Engineer and World Problems

America and the Rehabilitation of Europe was the general topic of the twenty-sixth Annual Meeting of the American Academy of Political and Social Science held in Philadelphia May 12 and 13. For the six sessions, various aspects were discussed under the subtopics: The Industrial and Financial Situation in Europe and Its Remedies; To What Extent is America's Prosperity Dependent on the Rehabilitation of Europe; America and the Debts of Europe; America and the Political Situation in Europe; Is America's Coöperation Indispensable to European Rehabilitation; America's Relation to the European Situation.

Alfred D. Flinn

Men and women from Europe and many parts of America were the speakers and treated the subjects from first-hand knowledge. Large audiences of thoughtful persons listened intently to all the papers and discussions.

Diplomats, business men, bankers, statisticians, representatives of Labor and the press, men experienced in governmental service, a manufacturer and an engineer, alike, presented, in the main, the economic and political phases of the topic. Russia and the Genoa Conference received much attention, as well as payment of international debts, upbuilding of mutual confidence among peoples, and stabilization of industrial, political and financial conditions.

In a broad way, all the papers were of interest to engineers. With one notable exception, however, the speakers referred but incidentally to the parts of the engineer, the scientist and the educator in the solution of present-day world problems. In the main, the speakers dealt with the mechanisms of industry, trade and government to the exclusion of fundamental principles, such principles as were dealt with being, for the most part, the rules of trade. Only by scant implication was there recognition of the mighty mental forces newly developing the world's resources, both physical and intellectual, through science and technology, or of man's increasing endeavors to know and use more effectively both his mental and physical capacities. Counting-room, rather than laboratory, supplied the tests for acceptability of proposed solutions of the world's problems.

The notable exception to which reference was just made, was the address of Dr. B. Stepanek, Minister at Washington of the Czecho-slovak Republic. He appealed for the establishment in Central Europe of a great American university and library as a center from which could be given out the best products of American culture, a source of correct information about America and of the best American ideas. He pleaded, also, for some influential alliance of the engineers of all countries—a World Federation of Engineers—through which this constructive type of mind could be brought more effectively into the service of the nations. He suggested that at an early date, there should be an international conference of such men, rather than of politicians and of statesmen, bound by tradition and self-seeking nationalism—a conference of constructively-minded men who could take fresh views of the world's condition, deal scientifically with fundamental causes, and suggest impartial, far-sighted plans for continuing progress.

But the politician yet holds the reins of government. Will he give the engineer a chance to contribute in any large measure to the direction of national and international affairs? What can the engineer do by way of preliminary demonstration of his capacity to deal with problems which need the engineer's loyalty to facts, power to analyze, and enthusiasm for construction, but which are not amenable to slide rules and instruments of precision? It is certainly noteworthy that a man, trained to diplomacy from his youth and who has devoted his life to that calling, should so insistently urge participation of the engineer in present-day problems of state. Is he not right, for have not the engineers and scientists, by their wonderful advancement of physical and intellectual development of the world, brought about social and industrial conditions with which statesmen and politicians are not yet prepared to deal?

How can Dr. Stepanek's remarkable suggestion, repeated on several occasions, be put into effect? Why not a "trial trip," in the parlance of the marine engineer, a joint convention of the great national American societies of engineers in Europe in the summer of 1923, to meet engineers of all the countries of Europe for discussion of such of the world problems as may be most vulnerable to engineering attack?

The meetings of the Academy were important and cannot fail to have widespread effect upon public opinion in the course of time. In the future, engineers should have places on the program and do their share in studying such subjects as the Academy selects for its meetings.

Alfred D. Flinn.[1]

Coöperation in Standardization—An Opportunity for Engineers

As a direct result of the report of the F.A.E.S. Committee on Elimination of Waste, Secretary Hoover instituted a countrywide program of simplification in sizes and varieties of commodities in general use, such as paving brick, axeheads, shot-gun loads, etc. To carry out this work properly, he established the Division of Simplified Practice in the Department of Commerce and placed at its head W. A. Durgin, formerly of the Commonwealth Edison Company of Chicago.

The American Engineering Standards Committee was organized in 1918 by the national engineering societies for the purpose of coördinating the standardization activities of the various engineering groups and industrial associations of this country. It also furnishes a valuable contact with the standardization work of foreign countries. This Committee has now developed into an organization with one hundred and sixty coöperating bodies and has established a noteworthy plan of procedure that provides for the absolute autonomy of the member bodies in standardization work. The success of the Committee's plan of procedure is fully demonstrated by the rapid increase in number of member bodies and by the fact that, to date, twenty standards have been approved and fifty standardization projects are in process.

To insure coöperation between these two organizations having

---

[1] Mr. Flinn, Secretary of the United Engineering Society, was appointed Honorary Vice-president to represent the A.S.M.E. at the Twenty-sixth Annual Meeting of the American Academy of Political and Social Science.

similar objects but different fields, as will be explained later, Mr. Durgin has been appointed a member of the American Engineering Standards Committee and A. A. Stevenson, a former chairman of the American Engineering Standards Committee, has been appointed as a member of an Advisory Committee to the Division of Simplified Practice.

The American Society of Mechanical Engineers is coöperating with the American Engineering Standards Committee through its delegation of three representatives. E. C. Peck, Chairman of this delegation is also Chairman of the A.S.M.E. Standing Committee on Standardization.

It is obvious, that to carry out an economical program of standardization, there must not be duplication on the part of this new activity of the Department of Commerce with the established American Engineering Standards Committee. It is well recognized that in the field of standardization the American Engineering Standards Committee is the logical body. This field embraces all projects which are of special interest to engineering and associated industries. The Division of Simplified Practice agrees not to enter this field. It desires to develop, however, a field of broad usefulness by reducing the number of sizes and by simplifying the varieties of manufactured articles in common use.

On May 4, Secretary Hoover invited the American Engineering Standards Committee to solicit the coöperation of its member bodies in a canvass to determine what simplification of manufactured products is most needed and most desired at this time. On May 22, the American Engineering Standards Committee unanimously accepted this invitation and voted to urge the immediate and active coöperation of the member bodies in carrying on this canvass. In accord with this action of the American Engineering Standards Committee, the Standardization Committee of the American Society of Mechanical Engineers met on June 13 jointly with some of the Society's members who served on the Waste Committee. This joint body recommended to the Council of the Society that immediate steps be taken to secure the suggestions desired by Secretary Hoover from the membership of the American Society of Mechanical Engineers. To this end the Society's membership has been addressed through the eleven Professional Divisions. Prompt replies have been requested as it is desired to place the suggestions of the membership in the hands of the Department of Commerce as soon as possible. Publicity has also been given in the June 22 issue of the *A.S.M.E. News*.

Every reader of Mechanical Engineering should realize his personal obligation to use his knowledge and experience in securing suggestions of manufactured products that will permit of simplification or standardization. This request of Secretary Hoover should be an incentive to the engineering profession to contribute a service it is eminently fitted to render. Give thought to the common manufactured articles that you touch and see daily and consider the possibilities of simplification or standardization. Send in the results of your study at once and you will have assisted materially in this sincere effort of the Secretary of Commerce to reduce in some measure the present wastes in industry.

Science for the Layman

As the life of the engineer is spent in applying the principles of science to the improvement of our condition, he should, above all others, be interested in the wide dissemination of accurate information concerning science among laymen, and should therefore give a hearty welcome to the recently published "Outline of Science." Here is a popular account of the essentials of present-day science, long enough to cover the outline, yet not long enough to be tiresome, eminently readable without attempting to be sensational, and amply and intelligently illustrated. The work is edited by J. Arthur Thomson, regius professor of natural history in the University of Aberdeen, whose standing vouches for the accuracy of the text.

After the flood of books of "popular" science that has recently emanated from so many unskilled pens, it is a pleasure to call attention to one that reports the latest opinions of authority, in a form suitable for young and old alike.

Harrison W. Craver.

Making a Start in Government Reorganization*

The continuance of great Government expenditures has shown the impossibility of cutting appropriations and payrolls to any great extent except by substituting sound business methods for wasteful and extravagant procedure. The first step needed in effecting this improvement must be to make thorough reorganizations, grouping under distinct departments those functions or activities which are of similar character or should logically be coördinated.

The business administrative methods of the Federal Government have no satisfactory provision for planning a department. Each bureau covers as much ground as is permitted by its construction of the authority received by it. The result is that many bureaus duplicate the work of others by doing much the same type of work. For instance, in the engineering and construction work of the Federal Government there are twenty-seven different agencies engaged in building construction, sixteen in road construction, nineteen in hydraulic construction, twenty-two in engineering research, twenty-five in surveying and mapping, six in coast fleets, sixteen in work on rivers, ten in public-land functions, and fifteen in chemical investigations.

Obviously there is need of a controlling agency to allocate specific work to each bureau, make it operate within prescribed limits and insure that its work supplements that of the others. This state of affairs is typical of conditions existing in other Government activities.

Engineers in touch with Government business methods and knowing the waste resulting from present practice, have for many years discussed plans for bringing together into one existing Department, all the commonly known Public Works. As a result, delegates from seventy-four engineering, technical, and business societies, with a combined membership of over one hundred thousand met at Chicago in April, 1919, and founded the National Public Works Department Association. Its object was to establish in the Federal Government a systematic, businesslike organization to carry out public works, similar to that in use by private concerns and by practically all other important nations.

The Association, whose task has been taken over by the American Engineering Council of the Federated American Engineering Societies, proposed no radical reorganization, additional Government Department or Cabinet officer. It advocated that the Department of the Interior be changed into the Department of Public Works, that bureaus in other Departments engaged in public works be transferred to this Department, and that Interior Department bureaus not so engaged be placed elsewhere.

The adoption of such a plan is essential to the success of a budget system in national works. It would reduce taxes by cutting down overlapping activities, and minimizing the duplication of work. The proposal serves the interest of no class, has no politics and is absolutely non-partisan.

A bill known as the Jones-Reavis Bill, providing for these changes, has been introduced in Congress and is securing general support.

Howard Monroe Raymond Heads Armour Tech.

On May 23, 1922, the Board of Trustees of Armour Institute of Technology announced the appointment of Dr. Howard Monroe Raymond as President of that institution. Dr. Raymond has served as Acting President of the Institute since the death of Dr. Frank W. Gunsaulus last year, and has also been Dean of Engineering since 1903.

President Raymond is well known in the educational and engineering world through his activities at the Institute during the past twenty-seven years. He is a graduate of the University of Michigan and a member of leading engineering and scientific societies.

His appointment to the presidency of this rapidly developing engineering college assures to its students and alumni a continuation of progressive plans for the future of the institution.

---

* Extracts from a Statement by Francis Blossom, Chairman during the War of the Board of Review of Construction of the War Department, and Representative on the American Engineering Council of The American Society of Mechanical Engineers.

Ambassador Jusserand and Secretary Hoover Attend Engineers' Dinner

In furtherance of its desire to cultivate camaraderie between French and American engineers, the American Section of the Société des Ingénieurs Civils de France entertained at dinner on May 29 the members of the deputation of American engineers who carried the John Fritz Medal last year to Eugene Schneider.

The dinner was given at the University Club in Washington. Herbert Hoover, Honorary President of the American Section of the Société, presided. The guests included, Ambassador Jusserand of France and the presidents and secretaries of the four Founder Societies, the United Engineering Society, the Federated American Engineering Societies, the Engineering Foundation, and the John Fritz Medal Board of Award. Dean Dexter S. Kimball, President of the American Society of Mechanical Engineers, was represented by Leon P. Alford. Regrets were received from Dr. Ira N. Hollis, Robert A. Cummings, F. L. Hutchinson, Dr. Wm. McClellan, and Dr. F. B. Jewett.

In speaking of the work of engineers, Ambassador Jusserand pointed out a marked difference between American and French engineers. The former have at their command colossal natural resources, the latter but limited resources. This has tended to make Americans careless. "They rush into their work with full steam on," he said. "All is hustle and bustle; they want results regardless of effort or expense; they waste their resources in reaching their ends. The French engineer is careful and cautious; each step is carefully calculated: there is nothing to waste, and hence nothing is wasted. And I believe," he added, "that in the end neither has much the advantage." "I think it is shameful the way you treat your locomotives. You build them strong and powerful; you put any driver into them and he runs his engine simply as a powerful machine to get results, and when the results are secured, the engine goes to the scrap heap. Our engines are built like a watch. They are cared for as a race horse, each by its own driver who is as careful of it as of any live thing, and who regards it as his child to be watched and cared for and tended through a life that may continue for many years."

"It is a mistake for us to send our young men just out of college to get their early practice training in this country. Your conditions are so different from ours; so it would be a mistake to send your young men to us. But after each has had training in his own country long enough to become acquainted with local conditions, then the study abroad is most valuable, in order that each may have the opportunity of learning those things which may be adapted to his own home conditions."

Aimé Dumaine, President of the American Section of the Société, then read several cables from France, among them one from the President, felicitating the Section on its happy idea of holding this joint meeting, and another from Marshal Foch, the only member of all societies represented, congratulating the Societies on this occasion, which he hoped would be the forerunner of many more similar gatherings.

M. Dumaine spoke of the friendship and respect which had grown up during the war between the engineers of the two countries. "Nothing must come to destroy this," he said, "and by our united action we can not only preserve it, but we can develop the same feeling between other professions and between the people at large.

"Ambassador Jusserand has been working for twenty years to establish and maintain an international good will which engineers now feel, and this may be made permanent through the International Organization of Engineers which we hope to form."

Mr. Hoover spoke of the criticisms which the people of each nation directed toward the other during normal times. "Do not take these criticisms too seriously," he said. "Some of them may have point, most of them have not; but I venture to say that in time of stress, if it ever comes again, we shall be found marching shoulder to shoulder with the same righteous end in view."

Ambrose Swasey, speaking for the members of the deputation, recited the many instances of hospitality shown its members when abroad. He said in part, "I trust that the American Section of the French Société will grow in numbers and influence. I trust that the French Sections of the American Societies will do the same, all to the end that there shall be just one great society, making for the peace of the world. We are handicapped by our ignorance of your language, but this is a small difference; while our tongues may not synchronize, our hearts are in perfect attune."

John R. Freeman, President of the American Society of Civil Engineers, pointed out to what great extent American engineers were indebted to the early French engineers for the mathematical formulas still in use, for our knowledge of hydraulic engineering, for city planning, and recently for the development of reinforced concrete construction.

J. Vipond Davies, President of the United Engineering Society, then offered the use of the Engineering Societies' Building in New York to the American Section of the Société for such purposes as it might require, and President Dumaine gratefully accepted this mark of courtesy.

Mr. Hoover, in bringing the dinner to a close, suggested that the most useful and constructive thing that could be done at this time was to bring into association men of similar callings. "In our association of engineers," he said, "there are no secrets. Their experiences, their skill and their inventions are freely interchanged and form a common bond. United they should and will form an irresistible force for the peace of the world, either by moral suasion or by making war too terrible to contemplate. Individually, or as relatively small units, we are impotent; by association only can the work be done. An international organization is not only possible, but it is practicable. We know that the French engineers have a hearty welcome here; we know that we are welcome over there, and when this new organization is formed, there will be no 'Article 10.'

The Longstreth Medal Awards

The Edward Longstreth Medal, awarded by the Franklin Institute for inventions of high order and for particularly meritorious improvements and developments in machines and mechanical processes, was presented to Joseph F. Keller of Brooklyn, N. Y., and Samuel T. Freas of Trenton, N. J., in the Hall of the Franklin Institute in Philadelphia on April 19, 1922. The Medals and accompanying Certificates are presented to "gentlemen whose inventions have been examined by the Committee on Science and the Arts and found worthy of recognition by the Institute."

The award was made to Mr. Keller for his invention of the Keller automatic die-cutting machines. These machines were described by their inventor in a paper he presented at the Annual Meeting of The American Society of Mechanical Engineers, of which he is a member, in December, 1920. The Institute believed that credit should be given to Mr. Keller for having met a recognized need for increasing die production and reproduction by methods which have resulted in easier, quicker and better production by less skillful operators and a reduction of the costs. Mr. Keller's invention which consists of a cutting tool with a tracer following a pattern, successfully overcomes the difficult problem of retaining sensitiveness with ability to do heavy cutting.

The Edward Longstreth Medal

Mr. Freas received the award for his invention of the "interlocking" tooth saw. The outstanding feature of this device is an unusual but very simple combination of wedges which holds the teeth firmly in place in spite of the intense stresses set up when doing heavy work. The excellence of his design has resulted in the extended and successful commercial use of the saw.

Presentation was made by Dr. Walton Clark, President of the Franklin Institute.

The *Majestic*, World's Largest Liner, Makes Its First Visit to New York

THE White Star liner *Majestic* docked in New York for the first time in May. Not only is she the largest liner afloat, but she will very likely continue to have this distinctive position for some time to come. The *Majestic* is the result of the prewar competition for size and speed in Transatlantic liners, and with the altered economic conditions and present high constructional costs, her equal will probably not be built for some time. Interest in the *Majestic* was doubtless increased by the fact that her sister ship, the *Leviathan*, (formerly the *Vaterland*) had recently been sent to Newport News to be refitted for Transatlantic traffic.

Originally built to the order of the Hamburg-Amerika Line at the Elbe shipyard of Blohm and Voss, Hamburg, and christened the *Bismarck*, work on her was well in hand when the outbreak of war came, and was continued till about the middle of 1916. After that time little progress was made, and about that period all copper pipes were removed and replaced by pipes of steel, which have for the most part been retained.

By the Versailles Treaty it was provided that vessels under construction should be completed by the Germans as designed and handed over to the Reparations Commission. The *Bismarck* was one of some twenty-five ships allotted to Great Britain, representing a gross tonnage of 225,000 tons. The White Star Line purchased the *Bismarck* from the Reparation Commission, and renaming her the *Majestic*, began nearly a year ago to supervise her completion.

The Majestic has an overall length of 956 ft., and is 100 ft. broad, with a gross tonnage of over 56,000 tons, and a displacement of 64,000 tons when loaded to her marks. Her height from keel to boat deck is 102 ft., and the look-out man in the crow's nest is perched 180 ft. above the water line. A special feature in the design of the *Majestic* is the arrangement of her decks. Above the five steel decks, which run from end to end of the ship, there are four steel-plated erection decks which cover at least half her length. The boiler casings, instead of passing up the centre of the vessel, are divided and placed towards the sides of the ship, and are then carried up above the top deck, where they unite to form a center superstructure for the funnels. This method, which is adopted for two of the funnels—the third being a dummy funnel—permits of better ventilation for the boiler rooms, and from an architectural point of view admits of great breadth in the disposition and size of the cabins and public rooms throughout the seven decks on which most of the first-class passenger accommodation is provided.

FIG. 1 THE WHITE STAR LINER *Majestic*

The full complement of the *Majestic* is over 5000 persons, this number including 850 first-class passengers, 545 second-class passengers, and 2392 third-class passengers, with a crew of over 1100.

The *Majestic* is driven by four-bladed propellers, each with a one-piece boss, made by the Manganese Bronze Company, Ltd., of London. Fig. 2 shows one of the spares. The propelling machinery consists of quadruple turbines of the combined-impulse and reaction type, Curtis wheels being fitted before the Parsons drums. The turbines are arranged in two engine rooms on the port and starboard. The steam enters the high-pressure turbine on the port inner shaft, and passes on to the intermediate-pressure turbine on the starboard inner shaft, from where, equally divided, it again passes to the two low-pressure turbines on the outer shafts. Each separate shaft, however, is available for running or manoeuvering by itself, but under ordinary working conditions the two low-pressure turbines operate in parallel. The total ahead horsepower is 66,000, and the astern power 36,000. According to contract, the vessel should travel at a speed of 23 knots when loaded to a mean draght corresponding to a departure draft of 35 ft. 6 in., and when the turbines are developing 66,000 shaft horsepower at a speed of 180 r.p.m., with a boiler pressure of 235 lb. per sq. in. On her run from Cuxhaven to Southampton she actually developed over 70,000 hp. and a speed of 25 knots was reached. The astern turbines are subdivided into high-pressure and low-pressure turbines, and the low-pressure turbines are again placed on the outer shafts. By-pass valves are provided whereby high-pressure steam may be supplied to the other turbines, should at any time excess steam warrant this procedure. Thrust blocks of the ordinary pattern are provided. The turbines exhaust into pear-shaped condensers, and Weir's dual air pumps are installed. The turbine controls are all worked from a special control station (Fig. 3) placed above the engine rooms, and all the main valves are hydraulically operated and electrically controlled. The boiler installation consists of 48 water-tube boilers of the Yarrow-Normand type, which are fitted with oil burners working on the White low-pressure system. The boilers, accommodated in four boiler rooms, are designed for a working pressure of 250 lb. per sq. in. The combined heating surface is over 219,000 sq. ft., and the total grate area exceeds 4000 sq. ft. The boilers are fitted throughout with Mumford's patent automatic feed controls. Aft of the main engine room is an outer engine room, containing 5 A.E.G. turbo-generating sets, each having an output of 280 kw. A large central switchboard is provided, from which the lighting and power requirements of the ship may be controlled. Current is supplied to over 15,000 electric lamps, in addition to various motors. On E deck there is a special 70-kw. emergency dynamo, driven by an A.E.G. two-stroke cycle opposed-piston type engine of the Diesel type, with two vertical cylinders, which, along with its generator, is completely enclosed. The emergency set supplies current for the lighting and wireless installations, and also provides power for the six 20-hp. motors which operate the Welin boat-handling gear.

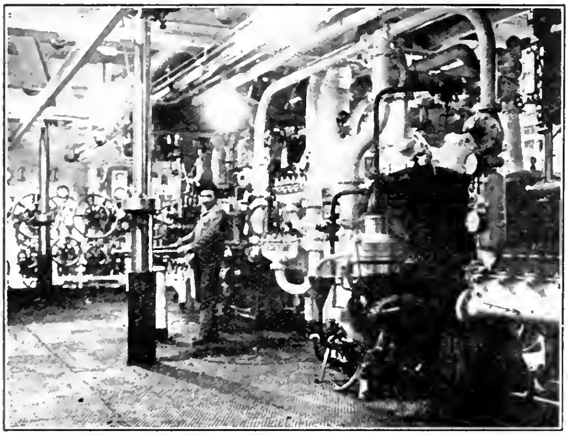
International

FIG. 2 ONE OF THE SPARE PROPELLERS

The system of telegraphs and telephones installed throughout the ship is very complete. Among the former may be mentioned the engine telegraphs, the starting telegraphs and rudder telltale, also the docking and anchor telegraphs, the boiler-room telegraphs and the distant revolution telegraph. A loud-speaking telephone system is installed for operating the ship and for communication

between the engine and boiler rooms, and this system is so arranged that any boiler room can speak to any other boiler room or to the engine rooms and the engineers' department. Communication between the look-out man in the crow's nest and the bridge is established by a loud-speaking telephone in addition to the ordinary telephone. The ordinary telephone system for executive and departmental use has its own central exchange, which may be connected to shore when the vessel is berthed.

There are three wireless stations, and the largest is capable of maintaining permanent connection with both continents during the whole of the voyage. A smaller station is used for communication over a distance of 800 miles, and a subsidiary one is reserved for use in case of an emergency. In addition to the usual signalling arrangements, special provision has been made to guarantee as far as possible the safe navigation of the vessel in fog. Submarine signalling gear has been installed, and the Willett Bruce electric fog bell and whistle fitted. The fire-alarm system includes some 450 fire alarms, distributed throughout the ship, which automatically indicate to the officer on watch when the temperature in any compartment has been exceeded. This system is centralized on the navigation bridge, and is combined with a smoke-detection device, consisting of lines of tubing through which air may be drawn. Other signals which are shown on the navigating bridge are the water-tight door indicators and the cooling-room door telltales. Electric clocks are fitted throughout the vessel. Every precaution has been taken to reduce as far as humanly possible dangers which might arise in case of fire or collision, and an ample complement of lifeboats is carried, including two motor lifeboats fitted with wireless. All boats are swung out and lowered on the Welin system, which, as previously mentioned, is electrically operated. A somewhat novel fitting is the Fram night lifebuoy, which may be instantly released from the bridge by electrical means. Fram anti-rolling tanks are also fitted in addition to the usual bilge keels. (Description of the *Majestic* taken from *The Engineer*, vol. 133, no. 3463, May 12, 1922, pp. 522–523.)



International

Fig 3 Turbine Control Station

William Gleason, of Rochester, Dead

William Gleason, president and founder of the Gleason Works in Rochester, N. Y., died at his home on May 24, 1922, in his 87th year. He was born in Tipperary County, Ireland, and came to this country at the age of 15. He went to work in the machine shop of Asa R. Swift in Rochester, serving his apprenticeship there and in the shop of I. Angell & Sons. During the Civil War he was a workman in the Colt Armory in Hartford, Conn. In 1865 Mr. Gleason returned to Rochester and formed the nucleus of the Gleason Works. For a few years he was in partnership with John Connell and James S. Graham, but this partnership was dissolved in 1873. It was just at this time that he perfected the first practical bevel-gear planer which revolutionized the bevel-gear-cutting machine industry, and Mr. Gleason went with the Kidd Iron Works as superintendent. Two years later he took over the business.

Expansion of the business necessitated a larger plant in 1896. In 1910 there was a further enlargement, and the business has extended not only all over the United States but to foreign fields as well. Beginning with six employees in a one-room plant, the Gleason Works now covers more than twenty-five acres and employs 800 men. During the War the plant employed 1700 men in making ordnance supplies for the Government, and expanded its production capacity to three times its prewar capacity.

William Gleason piloted his firm through many dangerous business periods. His interest was always primarily with his employees and customers, and oftentimes he lost sight of cost and profit in an endeavor to turn out high-grade tools. He kept his standards high, and it was this integrity which brought him through periods which sometimes wrecked his competitors. At the fiftieth anniversary of the founding of the plant, old employees bore witness to his fairness and honesty.

Up until the latter part of 1920 Mr. Gleason took an active part in the management of the firm. He leaves to carry on his work two sons and Kate Gleason, his daughter, who is one of the three women members of the Society. Mr. Gleason became a member of the A.S.M.E. in 1897. He was a member of the Automobile Club of Rochester and of the Oak Hill Country Club.

Death of Henry M. Howe

Henry Marion Howe, dean of scientists in the domain of iron and steel, died on Sunday, May 14, 1922, at his home in Bedford, N. Y. Dr. Howe was born in Boston, Mass., March 2, 1848, and was the son of Dr. Samuel G. and Julia Ward Howe, both of whom were prominent in public activities. He received his A.B. from Harvard in 1869, his B.S. from the Massachusetts Institute of Technology in 1871 and his A.M. from Harvard in 1872. He received a number of honorary degrees, including an LL.D. from Harvard.

With the exception of approximately five years devoted to the metallurgy of copper, Dr. Howe's entire professional life was given up to the development of the iron and steel industry. He had an extraordinary facility in writing, and a power and tact in presiding over public meetings. Combined with an unusual keenness of observation and a devotion to the search for truth, he possessed the faculties which enabled him not only to make discoveries of his own, but to correlate and interpret the investigations of others and to clothe his data in a language so concise and simple that the ordinary mind could comprehend. The results of his labors are accessible to all in a number of books, several of which have been translated into French and Russian, and in many articles in encyclopedias and technical journals. His works give him the rank of the world's greatest authority on the metallurgy of steel.

Dr. Howe was famous as an expert in litigation on iron and steel. At the time of his death he was professor emeritus at Columbia University, where he had been professor of metallurgy from 1897 to 1913. During the World War and for some years subsequently, he served as Chairman of the Engineering Division of the National Research Council. He was a Past-President of the American Institute of Mining and Metallurgical Engineers, the American Society for Testing Materials, the International Association for Testing Materials, the Jury of Awards, Mining and Metallurgy, Chicago Exposition, etc.

In January of 1917 Dr. Howe was awarded the John Fritz Medal for his "investigations in metallurgy, especially in the metallography of iron and steel." Dr. Howe was the thirteenth to receive this signal honor since its first award in 1902 to John Fritz. The Medal is awarded for notable scientific or industrial achievement by a Board of Sixteen appointed in equal numbers from the members of the four national societies; American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

Honors had been conferred upon him by scientific societies not only of our own country but of many of the steel-producing nations of the world. He was an honorary member of the American Iron and Steel Institute and had received the Bessemer Medal of the Iron and Steel Institute of Great Britain.

Engineering and Industrial Standardization

Standards in the Making

Gears. Reprints of the five standards published in the May issue of MECHANICAL ENGINEERING were presented to the American Gear Manufacturers' Association during its recent meeting in Buffalo. The Society of Automotive Engineers and the American Society for Testing Materials have also distributed copies of these reprints to their interested committees. The Sectional Committee on Gears is now awaiting comments. *Chairman*, B. F. Waterman; *Secretary*, J. P. Kotteamp.

Shafting. With the standards for transmission and machinery shafting diameters and their tolerances out of the way, this Sectional Committee is now turning its attention to key sizes and tolerance and also to the development of a standard method for determining the size of shaft necessary to transmit a given load.

The Sub-Committee which is working on this latter problem has completed the first third of its work which covers the various stress conditions that may be set up in a transmission shaft; the various theories, evolved from time to time, leading to the many formulas found in engineering literature; the application and limitation of the various theories of elastic failure as applied to ductile ferrous material used in shafts. *Chairman*, C. M. Chapman; *Secretary*, C. B. LePage.

Machine-Screw Threads. The Sectional Committee on the Standardization and Unification of Screw Threads is now reviewing the revised report of its Working Committee. An open meeting will be held in the near future at which this report will be passed on finally and the report of the Sub-Committee on Gages and Gaging Methods will be presented for discussion. *Chairman*, L. D. Burlingame; *Secretary*, C. B. LePage.

Ball Bearings. Following the return of Mr. O. R. Wikander from his visit to France and Germany where he conferred with standards authorities of these countries, and also those of Sweden, a series of meetings of the Sectional Committee was held in New York. At these meetings counter proposals to those made by the Germans and the Swedes were drafted and sent abroad. These proposals concern the standards for the widths and depths of radial bearings.

A Sub-Committee of the Ball and Roller Bearings Division of the Society of Automotive Engineers, one of the sponsor bodies, is at work on the standardization of thrust bearings. It is working on the O. D., I. D. and distance between faces of single- and double-direction flat-face and self-aligning bearings. *Chairman*, W. R. Strickland; *Secretary*, R. S. Burnett.

Pipe Flanges and Fittings. This large Sectional Committee is making excellent progress in the work assigned to it. Sub-Committee No. 3 has completed a set of dimensions for standard malleable cast-iron and non-ferrous screwed fittings from 1/8 inch to 6 inches. This report has passed the Sub-Committee and has been approved by the Sectional Committee. It will therefore appear in an early issue of MECHANICAL ENGINEERING.

Sub-Committee No. 1 is now considering the preliminary draft of its report on the revisions to the 125-lb. and 250-lb. flange standards issued by the Joint Committee in 1914.

Sub-Committee No. 2 has so far confined its activities to collecting information on the work which has already been done throughout the country in the design of flange joints for pressures above 250 lb. *Chairman*, C. P. Bliss; *Secretary*, A. C. Taylor.

Plain Limit Gages for General Engineering Work. The February 1921 issue of MECHANICAL ENGINEERING contained a questionnaire on the subject of Machine Fits which had been prepared by this Sectional Committee. This questionnaire was reprinted and 1000 copies distributed by mail to as many manufacturers and users of plain limit gages. The replies to the twenty-one questions it contained have been carefully studied by a Sub-Committee, which has just completed a 66-page report for the consideration of the Sectional Committee. Copies of this report are now in the hands of the members of the full Committee and a meeting is to be called during June. *Chairman*, E. C. Peck; *Secretary*, H. W. Bearce.

Bolt, Nut and Rivet Proportions. As previously reported this Sectional Committee was organized on March 16. The seven Sub-Committees which were appointed on that day have since been steadily at work securing information on present practice. These Sub-Committees are planning to prepare standards for (1) Large and Small Rivets, (2) Wrench-Head Bolts and Nuts, (3) Slotted Heads, (4) Track Bolts, (5) Carriage Bolts, (6) Special Bolts and Nuts for Agricultural Machinery, and (7) Body Dimensions and Material.

Small Tools and Machine-Tool Elements. The personnel of the Plan and Scope Committee mentioned in this page of the June issue has now been completed and the Committee is at work. Though it has so far issued no official report, it is probable that the first two projects which the Sectional Committee will be asked to undertake are (1) the reduction in the number of sizes of all the various kinds of machine tools and (2) the standardization of the tee (T) slots employed in these types of machines. The first of these will be accomplished most likely by the adoption of the "Preferred Number" method of determining standard sizes, while the second will of necessity be a compromise between the many sizes and proportions shown by the large amount of data already collected.

Color Schemes for Systems of Piping. This Sectional Committee has just been organized under the sponsorship of the National Safety Council and The American Society of Mechanical Engineers. A considerable amount of data on this subject has, however, been collected by the Sponsors during the past two years, so that the early issuance of a preliminary report may be expected.

Roller Transmission Chains. A series of four closely related standards has thus far been developed by this Joint Committee and published by the S.A.E. and the A.S.M.E. These standards cover (*a*) Roller Chain Dimensions including a System of Numbering, (*b*) Sprockets and their Tooth Form, (*c*) Minimum Breaking Strength for Standard Chains, and (*d*) Standard Nomenclature for Roller Chain-Components.

In connection with the work on the Roller-Chain Sprocket Cutters a slight change in the sprocket-tooth form has been suggested by a member of the Committee which, if adopted, will greatly simplify the present method of laying out the sprocket teeth. As a result of this suggestion the Committee is reconsidering its previous report.

The Sub-Committee which is making a preliminary study of the three remaining subjects, i.e., (*e*) Maximum Working Loads for Standard Chains, (*f*) Maximum Revolutions per minute for Sprockets and (*g*) Maximum Chain Velocities for Different Number of Teeth, states through its Chairman, Mr. G. M. Bartlett, that more research work at the plants of the manufacturers will be necessary before his Sub-Committee can submit a report to the Joint Committee.

Two Standard Specifications before the A.E.S.C. for Approval

Raw and Boiled Linseed Oil. Specifications for Purity of Raw Linseed Oil from North American Seed (D1–15) and for Purity of Boiled Linseed Oil from North American Seed (D11–15) were prepared by American Society for Testing Materials Committee D-1 on Preservative Coatings for Structural Materials. The development of these specifications was begun in 1908. Samples of linseed oil of known purity were obtained and specifications for analysis prepared; portions of these samples were distributed among competent chemists and the results of their examinations reported. Based upon these results, the specifications prepared were submitted to all the manufacturers of linseed oil in the United States with the request that the manufacturers comment upon their acceptability. The consensus of opinion was that work should be done on the examination of linseed oil from different crops of seed before adopting specifications. Additional work was carried on in the several years following, and in 1915 the revised specifications were adopted. Both standards have stood without revision since their adoption, although the committee is continuing to work to improve the specifications by additional methods of test.

Laboratory Methods of Sampling and Analysis of Coke. These methods were formulated by Committee D-6 of the American Society for Testing Materials in coöperation with the American

Chemical Society, the American Foundrymen's Association and the U. S. Bureau of Mines. The specifications are such that methods of coke analysis conform in as far as practicable, with methods of coal analysis, making due allowance for the difference in procedure desirable in the analysis for coke.

These two process standards are submitted by the American Society for Testing Materials to the American Engineering Standards Committee in accordance with the special procedure of the Committee, under which important standards in existence prior to 1920 may be approved without going through the regular process followed in new work.

The A.E.S.C. would be very glad to learn from those interested of the extent to which they make use of these specifications and to receive any other information regarding the specifications in meeting the needs of the industry.

Progress of Standardization in Belgium

Great strides toward standardization, particularly in the construction, metals, mining, and electrical industries of Belgium, are indicated in a report from the Association Belge de Standardization which has just been received by the American Engineering Standards Committee.

The report shows that the following standards have been approved for issue in Belgium: Rules for the Construction of Steel Roof Trusses, Rules for the Construction of Steel Tanks, Rules for the Construction of Galvanized Corrugated Roofs and Partitions, Standardization of Steel Bridges, Tentative List of Equal Angles, Standardization of Shafts and Pulleys, Standardization of Bolts and Rivets, Standard Requirements for Electrical Machinery, Electrotechnical Vocabulary.

These standards, with the exception of the Tentative List of Equal Angles, have been printed and copies are now available through the American Engineering Standards Committee. The Tentative List of Equal Angles is up for printing.

The report shows also that the following proposed standards have been published in the press of Belgium for criticism: Rules for the Design and Inspection of Reinforced-Concrete Structures, Chains (Dimensions of links; material; reception tests), Wire Cables for Cranes, Hoists, Elevators and Mining Purposes.

The Draft Specification for Methods of Analysis for Zinc Ores, Spelter, etc. is under consideration. It is also shown in the report that work on the following proposed standards is in the hands of Technical Committee: Cast-Iron Pipes and Fittings for Water Works, Rules for the Design of Shafting, Standardization of Tolerances, Dimensions of Paper, Drawing, etc.

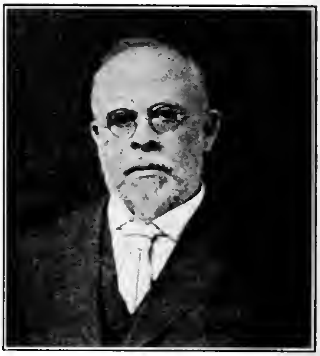
On the subject of Flanges for Steel Tubes and on Chains (Dimensions of rings and hooks) decisions have been made to undertake standardization.

Copies of pending standards will also be available through the American Engineering Standards Committee, 29 West 39th St., New York, as soon as published.

The Specifications and Tests for Portland Cement, for which the American Society for Testing Materials is sponsor, have been advanced to the full status of "American Standard" by the American Engineering Standards Committee. These specifications, which have been developed as a result of the experience of the industry through several years, were first approved by the A.E.S.C. as Tentative American Standard in 1919. They were reapproved in 1921 after agreements had been reached which eliminated slight differences between the Government and the commercial specifications, resulting in nationally recognized uniform specifications.

There are seven forms of nailed wooden boxes so universally used that they may be called the standard styles of nailed boxes. These boxes can be adapted to a wide range of uses, and it is the experience of the Forest Products Laboratory, Madison, Wis., that in meeting the majority of packing problems they are the most efficient of the nailed boxes. The advantages and disadvantages of each style, as revealed in laboratory tests and observations of boxes in commercial service, are given in a pamphlet recently issued by the Laboratory under the designation, Technical Note No. 164.

A. W. Gibbs, Chief Mechanical Engineer of the Pennsylvania System, Dies



Alfred Wolcott Gibbs

Alfred Wolcott Gibbs, chief mechanical engineer of the Pennsylvania Railroad System, died on May 19, 1922. Mr. Gibbs was born at Fort Filmore, N. M., on October 27, 1856. He received his preparatory schooling at Rutgers College Grammar School and then studied for two years in Rutgers College, when he entered Stevens Institute of Technology, being graduated in 1878.

In March, 1879 Mr. Gibbs entered the service of the Pennsylvania Railroad Co. as a special apprentice at the Altoona Shops, continuing such service until June 1, 1881, when he became draftsman with the Richmond and Danville Railway. In 1886 he was appointed master mechanic of the Atlantic and Charlotte Division of that line and two years later became superintendent of motive power of the Central of Georgia Railway. When that position was abolished he was again appointed master mechanic on the Atlantic and Charlotte Division.

In 1893 Mr. Gibbs reëntered the service of the Pennsylvania Railroad Co. as assistant mechanical engineer and nine years later was advanced to the position of superintendent of motive power of the Philadelphia, Wilmington & Baltimore Railroad Co. On January 1, 1913, Mr. Gibbs was appointed general superintendent of motive power of the Pennsylvania Railroad Co. In 1911 he assumed the duties of the newly created position of chief mechanical engineer of that line and under the reorganization in 1920 became chief mechanical engineer of the Pennsylvania System.

Mr. Gibbs became a member of The American Society of Mechanical Engineers in 1920. He was also a member of the Mechanical Division of the American Railway Association, of the American Engineering Standards Committee, the American Railway Engineering Association, the American Society of Naval Engineers, of the Board of Managers of the Franklin Institute, of the Board of Managers of the Philadelphia Institute and Free Library and Past-President of the American Society for Testing Materials.

Arthur J. Wood Appointed to Succeed Professor Fessenden at Pennsylvania State College

Arthur J. Wood, professor of railway mechanical engineering at Pennsylvania State College, has been appointed head of the department of mechanical engineering to succeed Professor E. A. Fessenden. Professor Fessenden goes to Rensselaer Polytechnic Institute in the fall.

Professor Wood was graduated in 1896 from Stevens Institute of Technology. He was associate editor of the *Railroad Gazette*, and preceding his appointment to the State College faculty he was an instructor in mechanical engineering at Worcester Polytechnic Institute and professor of mechanical and electrical engineering at Delaware College. He went to Pennsylvania State College as assistent Professor of Experimental Engineering in 1904 and was made associate professor of railway mechanical engineering in 1909.

Recently he has been in direct charge of the Engineering Experiment Station at State College, where he became greatly interested in problems of heat transmission. He has derived a method for testing insulation and in coöperation with a number of other experiment stations has carried on extensive insulation tests. He has developed the course in railway mechanical engineering and has written a textbook on locomotive operation. He is the chairman of the Central Pennsylvania Section of The American Society of Mechanical Engineers. He has been a member of The American Society of Mechanical Engineers since 1907.

NEWS OF OTHER SOCIETIES

American Water Works Association

In a convention notable for close adherence to program, the American Water Works Association met in Philadelphia at the Bellevue-Stratford Hotel the week of May 15, 1922. Fifty papers and committee reports, not including the topical discussions on Superintendent's Day, were presented. With the exception of Wednesday afternoon, which was the occasion of a boat ride on the Delaware, the entire time of the convention was devoted to papers and discussions.

In his presidential address, Dr. Edward Bartow stressed the duties of the water-works superintendent, particularly his relations with the public. Leonard Metcalf, member of the A.S.M.E., presented a valuable paper on the Improved Financial Condition of Water Works. Filtration, chlorination, tastes and odors, the effects of waste matters, and water softening were a few of the topics touched upon in other papers. Eight sub-committee reports on the work of the Council on Standardization were among the most valuable features of the week. The meetings of the Chemical and Biological Section were crowded throughout, and Superintendents' Day was an unusually successful undertaking.

Robert Morse, chairman of the Publication Committee, gave in his report a classification of the membership in groups such as executives, superintendents, engineers, chemists, etc. Of the entire membership, 43 per cent were classified as engineers.

An unusually attractive display of the Water-Works Manufacturers' Association featured the convention. It was voted to hold the meeting next year in Detroit. There was no opposition to the report of the Nominating Committee and the following officers were elected: President, W. S. Cramer; Vice-President, George W. Fuller; Treasurer, W. W. Brush; and Trustees, George W. Batchelder and J. W. Ellms.

National Electric Light Association

The forty-fifth convention of the National Electric Light Association, held in Atlantic City May 15–17, brought together delegates and guests from every corner of the United States to attend sessions that marked exceptional progress in the industry. The Association is undoubtedly in more intimate contact with its problems than ever before, and the convention this year points to continued solid progress. The industry is unanimously back of the better business movement and "Electrify America" is a slogan fast becoming a fact.

One of the high spots of the week was the dramatic demonstration by the American Telephone & Telegraph Company which made possible a half-hour of simultaneous meeting with the Pacific Coast association. The place of honor on the crowded program was given for the first time in the history of the organization to a symposium on business development, presented by Henry L. Doherty, Guy E. Tripp, W. E. Robertson, W. W. Freeman, Farquson Johnson and H. A. Lane.

It was necessary to hold a number of parallel sessions during the week. In addition to the general sessions there were technical, commercial, accountants, and public-relations sessions.

The feature of the meeting of most importance to mechanical engineers was the presentation of the Prime Movers Report which had been prepared under the direction of H P. Liversidge, Chairman of the Committee on Prime Movers. This document comprises 340 pages and provides much valuable information showing progress in central-station development. Due to the delay in printing the report, the discussion was limited to a record it included which showed idle time of a number of large generating units.

O. F. Jungren of the General Electric Company and F. Hodgkinson of the Western Electric and Manufacturing Company discussed the respective merits of single- and double-drum turbines. I. E. Moultrop, of the Edison Electric Illuminating Company, stated his opinion that turbine reliability was of much greater importance than efficiency.

John Anderson of the Milwaukee Electric Railway and Light Company presented some of the facts regarding the installation of pulverized fuel in the Lakeside Plant, which, after fourteen months of operation, has generated 200,000,000 kw-hr. without interruption due to prime mover or generating equipment. This station was designed for a thermal efficiency of 19.2 per cent and a boiler and economizer efficiency of 88 per cent. Mr. Anderson was confident that these efficiencies could be obtained under normal operating conditions with the complete installation. Nevertheless, using coal averaging from 9000 to 13,500 B.t.u. per lb. and with a night load only 30 per cent of the day load, an average station water rate of 12.7 lb. per kw-hr. has been obtained. Boiler efficiencies during steaming period have varied from 84.2 to 85.9 during the past six months. The overall boiler-room efficiency varied from 83.2 to 84.18 during the same period, and 19,097 B.t.u. per kw-hr. (net) or a thermal efficiency of 17.88 has been achieved. Mr. Anderson stated that preheating the air to the furnace will not entirely eliminate feeding trouble, and that coal to feed regularly must have less than 8 per cent moisture. To remove ash in the smoke a washer was installed in the underground breeching in a ten-day test. This washer, which consists of a curtain of water, caught 70 per cent of the ash.

At the concluding general and executive session the following officers were elected: President, Frank W. Smith; vice-presidents, Walter H. Johnson, Franklin T. Griffith, J. E. Davidson and R. F. Pack; Treasurer, Walter Neumuller.

American Boiler Manufacturers' Association

The thirty-fourth Annual Convention of the American Boiler Manufacturers' Association was held at Shawnee-on-Delaware, Pa., June 5, 6 and 7. President A. G. Pratt of the Babcock & Wilcox Co. opened the meeting with an address dealing with the attitude of the Federal administration toward the trade association and favoring coöperation along methods outlined at the conference of trade associations called by Secretary Hoover.

Dr. M. W. Alexander, managing director of the National Industrial Conference Board, described the methods and purposes of the Board and showed some of the results of its analyses and studies on the labor supply, the rise and fall of wages as compared with the cost of living, etc.

In the evening E. C. Fisher of the Wickes Boiler Co. presented a paper on A Study of Thickness of Shell Plates in Return-Tubular Boilers and R. Sanford Riley, president of the Sanford Riley Stoker Co., exhibited films of a stoker fire in operation.

On Tuesday morning E. R. Fish, who represents the Association on the Boiler Code Committee of the A.S.M.E., told of the work of that Committee, and Chas. E. Gorton, chairman of the Uniform Boiler Law Society, reported the progress of boiler legislation in several states. J. F. Scott, chairman, and C. O. Myers, secretary-treasurer of the National Board of Boiler and Pressure-Vessel Inspectors, gave reports on the progress of that organization. Reports were also presented by the Conference Committee with the Stoker Manufacturers' Association, the Committee on Ethics and the Committee Appointed to Investigate the Proper Setting Heights of Hand-Fired Return-Tubular Boilers.

The last named Committee recommended that a committee be named to confer with a similar committee to be appointed by the Affiliated Smoke Prevention Bureaus, meeting in Cleveland in the near future, with the view of taking coöperative action to standardize setting heights in the various districts that would meet with the approval of the boiler manufacturers and the legal authorities having the matter in charge.

On Wednesday morning the meeting was addressed by Charles Aubrey Eaton of the American Educational Association on the broad effects of education on citizenship and political, industrial and social relations, the satisfactory adjustment of which depends upon the creation of right thinking and intelligence rather than the accumulation of undigested knowledge.

C. S. Blake, president of the Hartford Steam Boiler Inspection and Insurance Co. and chairman of the sub-committee of the A.S.M.E. Boiler Code Committee, presented for discussion and advisement the tentative code on Inspection of Steam Boilers now being formulated.

The Buckwood Inn at which the convention was held afforded unusual opportunities for entertainment between sessions, not the least of these being the nationally known golf course on which several tournaments were held. At the banquet on Tuesday evening C. V. Kellogg acted as toastmaster.

LIBRARY NOTES AND BOOK REVIEWS

A Dictionary of Applied Physics

A Dictionary of Applied Physics. Edited by Sir Richard Glazebrook. Vol. 1. Macmillan and Co., Ltd., London, 1922. Cloth, 6×9 in., 1067 pp., illus., diagrams, $15.

During the past twenty-five years the applications of physics to industry have grown enormously. Governments, universities and manufacturers have undertaken research upon a large scale and a vast amount of information of practical usefulness has accumulated.

The development of the science has paralleled that in the sister science, chemistry, with one important difference. While the chemist has from time to time published cyclopedias and dictionaries from which he could quickly ascertain the salient facts concerning any subject, the results of the labors of physicists have remained scattered in the proceedings of learned societies or stored in the brains of the workers themselves. The engineer or manufacturer interested in getting the latest and most accurate information upon the subject with which he was concerned, faced a long search in libraries and a tedious inquiry for experts.

The Dictionary of Applied Physics is the first serious attempt to remedy this condition. It will appear in five volumes of 800 to 1000 pages, and will contain modern information on the wide range of subjects included within its title. The editorial direction has been placed in the competent hands of Sir Richard Glazebrook, and the assistance of the most competent physicists of Great Britain has been obtained.

In order that it may not be necessary for the individual to purchase all the volumes, the work is arranged so that all of any subject is contained in a single volume. Within each volume, the arrangement is alphabetical. The first volume covers Mechanics, Engineering and Heat, and is of particular interest, therefore, to mechanical engineers.

The following list of the contributors and subjects of the important articles indicates the scope and authoritativeness of the first volume: George S. Baker, Ship Resistance and Propulsion; Reginald A. Batson, Determination of Elastic Constants and the Testing of Materials of Construction; Dr. G. T. Bennett, Gyroscope; Charles H. Beeleid, Kinematics of Machinery; Andrew Cruickshank, Reciprocating Steam Engine; William E. Dalby, Balancing of Engines and Prime Movers; Robert Dawson, Development of the Steam Turbine; Aubrey T. Evans, Water-Cooled Petrol Engine; Dr. Angus R. Fulton, Hydraulics; James H. Hyde, Dynamometers, and Mechanical Powers; Dr. Horace Lamb, Fourier's Series, Simple Harmonic Motion, Stream-Line Motion, and the Mathematical Theory of Conduction of Heat; J. W. Landon, Strength of Structures; Dr. Hyman Levy, Principles of Dynamical Similarity; Research Staff of the General Electric Company, Air Pumps; R. V. Southwell, Theory of Elasticity; Dr. T. E. Stanton, Friction; W. J. A. Butterfield, Fuel Calorimetry; Sir Dugald Clerk, Thermodynamics of Internal-Combustion Engines, and Some Typical Internal-Combustion Engines; Dr. Arthur L. Day, Realization of the Absolute Scale of Temperature; Sir J. A. Ewing, Liquefaction of Gases, Refrigeration, Theory of the Steam Engine, and Thermodynamics; Dr. Ernest H. Griffiths, Mechanical Equivalent of Heat; Dr. Ezer Griffiths, Bomb Calorimeters, Calorimetry; Latent Heat Pyrometry, Resistance Thermometers, and Thermocouples; William B. Hardy, Boundary Conditions in Lubrication; Dr. John L. Haughton, Thermostats; William F. Higgins, Flash-Point Determination, Thermometry, and Viscometry; Alfred W. Porter, Thermal Expansion; David R. Pye, Specific Heat of Gases; F. H. Schofield, Conduction of Heat, and Convection of Heat.

Bibliographies are frequently given and an index to authorities cited is added to the volume. The articles are sufficiently long to be satisfactory summaries of present knowledge. The work, judging by the first volume, will be an invaluable work of reference to every one who is interested in the field of engineering research.

Harrison W. Craver.

Metal Cutting Tools

Metal Cutting Tools. By A. L. DeLeeuw. First edition. McGraw-Hill Book Co., New York, 1922. Cloth, 6×9¼ in., 328 pp., 306 figs., price $3.50.

Mr. DeLeeuw's book as compared, for example, with the classical work of Fred W. Taylor on The Art of Cutting Metals, belongs to a distinctly new era.

Some 25 years ago tools were primarily built for general purpose work. There were a few specialized shops using quantity production on what was supposed to be single-purpose tools, such as sewing machines and typewriters, but the number of these shops was very small and the tools which they employed were really crude adaptations of standard tools to the particular tasks performed.

In the last quarter of a century, primarily under the leadership of the automobile industry, a profound change has taken place. Single-purpose tools, sometimes of considerable size and not unusually of quite complicated construction, have been developed to supply the millions of parts on repetition work that modern standardized industry demands.

When a tool has to perform one function or one set of functions day in and day out, possibly in a number of plants, it becomes worth while to devote a good deal of attention and research to the particular performance of that tool, because even a slight saving in the cost of production per part made, would amply repay for the time and labor spent. We see therefore the appearance of extensive and highly organized investigations on the performance of various machine tools, of which a good example may be seen in the recent paper by Professor Coker before the Institution of Mechanical Engineers.

The book on Metal Cutting Tools by A. L. DeLeeuw represents an interesting attempt to give a synopsis of our knowledge of the facts underlying the performance of the various classes of tools and to discuss various tools in the light of these underlying facts. From this point of view Chapter 1 is perhaps of the greatest interest, as it explains the fundamental conditions affecting the action of a cutting tool and thus provides the basis for understanding the general principles of design of metal-cutting tools.

The book covers the various types of planer tools, boring tools, milling cutters, form and shear tools, generating tools, thread-cutting tools and hollow mills. In discussing every one of these types of tools the author starts with an analysis of the conditions underlying operation and from that builds up first the ideal conception of what a tool of that particular class should be, proceeding from this to a description, and at times criticism, of the particular tools now available.

The book is written in remarkably simple language and (which is by no means as usual as it should be) is not encumbered by unnecessary mathematics and antiquated tables of experimental data.

L. Cammen.

Book Notes

Annals of the American Academy of Political and Social Science. May, 1922. Paper, 6×9 in., 315 pp., $1.

The American Academy of Political and Social Science has done a great service to all the professions by bringing together for the first time in one collection the concepts of what constitutes the attainment of the ideals of a profession, in distinction from those of a vocation. As respects the Engineering Societies, the authors representing the leading societies have, by long contact in their respective organizations, not only themselves advanced the high ideals of their professions but have contributed personally, both in conference and in committee, to the adoption of those principles which they describe in their several articles. Every engineer wishing to stand for the advancement of his profession should read this entire issue of The Annals.

Cours de Mecanique Appliquee. By Marcel Lamotte. Gauthier-Villars et Cie, Paris, 1922. Paper, 6×10 in., 282 pp., diagrams, 25 fr.

Professor Lamotte feels that most textbooks of applied mechanics require more extensive knowledge than the usual student possesses and are unnecessarily difficult He has prepared this book, not to replace the more elaborate treatises on the subject, but to prepare the student for them, so that he may derive the most profit from their perusal. This is accomplished by presenting, in the simplest form possible, some of the questions that affect the applications of mechanics. He is less concerned in establishing general theories than in showing, by examples, how practical problems may be solved.

Cyaniding Gold and Silver Ores. By H. Forbes Julian and Edgar Smart. Third edition, revised and enlarged J. B. Lippincott Co., Philadelphia, 1921 Cloth, 6×9 in., 417 pp., diagrams, tables, $12.50

The second edition of this well-known treatise appeared in 1907. Work upon the present edition began in 1914, was interrupted by the death of Mr. Smart and by the Great War, but was finally completed by A. W. Allen. Much new material dealing with recent modifications in the theory and operation has been added and the chapters have been rearranged to secure greater uniformity. The principal additions are in connection with colloidity and absorption; the theory of gold precipitation on charcoal; milling in cyanide solution, flotation and cyanidation; zinc-box practice; deoxidizing solutions, counter-current decantation; aluminium, sodium sulfide and charcoal precipitation; agitation, slime-settlement and filtration equipment.

Fuel and Refractory Materials. By A. Humboldt Sexton. New edition, revised by W. B. Davidson. D. Van Nostrand Co., New York, 1921. Cloth, 6×9 in., 382 pp., illus., diagrams, tables, $4.

No important alterations have been made in the original text of this well-known work, but minor corrections have been made throughout. The chapters on liquid and gaseous fuels have been modified and enlarged, and the chapter on by-products has been rewritten. The chapters on fuel testing and refractories have been modernized and enlarged. The book discusses the important industrial fuels, metallurgical furnaces, pyrometry, calorimetry, fuel testing and the refractory materials used for furnaces and crucibles.

Lapping and Polishing. By Edward K. Hammond. First edition. Industrial Press, New York, 1921. (*Machinery's* blue books.) Paper, 6×8 in., 60 pp., illus., $0.50.

This pamphlet reviews modern practice in lapping operations, in the light of the improvements developed during recent years, and also gives an account of current methods for polishing tools and parts.

Manual of Flotation Processes. By Arthur F. Taggart. John Wiley & Sons, Inc., New York, 1921. Cloth, 6×9 in., 181 pp., diagrams, $3.

Widespread understanding of the physical principles underlying flotation phenomena and of the diversity of flotation processes has been delayed, partly by the apparent complexity of the phenomena and the difficulties of investigation, in part by the attitude of corporations owning patents on flotation processes. It is the purpose of this book, in part, to counteract the further spread of false conceptions, by setting forth some of the facts that contradict them, in part to describe apparatus and methods of testing which will aid investigators in their researches; and finally to give some generalizations from mill practice, by means of which the investigator may translate laboratory results into commercial operations.

Manufacture of Pulp and Paper. Vol. 3. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., illus., diagrams, $5.

This is the third volume of the course of instruction in pulp and paper manufacture prepared by the pulp and paper industry of North America for those actively engaged in the industry. Previous volumes have been devoted to the elementary scientific knowledge—physical, chemical and mathematical—needed by the paper maker; the present volume takes up the actual manufacturing processes. It is, the editor announces, the first work in English dealing solely and comprehensively with wood-pulp manufacture. The various sections have been prepared by specialists. They describe the properties of pulpwood, its preparation, the manufacture of mechanical, sulphite, soda and sulphate pulps, and the treatment, refining, testing and bleaching of pulp.

Metric System for Engineers. By Charles B. Clapham. Dutton & Co., New York, 1922. (Directly useful technical series.) Cloth, 6×9 in., 181 pp., $6.

This book is not concerned with the controversy regarding the metric system. Its object is to give a full, practical explanation of the system as it is met in engineering calculation and measurement, for use by draftsmen, mechanics and engineers. After an introduction explaining basic principles, the simple measures of length, area, volume, capacity and weight are discussed, with special attention to the usual measuring tools found in workshops and drafting rooms. Compound measures used in engineering are then described, with the derivation of the corresponding British equivalents. Succeeding chapters give tables of the commoner engineering constants in British and metric units, and examples of the alteration of numerical constants in formulas when metric values are to be used.

Motor Truck Transportation. By F. Van Z. Lane. D. Van Nostrand Co., New York, 1921. Cloth, 6×9 in., 153 pp., illus., $2.

A practical presentation of the principles of truck-operating cost; operating efficiency and cost records; operating cost laws; truck details, such as bodies, loading and unloading devices, trailers and semi-trailers, and tires; and the factors that determine the fields of economical operation. Gives no attention to design or manufacture.

Physique Elementaire et Theories Modernes. By J. Villey. Part 1. Molecules and atoms. Gauthier-Villars & Co., Paris, 1921. Paper, 6×10 in., 197 pp., 15 francs.

The author has prepared a work, less scholastic than usual textbooks and more suited for reading, in which the essential phenomena of physics are set forth and explained by the most modern theories. Attention is especially directed to those phenomena which have received industrial application. The work is intended for the general public desirous of information about the fundamentals of physics and modern theories, as well as for use as a text book.

Protective Relays. By Victor H. Todd. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×8 in., 274 pp., illus., diagrams, $2.50.

This book attempts to cover the subject from first principles to the protection of high-tension networks, in a manner suited to the needs of operators and testers with a fair knowledge of electricity, and also of designers.

Sewerage and Sewage Disposal. By Leonard Metcalf and H. P. Eddy. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 598 pp., illus., diagrams, $5.

This work is practically a one-volume abridgment of the three-volume treatise American Sewerage Practice published by these authors in 1914–1915. It is intended for class use in engineering schools, but reflects the viewpoint of the engineer, not the teacher, and presents the information that its authors believe young students should acquire before taking up work in the field of sewerage engineering.

Short Course in the Testing of Electrical Machinery. By J. H. Morecroft and F. W. Hehre. Fourth edition, revised and enlarged. Van Nostrand Co., New York, 1921. Cloth, 6×9 in., 220 pp., diagrams, $3.

All students of engineering at Columbia University are required to take courses in testing direct and alternating-current machinery. These notes are prepared to meet the needs of students in mining, mechanical and civil engineering, who have not studied the theory of electrical machinery, and hence need a brief summary of it as preparation for the laboratory work. Besides giving specific directions for the tests, a brief analysis of the characteristics of the machines is given. The new edition includes new material on batteries, illumination, measurement of electrical energy and other subjects of interest to engineers generally.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACETYLENE

High-Pressure Apparatus. High-Pressure Acetylene Apparatus (Hochdruck-Acetylenapparat), K. Matzinger. Autogene Metallbearbeitung, vol. 15, no. 6, Mar. 15, 1922, pp. 80–82, 4 figs Describes apparatus used for Schoop's metal-spraying process built by Continental Light & Apparatus Construction Co. in Zurich-Dübendorf.

AERIAL PHOTOGRAPHY

Cameras. Practical Uses of Aerial Photography. Aviation, vol. 12, no. 15, Apr. 10, 1922, pp. 424–426, 5 figs. Describes Fairchild camera used for producing aerial map of New York City.

AERONAUTICAL INSTRUMENTS

Air-Speed Recorder. Manometer For Recording Air Speed, C. Wieselberger. Aerial Age, vol. 15, no. 6, Apr. 17, 1922, pp. 131–132, 3 figs. Describes instrument made at Göttingen aerodynamic laboratory, answering following conditions: (1) Must respond quickly so that all speed variations will be correctly recorded. (2) Must not be affected by rectilinear or curvilinear accelerations. Hence, movable parts must be counterbalanced. Translated from Zeit. für Flugtechnik u. Motorluftschiffahrt.

Electrical. Electrical Instrument Equipment for Aircraft, Edgar A. Griffiths. Beama, vol. 10, no. 4, Apr. 1922, pp. 299–307, 16 figs. Characteristics of engine revolution indicator, oil pressure transmitter, thermometric instruments, rate of climb meter, gyroscopic devices, and transmitting compass.

AERONAUTICS

Seaplane Coefficients. Full Scale Seaplane Coefficients, Max M. Munk. Aviation, vol. 12, no. 17, Apr. 24, 1922, pp. 482–483, 1 fig. Lift and drag coefficients of Brandenburg seaplane determined in free-flight tests.

AIRCRAFT

Research. The Progress of Research, R. K. Bagnall-Wild. Aerial Age, vol. 15, nos. 4 and 5, Apr. 3 and 10, 1922, pp. 78–79 and 103–104. Aero engine research; navigation; machines; materials. See also Flight, vol. 14, no. 8, Feb. 23, 1922, pp. 122–124.

AIRCRAFT CONSTRUCTION MATERIALS

Brazing. Investigation of Dip Brazing with High Melting Point Brass. Air Service Information Circular, vol. 3, no. 297, Feb. 15, 1922. Continuation of investigation recorded in A.S.I.C. vol. 3, no. 203. Determination of best flux and heat treatments for brass of this type.

AIR COMPRESSORS

New Efficient Type. A New Air Compressor. Oil Eng. & Finance, vol. 1, no. 2, Mar. 25, 1922, pp. 378–380, 2 figs. Design by A. H. Sproule which overcomes some of previous losses.

Rotary. The Planche Rotary Compressor (Compresseur rotatif, systeme R. Planche), Lucien Fournier. Génie Civil, vol. 80, no. 12, Mar. 25, 1922, pp. 275–277, 10 figs. Describes rotary air compressor based on principle of conchoidal motion of a disk-piston, and gives results of tests.

AIRPLANE ENGINES

Detonation. The Background of Detonation, Stanwood W. Sparrow. Aerial Age Weekly, vol. 15, no. 9, May 8, 1922, pp. 201–203, 206, 4 figs. Discussion of charge temperatures and pressures before and after combustion.

Installation. Engine Installation, Bagnall-Wild Aeronautical Jl., vol. 26, no. 136, Apr. 1922, pp. 121–129 and (discussion) 130–136, 1 fig. Discusses lack of development. Principal features required for evolution of a sound installation, and how far these aims may be realized in the light of present-day experience.

Large-Bore. An American Development in Large-Bore Aircraft Engines, Herbert Chase. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 852–856, 4 figs. Wright Aeronautical Corp. design for Navy Zeppelin-type ships which develops 400 b.hp. at 400 r.p.m. Accessibility for repair in air one of outstanding features.

Light-Weight. Special Light-Weight Aero Engine A. E. L. Chorlton. Aeronautical Jl., vol. 26, no. 136, Apr. 1922, pp. 137–148, 1 fig. Discusses the more important types of engines and gives principal characteristics in tables.

Starting at Low Temperatures. Starting Aircraft Engines at Low Temperatures. Aviation, vol. 12, no. 18, May 1, 1922, p. 505. Abstract from technical memorandum no. 29, Canadian Air Board, by Prof. Robb at Edmonton, Alberta.

Wright Six-Cylinder. The Wright 6-Cylinder Airship Engine. Aviation, vol. 12, no. 18, May 1, 1922, pp. 504–505, 1 fig. First American high-power airship engine develops 350–400 hp. and has low fuel and oil consumption.

AIRPLANE PROPELLERS

Design. Notes on Propeller Design, Max M. Munk. Aerial Age Weekly, vol. 15, nos. 8 and 10, May 1 and 15, 1922, pp. 178–179 and 225–226. May 1: Energy losses, in particular that of friction between air and blade. May 15: Distribution of thrust over a propeller blade. Tech. Note N.A.C.A.

Theory. The Theory of the Screw Propeller, A. Betz. Aerial Age, vol. 15, no. 5, Apr. 10, 1922, pp. 105–106, 2 figs. Discusses our inadequate geometrical presentation and mathematical treatment of hydrodynamical phenomena connected with propeller and shows possibility of investigating phenomena in vicinity of propeller so as to be able to calculate its action on basis of fewer experimental values. Translated from Die Naturwissenschaften, No. 18, by N.A.C.A.

Variable Pitch. The "Universal Propeller," David L. Bacon. Aerial Age Weekly, vol. 15, no. 7, Apr. 24, 1922, pp. 152–153, 3 figs. Brief description of developments by Spencer Heath. May also be used in helicopters.

AIRPLANES

Commercial. The Commercial Aeroplane, W. H. Sayers. Aeroplane, vol. 22, nos. 5, 6, 8, 10, 11, 12 and 15, Feb. 1, 8, 22, Mar. 8, 15, 22 and Apr. 12, 1922, pp. 83–84, 99–100, 138, 171–172, 191–194, 207–208 and 263–264, 4 figs. Feb. 1: Deficiencies of present type of aircraft, and need for radical improvement in aerodynamic and structural design. Feb. 8: Incentives to stagnation in design. Feb. 22: Arrest of aerodynamic development. Mar. 8: Where research has so far failed. Mar. 15: How airplane can be improved Mar. 22: A possible type of economical airplane.

Flight Phenomena. Mechanical Phenomena of the Airplane in Flight (Mechanische Vorgange beim fliegenden Flugzeug), H. Schuster. Glasers Annalen, vol. 90, nos. 5 and 6, Mar. 1 and 15, 1922, pp 67–71 and 83–89 and (discussion) pp. 89–90, 29 figs. Review of what has been accomplished in fathoming secrets of flight phenomena. Deals with action of air forces on bodies and surfaces, especially effect of air resistance on aerofoil; design and stability of aerofoils; azimuth and altitude steering; high-altitude motors, etc.

Fire Elimination. Eliminating Fires in Airplanes, C. H. Butman. Aviation, vol. 12, no. 18, May 1, 1922, p. 508. Special study of subject by Air Service shows considerable progress made in past year.

Guiding Through Fog. The Loth Guide Cable for Flying in Fog. Aviation, vol. 12, no. 15, Apr. 10, 1922, pp. 422–423, 3 figs. Fundamental principle rests on fact that if high-frequency a.c. current is sent through cable earthed at each end, a magnetic field is created, which can be detected by receivers in airplane. System similar to directing ships in fog.

Handley Page W. 8b. The Handley Page W. 8b. Aeroplane, vol. 22, no. 16, Apr. 19, 1922, pp. 280–281, 12 figs. Description of design to be used on Handley Page service, modification of well-known W. 8.

Suspended Wing for Test. Aeroplane Will Carry Suspended Wing in Test. Aerial Age Weekly, vol. 15, no. 7, Apr. 24, 1922, p. 151. Full size wing to be tested for first time at Langley Field Laboratory of Nat. Advisory Com. for Aeronautics. Inverted and supported from plane by three wires.

Theory of Stability. A Theory and Its Proof, G. A. Spratt. Aviation, vol. 12, no. 18, May 1, 1922, pp. 510–511, 2 figs. Some theoretical considerations in the design of gliding and soaring aircraft, especially low-power sport airplanes.

Wibault Night Bomber. The Wibault Night Bombing Biplane, John Jay Ide. Aviation, vol. 12, no. 18, May 1, 1922, p. 509. French two-seater fitted with 600-hp. Renault engine has useful load to total weight ratio of 52 per cent.

AIRSHIPS

Non-Rigid. Trials of Goodyear Type AC Airship. Aviation, vol. 12, no. 14, Apr. 3, 1922, pp. 395–396. Nonrigid military airship of novel type makes successful trials at Goodyear-Akron air station; Aeromarine 130 hp. U6D engines; volume, 185,000 cu. ft.; speed, 65 m.p.h.; propeller speed, 775 r.p.m.

Rigid. Rigid Airships in the United States Navy, R. G. Pennoyer. U. S. Naval Inst. Proc. vol. 48, no. 4, Apr. 1922, pp. 517–529. Brief historic sketch. Cause of crashing of ZR-2. A German rigid for U. S. Some facts and figures on latest types; performance; value to Navy.

Surface Area. Determination of Surface Area for Airships, Edward P. Warner. Aviation, vol. 12, no. 16, Apr. 17, 1922, pp. 450–451, 1 fig. Discusses use of Lieutenant Diehl's formula.

Testing Models. Hydrostatic Test of an Airship Model. Aerial Age Weekly, vol. 15, no. 7, Apr. 24, 1922, pp. 154–155, 158, 166, 4 figs. Goodyear Rubber Co. model studies with both ballonets empty, forward ballonet filled with air, rear ballonet filled with air, and both ballonets filled with air.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Calite. Calite—A New Heat Resisting Alloy. Automotive Industries, vol. 46, no. 18, May 4, 1922, p. 955. New heat-resisting alloy containing aluminum, nickel and iron which resists oxidization up to 2200 deg. fahr.

Cobalt-Tungsten. Cobalt-Tungsten Alloys (Kobalt-Wolframlegierungen), Karl Kreitz. Metall u. Erz, vol. 19, no. 6, Mar. 22, 1922, pp. 137–140, 1 fig. A diagram of state for cobalt-tungsten alloys is

---

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

plotted and conditions for obtaining a faultless casting are determined.

Electrochemistry. The Electrochemistry of Metal Alloys (Die Elektrochemie der Metallegierungen), R. Kremann. Metall, no. 3, Mar. 10, 1922, pp. 53-55. Effect of precipitation on behavior and composition of alloys.

Nickel. See NICKEL ALLOYS.

Zinc. See ZINC ALLOYS.

ALUMINUM

Plate, Decomposition. Decomposition of Aluminum Plate (Zersetzungserscheinungen an Aluminiumblechen), H. Kropf. Metall-Technik, vol. 48, no. 8-9, Feb. 23, 1922, pp. 68-69. Gives results of investigations carried out by Prof. Heyn and Bauer on three different kinds of aluminum plate showing signs of decomposition.

ALUMINUM ALLOYS

Aluminum-Silicon. Aluminum-Silicon Alloys, Zay Jeffries. Chem. & Met. Eng., vol. 26, no. 16, Apr. 19, 1922, pp. 730-734, 15 figs. Coming into use because of superior casting qualities; history, technical properties, and characteristics.

Alloys of Aluminum with Silicon, H. Sutton. Metal Industry (Lond.), vol. 20, no. 16, Apr. 21, 1922, pp. 365-366, 2 figs. Some investigations of ternary and more complex alloys.

Bronzes. Aluminum Bronze, An Alloy of Strength. William Dent Williams. Raw Material, vol. 5, no. 3, Apr. 1922, pp. 105-109, 15 figs. Discusses an alloy of 90 per cent Cu and 10 per cent Al, its properties, macrographic examination, casting, etc. Taken from Revue de Metallurgie.

Cerium, Influence of. Influence of Cerium on Aluminum and Other Light Metal Alloys, Josef Schulte. Metal Industry (N. Y.), vol. 20, no. 4, Apr. 1922, pp. 142-144, 1 fig. Describes experiments carried out with view to improving melting and soldering of light metals. Translated from Metall und Erz, May 22, 1921.

Failure, Cases of. Some Cases of Failure in "Aluminum" Alloys, W. Rosenhain. Metal Industry (N. Y.), vol. 20, No. 4, Apr. 1922, p. 140, 2 figs. Shows that many of aluminum alloys which fail are not really aluminum alloys. Read before British Inst. Metals.

High Strength. New Aluminum Alloys of High Strength. Chem. & Met. Eng., vol. 26, no. 15, Apr. 12, 1922, pp. 689-694, 5 figs. Digest of eleventh report of Alloys Research Committee of British Instn. Mech. Engrs. Properties of some alloys; permanence and constitution of alloys, age-hardening with magnesium and silicon.

"Y Alloy." Y Alloy (Aluminum-Copper-Nickel-Magnesium). Chem. & Met. Eng., vol. 26, no. 17, Apr. 26, 1922, pp. 785-787, 6 figs. A light aluminum alloy having strength of soft steel and good ductility; easy to cast and roll; retains its desirable properties in gas-engine parts working at 250 deg. cent.; immune from season cracking and corrosion.

AMMONIA

Refrigerating Capacity of. A Pound of Ammonia, John E. Starr. Refrig. World, vol. 57, no. 4, Apr. 1922, pp. 11-12. Method by which amount of refrigeration can be computed directly from weight of ammonia boiled per hour.

AMMONIA COMPRESSORS

Dry and Wet Methods. Operating Ammonia Compressors, W. S. Doan. Refrig. World, vol. 57, no. 4, Apr. 1922, pp. 17-18, 3 figs. Relative merits of two methods of compression.

APPRENTICES, TRAINING OF

New Plan. A Constructive Apprenticeship Movement. Sheet Metal Worker, vol. 13, no. 5, Mar. 31, 1922, pp. 153 and 161. Discusses new plan approved by employer and employee, in operation in New York, and recommended by New York Building Congress.

ASBESTOS

Utilization of Waste. The Utilization of Asbestos Waste. India-Rubber Jl., vol. 63, no. 15, Apr. 15, 1922, pp. 13-14, 1 fig. Difference of asbestos from other organic fiber makes this special problem. Suggestions of various uses for same.

ASH HANDLING

Plants. Ash-Removal Plants for Furnaces (Entaschungsanlagen für Feuerungen), P. Ledar. Wärme, vol. 45, no. 2, Jan. 13, 1922, pp. 31-33, 14 figs. Describes recent German and English patented improvements.

ASPHALT

Trinidad's Pitch Lake. Trinidad's Famous Pitch Lake, Col. H. A. Judd. Petroleum Times, vol. 7, no. 171, Apr. 15, 1922, pp. 501-502, 4 figs. Description giving some idea of its value as a source of supply.

ATOMS

Artificial. Artificial Disintegration of the Elements, Ernest Rutherford. Chem. Soc. Jl., vol. 121-122, no. 713, Mar. 1922, pp. 400-415, 4 figs. Concludes that atoms are such stable structures and nuclei are held together by such powerful forces that only most concentrated source of energy like the α-particle is likely to be effective in an attack.

AUTOGENOUS WELDING

Preheating. Preheating in Autogenous Welding (Über das Vorwärmen bei der autogenen Schweissung), Theo. Kautny. Autogene Metallbearbeitung, vol. 15, no. 3, Feb. 1, 1922, pp. 25-30, 8 figs. Advantages of preheating; describes Acme preheater, built by Lausanne Machine Co.

AUTOMOBILE ENGINES

Assembling. Methods Used in the Assembling of 150 Engines per Day, J. Edward Schipper. Automotive Industries, vol. 46, no. 15, Apr. 13, 1922, pp. 818-821, 11 figs. Describes assembling, inspection and testing operations and equipment employed in fabricating powerplant of Jewett car.

Heavy-Oil. A Heavy-Oil Automobile Engine (Un moteur d'automobile a huile lourde). Nature, no. 2499, Feb. 25, 1922, pp. 115-120, 4 figs. Describes the Peugeot engine which operates on kerosene, mazout or vegetable oils and has smaller fuel consumption in addition.

Heavy-Oil. The Peugeot Heavy-Oil Automobile Engine (Der Peugeot-Automobilmotor für Schwerölbetrieb), Lachmann. Motor U. Auto, vol. 19, no. 6, Mar. 31, 1922, pp. 81-86, 4 figs. Can be operated on 400 to 1600 revolutions; is of hot-bulb type; provided with special atomizer giving a perfect mixture.

Manufacture. Manufacturing Practice on Light Motor-car Power Units. Machy. (Lond.), vol. 19, nos. 493, 494 and 496, Mar. 9, 16 and 30, 1922, pp. 685-688, 723-731 and 781-787, 34 figs. Practice of Hotchkiss et Cie, Coventry, in connection with manufacture of 11.9 hp. light car power units for Morris Motors, Ltd., including tooling arrangements, works organization, arrangement of plant, etc.

Oil-Cooled. British Oil-Cooled Car Engines, M. W. Bourdon. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 849-851, 3 figs. Description of oil-cooled engines developed by G. M. Bradshaw, English airplane engine expert. Claimed to have all advantages of air-cooled engine and none of drawbacks.

Stutz. New Stutz Engine More Powerful; Higher Maximum Car Speed. Motor Age, vol. 41, no. 15, Apr. 13, 1922, pp. 16-17, 5 figs. Better handling of fuel, lighter and shorter pistons, better water circulation.

AUTOMOBILE FUELS

Alcohol and Gasoline Mixtures. Using Mixtures of Alcohol and Gasoline in Engines (Note sur l'utilisation, dans les moteurs, des mélanges d'alcool et d'essence), Nicolardot. Technique Automobile et Aérienne, vol. 12, no. 115, 1921 and vol. 13, no. 116, 1922, pp. 116-124 and 18-21, 9 figs. No. 115: Discusses solubility of alcohol in gasoline and experiments made for French war office. No. 116: Gives curve diagrams for solubility limits of alcohol, gasoline, benzol, and explains their application.

Detonation. Detonation—A Consideration of Its Causes, Stanwood W. Sparrow. Automotive Industries, vol. 46, no. 18, May 4, 1922, pp. 951-955, 5 figs. Consideration of tendency of fuel to detonate. Effect of explosion pressure, spark advance and other related factors.

Naphthalene. Hydrated Naphthalene as Automobile Fuel (Hydriertes Naphthalin als Betriebsstoff fur Automobile), J. Formànek. Allgemeine Automobil-Zeitung, vol. 23, no. 10, Mar. 11, 1922, pp. 27-29. Describes experiments made which show that tetraline and decaline mixed with benzol and benzene can be used to advantage; tetraline is superior to benzene or benzol.

AUTOMOBILES

Angus-Sanderson 14 Hp. The 14 Hp. Angus-Sanderson Car. Auto, vol. 27, no. 14, Apr. 6, 1922, pp. 283-285, 10 figs. Outstanding features of this London-built vehicle.

Automatic Chassis Lubrication. An Automatic Chassis Lubricating System. Automotive Industries, vol. 46, no. 18, May 4, 1922, pp. 950, 1 fig. New Chalco system does away with oil and grease cups on chassis.

Body Types, Names for. S.A.E. Standard Names for Body Types. Motor Age, vol. 41, no. 18, May 4, 1922, pp. 24-25, 14 figs. S.A.E. committee on body names has reported to parent society and names given have been adopted as standard by that organization.

Diatto 10-Hp. The 10 Hp. Diatto. Auto, vol. 27, no. 13, Mar. 30, 1922, pp. 263-265, 11 figs. Italian car built of British steel and with British body. Engine is of monobloc type with all valves on one side; it has four cylinders, 66-mm. bore, and piston stroke is 90 mm., giving cubic capacity of swept volume of 1017 cc.

Differential, Compensating. A New Type of Compensating Differential. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 857-858, 3 fig. Description of Krohn differential, which allows maximum differential action at low-axle speed and increasing resistance at greater r.p.m.

Dynamometer Test, Rear-Wheel. Rear Wheel Dynamometer Tests and Their Significance to the Engineer, Herbert Chase. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 859-868, 27 figs. Description and data from apparatus in Mason Laboratory, Sheffield Sci. School, Yale Univ. Includes comments on rolling friction, wind resistance, tractive effort, and fuel economy.

Gear Ratio 1914-1922. Rear Axle Gear Ratios of Passenger Cars from 1914 to 1922. Motor Age, vol. 41, no. 18, May 4, 1922, pp. 48-51, 1 fig. Tables of gear ratios for passenger cars by the year.

German Manufacture. The Stoewer Works, Stettin, Germany, and Their Products (Die Stoewer-Werke A.-G. und ihre Erzeugnisse). Motor u. Auto, vol. 19, no. 5, Mar. 15, 1922, pp. 68-72, 8 figs. Products consist of four- and six-cylinder automobiles, motor trucks, tractors and plows. Details of engines, etc.

Light Cars, French. Trend of French Cycle Cars and Light Cars, W. F. Bradley. Automotive Industries, vol. 46, no. 15, Apr. 13, 1922, pp. 801-806, 10 figs. Heavy taxes on automobiles increases interest in cycle cars, tendency toward 4-cylinder water-cooled type, with standard transmission and drive.

Maintenance. Aircraft Maintenance as a Standard for Motor Car Maintenance, P. L. Dumas. Motor Age, vol. 41, no. 14, Apr. 6, 1922, pp. 30-36, 11 figs. Importance of accuracy of tolerances and rigid inspection. Serious consequences of trivial omissions. Function of log book, tolerance sheet and timing disk.

Suspension Springs. Design and Functioning of Laminated Automobile Suspension Springs, A. A. Remington. Automotive Industries, vol. 46, nos. 14 and 15, Apr. 6 and 13, 1922, pp. 757-763 and 807-812, 21 figs. Also Automobile Engr., vol. 12, no. 162, Apr. 1922, pp. 118-127, 21 figs. Apr. 6: Character of laminated springs, and their theoretical and actual functioning; suggestions for improvement in design. Apr. 13: Deals with different spring steels, and gives specifications for standard testing procedure of raw spring material and finished product. Paper, slightly condensed, read before Instn. Automobile Engrs.

A Spring Suspension Which Secures Greater Flexibility. Automotive Industries, vol. 46, no. 18, May 4, 1922, p. 969, 1 fig. In this spring suspension system practically entire sprung weight is supported on two equalizing bars, one at each end of chassis. It is claimed that all rolling is eliminated and after-bounding is damped out.

Transmission Production. An Efficient Method of Transmission Production, J. Edward Schipper. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 869-872, 13 figs. Methods employed in Hudson and Essex Transmission Dept. Drilling of cases and machining of gear blanks accomplished by labor-saving methods. Gears matched for best mesh by special testing device.

AVIATION

Aerial Navigation. The Basic Principles of Aerial Navigation (Ueber die Grundlagen der Nautik des Luftmeeres), Conrad Harmsen. Schiffbau, vol. 23, nos. 14, 15, 17 and 18, Jan. 4, 11, 25 and Feb. 1, 1922, pp. 403-408, 435-439, 495-501 and 533-538, 10 figs. Study based on author's experiences during war. Comparison of general nautical and aeronautical principles. Discussion and graphic solution of three most important problems of aerial navigation.

Commercial Airways. The Development of Commercial Airways, Henry White-Smith. Inst. of Transport Jl., vol. 3, no. 3, Mar. 1922, pp. 145-163 and (discussion) 164-170. Summarizes development of air service in Great Britain and other countries and points out some possibilities.

Maps and Navigation. Maps and Navigation Methods, A. Duval. Aerial Age Weekly, vol. 15, no. 9, May 8, 1922, pp. 198-199. International agreement as to maps and merits of flying by compass rather than landmarks. From Preimer Congrès International de la Navigation Aérienne, Nov. 1921.

Sperry Flight Indicator. The Sperry Flight Indicator. Aviation, vol. 12, no. 14, Apr. 3, 1922, pp. 393-394, 1 fig. Describes instrument built for flying in fog and in clouds which combines features of turn indicator and inclinometer.

B

BEAMS

Continuous. Method for Calculating Lines of Influence of Bending Moments of Continuous Beams (Verfahren zur Ermittlung von Einflusslinien der Biegungsmomente durchlaufender Träger), H. Kayser. Beton u. Eisen, vol. 21, no. 4, Feb. 23, 1922, pp. 56-60, 12 figs. Describes simple method of calculating lines of influence for beams with unsymmetrical opening having no particular ratio to one another and for varying moments of inertia.

T-Shaped Cross-Sections. Method for Measuring T-Shaped Cross-Sections (Bemessungsverfahren für T-förmigen Querschnitt), Franz Kardos. Beton u. Eisen, vol. 21, no. 4, Feb. 23, 1922, pp. 62-65, 4 figs. Presents chart for measurement of T-shaped cross-sections and describes its applications.

BEARING METALS

Babbitt, Pouring Temperature for. Definite Temperature Control Necessary in Babbitt Pouring, Karl F. Smith. Elec. World, vol. 79, no. 18, May 6, 1922, pp. 886-887. Challenge of article on "Suggestions on Rebabbitting Bearings," by M. M. Brown, p. 434 of Elec. World, Mar. 4.

BEARINGS

Frictional Resistance of Lubricated. The Synthetic Calculation of Frictional Resistances of Lubricated Bearings (Die synthetische Berechnung der Reibungswiderstände geschmierter Lager, Etc.), W. v. Dallwitz-Wegner. Zeit. für technische Physik, vol. 3, no. 1, 1922, pp. 21-28, 8 figs. Calculation to determine properties of lubricating oil, based on internal friction of lubricating oil and capillary properties of oil and bearing metal.

Unsymmetrical. Pressures in Unsymmetrical Bearings, A. W. Knight. Machy. (Lond.), vol. 19, no. 496, Mar. 30, 1922, pp. 789-790, 2 figs. Makes calculations from which it is concluded that it is bad practice to use unsymmetrical bearings of whatever proportions.

BEARINGS, ROLLER

Railway Motors. Roller Bearings for Railway Motors (Wälzlager für Bahnmotoren), H. Mecke.

Zeit des Vereines deutscher Ingenieure, vol. 66, no. 12, Mar. 25, 1922. pp. 269-274, 23 figs. Notes on first experiments with ball bearings; ball and roller bearings for railway motors and advantages of latter.

BELTING

Care and Splicing. Splicing and Care of Leather, Rubber and Canvas Belts, G. H. Radebaugh. Coal Age, vol. 21, no. 17, Apr. 27, 1922, pp. 687–690, 25 figs. Oak-tanned leather preferable for power transmission; why short-lap belt is recommended; tallow and cod-liver oil make good dressing; cement, wire and rawhide fastenings.

Leather. Leather Belt Research Conclusions, J. Edgar Rhoads. Can. Mfr., vol. 42, no. 4, Apr. 1922, pp. 25–26. Manufacturers have conducted investigations into various phases of uses of leather belting, results of which are outlined.

V-Type. New Belt That May Revolutionize Drives to Light Machinery, Roger Fison. Belting, vol. 20, no. 4, Apr. 1922, pp. 26–28, 1 fig. Due to greater friction surface and flexiblity this type can transmit much greater power under less tension than round belt. Hints on other sizes.

Widths, Relative Capacity. Relative Capacity of Leather Belts of Different Widths, Belting, vol. 20, no. 4, Apr. 1922, pp. 36–38, 1 fig. Experiments by R. S. Jones of Leather Belting Exchange Foundation, Cornell Univ. Power transmitted increased from 22 at end of 9 hr. to 57 at end of 47½ hr. Capacity apparently varies directly with width.

BLAST-FURNACE GAS.

Cleaning. Economy of Modern Blast-Furnace-Gas Cleaning Processes in the Rhur and Minette Districts (Wirtschaftlichkeit neuzeitlicher Hochofengasreinigungen im Ruhr- und Minettebezirk), Max Schlipköter. Stahl u. Eisen, vol. 42, nos. 8 and 11, Feb. 23 and Mar. 16, 1922, pp. 285–290 and 408–422, 4 figs. 1 on supp. plate. Advantages of use of well-purified gases in air heating. Influence of water content of gases. Requirements of blast-furnace gas for economical operation. Determination of operating costs of cleaned gases based on practical examples with different cleaning processes. Advantages of dry filter process.

BLAST FURNACES

Oxygen Admixture to Air. The Admixture of Oxygen to Blast in Blast-Furnace Plants (Verwendungsmöglichkeiten der Lindeluft in Hochofenbetrieben), Theodor Wagner. Stahl u. Eisen, vol. 42, no. 12, Mar. 23, 1922, pp. 456–460. Notes on earlier opinions and experiments; changed conditions in blast-furnace practice since war; reduction of coke charge and introduction of producer gas or pulverized coal through tuyeres; use of air rich in oxygen in blast furnaces with pulverized-coal heating.

BOILER FEEDWATER

Preheating. Preheating of Locomotive Feedwater (Les réchauffeurs de l'eau d'alimentation des locomotives). Génie Civil, vol. 80, no. 14, Apr. 8, 1922, 320–324, 8 figs. Compares open and closed types and discusses American practice.

Regulator, Automatic. Hydraulic Feed-Water Automatic Regulator. Mar. Engr. & Naval Architect, vol. 45, no. 535, Apr. 1922, pp. 169. Some features of new Aster-Anthony hydraulic feedwater regulator.

Self-Cleaning Evaporator Coils. Self Cleaning Evaporator Coils. Am. Mar. Engr., vol. 17, no. 5, May 1922, p. 33. Reilly evaporator, submerged type, self-scaling coil solved problem of accumulation of salt scale.

Treatment of Water. Boiler Water, C. E. Joos and A. W. Binns. Power Plant Eng., vol. 26, nos. 9 and 10, May 1 and 15, 1922, pp. 456–460 and 511–514, 23 figs. May 1: Up-to-date methods of eliminating impurities which cause trouble in boilers. May 15: Priming, its causes and their relative importance; continuous determination of steam quality.

BOILER FIRING

Brown Coal. Boiler Firing with Brown Coal (Feuerungsanlagen für Rohbraunkohlen), O. Binder. Wärme- u. Kälte-Technik, vol. 24, no. 6, Mar. 15, 1922, pp. 65–67, 4 figs. Suitable firebox and grate arrangements; mechanical stoking; etc.

Peat. Firing Peat Under Boilers with Inclined Grate and Automatic Stoking (Die Verfeuerung von Torf in einer Schrätiger Beschickung unter Luftabschluss), W. Ledler. Wärme, vol. 45, no. 10, Mar. 10, 1922, pp. 121–124, 2 figs. Describes furnace built by Varel Iron Wks., near Oldenburg, and gives results of number of evaporation tests.

Pure and Mixed Peat Fuel for Boiler Firing (Reine und gemischte Torffeuerung in Dampfkesselfeuerungen). Rauch u. Staub, vol. 12, no. 6, Mar. 1922, pp. 53–56. Adaptation of firebox conditions to burning of peat, and advantages of peat in firing with brown coal and other low-grade fuels.

BOILER OPERATION

Load Indicators. Indicating Station Load in the Boiler Room, F. F. Leilich. Power, vol. 55, no. 15, Apr. 11, 1922, pp. 579–580, 4 figs. Automatic load indicator is described which has made it possible to hold steam pressures within prescribed limits under fluctuating loads and practically to prevent safety valves popping off.

Sugar Factories. Boiler House Operation in Sugar Factories (Kesselhauswirtschaft in Zuckerfabriken), H. Berner. Wärme, vol. 45, no. 3, Jan. 20, 1922, pp. 41–47, 11 figs. Deals with inherent difficulties in sugar factories; advantage of high boiler pressure; heat storage; saving of fuel through use of heating-gas preheater; high-pressure economizers, also for low-pressure boilers; forced-draft installations; practical tests on gas losses in anthracite furnaces; efficiency of the Eimert boiler-tube nests.

BOILERS

Cleaning. Cleaning Boilers by Means of Sand-Blast Apparatus (Reinigung von Dampfkesseln durch Sandstrahlgebläse), W. Kaempfer. Technische Blätter, vol. 12, no. 15, Apr. 14, 1922, pp. 153–154, 6 figs. Describes various experiences, especially with cleaning locomotive boilers; process requires about 200 kg. of sand per hr.

Furnace. See FURNACES, BOILER.

Locomotive. See LOCOMOTIVE BOILERS.

Marine. See MARINE BOILERS.

Settings. Progress in Boiler Setting (Fortschritte auf dem Gebiete der Dampfkesseleinmauerung), W. Ritter. Feuerungstechnik, vol. 10, no. 12 Mar. 15, 1922, pp. 125–126. Describes innovations in boiler brickwork.

Upkeep of Idle. Upkeep of Idle Boilers (La conservation des chaudieres en chomage), V. Kammerer. Bul. des Associations Françaises de Propriétaires d'Appareils a Vapeur, no. 3, Jan. 1921, pp. 133–138. Precautionary measures to keep out rust, contact with air or water, etc.

BOILERS, WATER-TUBE

Marine. A New American Water-Tube Boiler for Capital Ships. Mar. Engr. & Naval Architect, vol. 45, no. 535, Apr. 1922, pp. 150–153 and 154–155, 2 figs. Features of experimental boiler designed by Rear-Admiral Dyson, U. S. N. and tested by Phila. Navy Yard.

BRAKES

Freight-Train, French. The Question of Continuous Brakes in the French Freight Trains (Die Frage der durchlaufenden Bremse für Güterzüge in Frankreich), H. Pechot. Organ für die Fortschritte des Eisenbahnwesens, vol. 77, no. 2, Jan. 15, 1922, pp. 17–22. Discusses experiments with air and vacuum brakes on French railways; also the Clayton Hardy, Kunze-Knorr, Westinghouse, and other brakes. Pp. 22–25, criticism by A. Führ.

BRASS

Cold Strip Rolling. American Practice in Cold Rolling Brass Strip, C. E. Davies. Metal Industry (Lond.), vol. 20, no. 13, Mar. 31, 1922, pp. 293–297, 2 figs. Points out that main points of difference in American from English practice are (1) machining or overhauling cast ingot before rolling; (2) increased rolling speeds; and (3) improved methods and appliances for handling and cleaning metal.

BROACHES

Pull. The Design of Pull Broaches. Machy. (Lond.), vol. 20, no. 497, Apr. 6, 1922, pp. 13–15, 4 figs. Depth of cut; pitch of teeth; length; shape of teeth; methods of attaching broaches to machines.

BRONZES

Cast, Analysis of. Notes on the Analysis of Cast Bronze, G. E. F. Lundell and J. A. Scherrer. Jl. of Indus. & Eng. Chem., vol. 14, no. 5, May 1922, pp. 426–429. Desirable procedures and precautions often ignored. Based on work done at Bur. of Stand. and by coöperating analysts.

BUSES

Gasoline-Electric, England. Gasoline-Electric Bus with Unusual Features Operated in England. Bus Transportation, vol. 1, no. 5, May 1922, pp. 283–284, 2 figs. Description of type carrying gasoline engine, dynamo and electric motor.

C

CABLEWAYS

Aerial Passenger. Suspended Railways for Passenger Service in Comparison with Surface Mountain Railways (Drahtseilschwebebahnen zur Beförderung von Personen im Vergleich zu ebenerdigen Bergbahnen), H. Gatzweiler. Verkehrstechnik, vol. 39, no. 12, Mar. 24, 1922, pp. 142–145, 3 figs. Describes Bleichert system of suspended cableway and points out advantages of such systems.

CALORIMETERS

Continuous-Flow. A Continuous-Flow Calorimeter, and the Determination of the Heat of Neutralization of a Solution of Hydrochloric Acid by one of Sodium Hydroxide, Frederick G. Keyes, Louis J. Gillespie and Shinroku Mitsukuri. Am. Chem. Soc. Jl., vol. 44, no. 4, Apr. 1922, pp. 707–717, 3 figs. Describes experiments carried out and apparatus used.

CALORIMETRY

Bomb Corrosion. The Effect of Bomb Corrosion on the Accuracy of Calorimetric Determinations, H. L. Olin and R. E. Wilkin. Chem. & Met. Eng., vol. 26, no. 15, Apr. 12, 1922, pp. 694–696. Describes experiments made with nickel-lined bombs.

CAMS

Calculation Calculation of Cams (Calcul des cames), Octave Lepersonne. Technique Automobile et Aerienne, vol. 12, nos. 113 and 114, 1921, pp. 33–42 and 68–71, 15 figs. No. 113: Discusses theory, determination of geometric form, application of straight line and arc profiles. No. 114: Graphic calculation and numerical examples.

CARS

Design Problems. Springs, Draft Gears and Other Problems in Car Design, Louis E. Endsley. Ry. Rev., vol. 70, no. 17, Apr. 29, 1922, pp. 591–594, 3 figs. Shorter spring travel and longer draft-gear travel suggested as solution to most serious problem. Address before Virginia Section of A.S.M.E.

Restaurant and Sleeping. Restaurant and Sleeping Cars for the Siamese State Railways. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, pp. 554–556, 11 figs. partly on pp. 559–560. Designed to afford maximum comfort to travelers; workmanship of highest class.

CAST IRON

Early History. The Early History of Iron with Special Reference to Cast Iron, J. Newton Friend. Foundry Trade Jl., vol. 25, nos. 290, 291 and 292, Mar. 9, 16 and 23, 1922, pp. 182–183, 193–194 and 216–218, 9 figs. Discusses iron in Egypt and Palestine, Mesopotamia, Europe, Great Britain and Central Africa; direct reduction of iron ores; reduction of iron in Africa; discovery of cast iron; 18th century developments.

Mechanical Tests. Mechanical Tests of Cast Iron (Considérations générales sur les essais mécaniques des fontes), M. Portevin. Révue Universelle des Mines, vol. 12, no. 6, Mar. 15, 1922, pp. 507–511. Discusses the various tests available and shows that some, such as the impact test, are of no value. Recommends tensile strength and Brinell tests.

CEMENT

Canadian Specifications. New Cement Specifications, Canadian Engineering Standards Association. Can. Engr., vol. 42, no. 17, Apr. 25, 1922, pp. 428–429. Résumé of new report from Can. Standards Assn. based also on specifications of Eng. Inst. of Canada, Am. Soc. for Testing Matls., and Brit. Standards for Portland Cement.

Fused. Fused Cement (Le Ciment fondu). Vie Technique et Industrielle, vol. 3, no. 30, Mar. 1922, pp. 503–506, 4 figs. Discusses French process for making cement containing 10 per cent silica, 40 alumina, 10 iron oxide, 40 lime, raised to temperature of complete fusion, and its properties and characteristics.

Hardening. Experiments on the Effect of Low Temperatures on the Hardening of Cement (Versuche über die Einwirkung von niedrigen Temperaturen auf das Erhärten des Zements), H. Kreüger. Beton u. Eisen, vol. 21, no. 5, Mar. 18, 1922, pp. 74–78, 4 figs. Discusses tests with cement cubes to show effect of freezing temperature and draws number of conclusions.

CENTRAL STATIONS

Heating and Power. Investigating the Efficiency of a Central Heating and Power Station (Wirtschaftliche Untersuchungen an einem Fern-Wärmekraftwerk), M. A. Nüscheler. Gesundheits-Ingenieur, vol. 45, no. 13, Apr. 1, 1922, pp. 169–177, 5 figs. Author's experience in construction and operation of steam piping for central heating stations, either in connection with central power stations or without it.

Superpower. Superpower System for Japan, C. A. Powel. Elec. Rec., vol. 31, no. 5, May 1922, pp. 357–359, 1 fig. Program for furnishing electricity over large area between Tokio and Osaka.

Hoover Sees Super-Power Project as Possible Stabilizer of Coal Industry. Min. Congress Jl., vol. 8, no. 5, May 1922, pp. 729–730. Theory that project in Atlantic Coast region between Washington, D. C. and Portland, Me., might stabilize coal industry.

CHIMNEYS

Heat Losses in. The Relation Between CO_2 and Stack Losses. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 429–431, 3 figs. Discusses various factors governing chimney loss, and shows that the magnitude of chimney loss bears definite relation to percentage of CO_2 in flue gases.

CLUTCHES

Magnetic. Magnetic Clutches in the Cement Industry, W. H. Costello. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 5, May 1922, pp. 361–363, 2 figs. Clutch requirements and description of magnetic type which meets them.

Systems. Study of the Various Clutch Systems (Étude des divers systèmes d'embrayages), Henri Petit. Technique Automobile et Aerienne, vol. 13, no. 116, 1922, pp. 4–17; 28 figs. Describes English and American gear systems for automobiles, including cone clutches and disk clutches, and gives tabulated statement of their characteristics.

COAL

Analysis. Coal Analyses May Be Misleading Because of Crude and Insufficient Sampling, O. P. Hood. Coal Age, vol. 21, no. 12, Mar. 23, 1922, pp. 484–486. Advises averaging of numerous samples taken over long period to get representative value. Based on address before Nat. Assn. Purchasing Agents.

Coking Propensities. The Coking Propensities of Coals, W. A. Bone, A. R. Pearson, E. Sinkinson, W. E. Stockings. Gas World, vol. 76, no. 1967, Apr. 1, 1922, pp. 16–20, 1 fig. Results of experimental investigations into resinic constituents of bituminous coals and their supposed determining influence upon coking propensities of coals. (Abstract.) Paper read before Royal Soc.

Combustion. Combustion of Coal, R. B. MacMullin. Combustion, vol. 6, no. 3, Mar. 1922, pp. 118–123, 5 figs. Composition and classification of coal; oxidation of carbon.

Recovery from Ashes of Coke and. Recovery of Coke and Coal From Ashes (Rückgewinnung von Koks und Kohlen aus Asche), Ullrich. Montanistische Rundschau, vol. 14, nos. 3 and 7, Feb. 1 and Apr. 1, 1922, pp. 56–58 and 153–156, 7 figs. Describes electromagnetic ash separators and shaking tables, and gives results of some experiments with ashes from anthracite firing at experiment station of Krupp-Gruson works.

Sampling. Sampling Fuel (Prélèvement et préparation d'un échantillon moyen de combustibles) Bul. des Associations Françaises de Propriétaires d'Appareils à Vapeur, no. 6, Oct. 1921, pp. 330–331, 1 fig. Procedure adopted by French associations for drawing and preparing average sample of coal.

COAL GAS

Economical Use. Economical Use of Illuminating Gas (L'emploi économique du gaz d'éclairage), R. Villers. Nature, no. 2500, Mar. 4, 1922, pp. 134–138, 7 figs. Various uses of the gas, types of burners, proper mixing with air, compressing.

COAL HANDLING

Bunkering Cranes. Recent Developments in Bunkering Cranes, Cargo, Coal Loading Equipment and Shipbuilding Cranes, Justin Green. World Ports, vol. 10, no. 6, Apr. 1922, pp. 47–53. Describes methods for bunkering coal at various harbors.

Equipment. Coal and Ash-Handling Equipment, Harry R. Westcott. Steam, vol. 29, no. 4, Apr. 1922, pp. 93–100. Description of various units from yard storage through traveling bridges, feeders, chain elevators and conveyors to ash hoppers.

COAL STORAGE

Methods. Coal Storage (La conservation des charbons), E. Schmidt. Bul. des Associations Françaises de Propriétaires d'Appareils à Vapeur, no. 4, Apr. 1921, pp. 163–181. Discusses change in coal exposed to air, spontaneous combustion, storage under water, coal piles, etc.

COKE BREEZE

Steam Generation. The Utilization of Coke Breeze for the Generation of Steam, W. Francis Goodrich. Gas Engr., vol. 38, no. 530, Feb. 15, 1922, pp. 44–46. Features of this fuel which make it of real value.

COLD STORAGE

Indirect Air Cooling. Indirect Air Cooling for Cold Storage—A Problem in Design, H. E. Corl. Refrigeration, vol. 29, no. 8, Mar. 1922, pp. 26–28, 1 fig. Considerations necessary in design; refrigeration; bunker coil surfaces, selection of fan and motor; thermostatic control of temperature.

COMBUSTION

Coal. Combustion of Coal, R. B. MacMullin. Combustion, vol. 6, no. 5, May 1922, pp. 224–228, 4 figs. Relation between temperature, excess air, and rate of combustion.

COMPRESSED AIR

Mines. Determining the Drop in Pressure in Compressed Air Piping in Mines (Ermittlung des Druckabfalls in Pressluftleitungen untertage), W. Reinhard. Glückauf, vol. 58, no. 15, Apr. 15, 1922, pp. 433–436, 1 fig. Discusses drop due to pipe resistance, and gives chart from which average loss of head can be calculated.

CONDENSERS, STEAM

Steam. Season Cracking in Condenser Tubes. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 461–462, 6 fig. Cracking of tubes. Study of costs and suggestions toward elimination.

CONVEYORS

Belt. Biggest Belt-Conveyor System in the World, D. R. Egbert. Belting, vol. 20, no. 4, Apr. 1922, pp. 17–25, 5 figs. Parcel-post station in Chicago to be completed June 1922, will have 8 miles canvas-stitched belting. Description of installation, largest in world.

Monorail. Monorail Conveyors on Clay Plants. Brick and Clay Rec., vol. 60, no. 8, Apr. 18, 1922, pp. 613–615, 9 figs. This type desirable for clay plants. Description of installations at R. Thomas & Sons, East Liverpool, Ohio, and Brooklyn (Ind.) Brick Co.

Steel-Belt. Flexible Steel Belt Conveyors, Harry Carlson. Gas Age-Rec., vol. 49, no. 13, Apr. 1, 1922, pp. 283–285, 6 figs. Describes steel belt made by Sandviken Steel Works, Sweden, and gives particulars as to strength, corrosion, loading width, etc.

Steel-Band Conveyors. Eng. Progress, vol. 3, no. 5, May 1922, pp. 109–110, 13 figs. Application and advantages of steel-band conveyors of Sandviken type.

Telphers vs. Telphers vs. Conveyors for Gas Works Purposes, Herbert Blyth. Gas. Engr., vol. 38, no. 549, Jan. 16, 1922, pp. 6–7, 2 figs. Features of gas manufacturing plant and comparative advantages of overhead telphers and conveyor systems.

COOLING TOWERS

Recooling of Water in. Recooling Plants (Ueber Rückkühlanlagen), Fritz Hoyer. Wärme, vol. 45, no. 6, Feb. 10, 1922, pp. 77–80, 7 figs. Desiderata for obtaining good results from cooling installations. Details and advantages of modern types.

CORROSION

Colloids, Influence of Protective. The Influence of Protective Colloids on the Corrosion of Metals and on the Velocity of Chemical and Physical Change, John A. N. Friend and Reece H. Vallance. Chem. Soc. Jl., vol. 121–122, no. 713, Mar. 1922, pp. 466–474, 2 figs. Concludes that after a general law protective colloids tend to retard velocity of such reactions as involve change of state from solid to liquid, or vice versa, in one or more of the components.

Ferrous Metals. Corrosion of Ferrous Metals, Robert Abbott Hadfield. Metal Industry (Lond.), vol. 20, no. 16, Apr. 21, 1922, pp. 381–382. Preparation of various ferrous metals used in corrosion research of Inst. Civil Engrs. together with their physical and mechanical properties and some general considerations on subject of corrosion. (Abstract.) Paper read before Inst. Civil Engrs.

Rust Prevention. The Prevention of Rust. Motor Transport, vol. 34, no. 896, May 1, 1922, p. 529, 1 fig. Notes on application of thermozine process for protecting certain parts of motor vehicles against corrosion.

Oxidization Prevention. Calorizing and Calite, G. H. Howe and G. R. Brophy. Gen. Elec. Rev., vol. 25, no. 5, May 1922, pp. 267–272, 5 figs. Description of process developed in Schenectady Research Laboratory to prevent corrosion.

COST ACCOUNTING

Depreciation and Retirement of Property. Depreciation and Retirement of Property, William H. Bell. Jl. of Accountancy, vol. 33, no. 4, Apr. 1922, pp. 253–258. Shows that where average rate of depreciation is used, if a unit of property is retired in advance of average estimated life of all units in its class, entire cost of unit retired should be charged to reserve for depreciation.

Engineering Methods Applied to. Engineering Methods Applied to Cost Finding, Robert S. Denham. Indus. Management, vol. 63, nos. 2, 3, 4 and 5, Feb., Mar., Apr. and May, 1922, pp. 67–73, 161–166, 218–220, and 310–312, 4 figs. Feb.: Effect upon profit margin of traditional and misleading cost methods. Mar.: General principles underlying application of expense items. Apr.: Six fundamental principles of cost engineering. May: Definite procedure for surveying the requirements of production.

Factory. Factory Accounts, Costs, and Statistics, R. Dunkerley. Foundry Trade Jl., vol. 25, nos. 293 and 294, Mar. 30 and Apr. 6, 1922, pp. 233–235 and 248–249. Comparative factory expenses; underlying principles and essential details; foundry tackle; monthly statements; individual costs; overhead charges; wasters; etc.

New Plan. Cost Accounting, Guy Foote Wetzel. Armour Engr., vol. 13, no. 3, Mar. 1922, pp. 163–171. Discusses cost accounting plan with some new features, by A. W. Torbet, installed in large manufacturing plant, and compares with usual methods.

Scientific, Necessity for. Costing in Industry. Eng. & Indus. Management, vol. 7, no. 12, Apr. 20, 1922, pp. 357–360. First part of special report of Costing Conference held in Lond., covering cost accountant's position, works expenditure, periodical comparisons, and productive labor.

COTTON INDUSTRY

Electrical Equipment. The Electrical Equipment of the D. R. Cotton Mills. Electrician, vol. 88, no. 2292, Apr. 21, 1922, pp. 473–474, 4 figs. Some details of mills which contain both spinning and weaving sections.

CRANES

Classification. Classification of Hoisting Machines Particularly Cranes (Einteilung der Hebe- und Transportmaschinen, insbesondere der Krane), R. Dub. Fördertechnik u. Frachtverkehr, vol. 15, nos. 1 and 2, Jan. 6 and 20, 1922, pp. 1–4 and 22–26, 59 figs. Classification of the various types of cranes into groups according to their kinematic characteristics, assuming that load is always concentrated at center of gravity.

Floating. A 60-ton Floating Crane, W. Fox. Mech. World, vol. 71, nos. 1837 and 1838, Mar. 17 and 24, 1922, pp. 207–209 and 224–226, 10 figs. Describes in detail revolving jib type floating crane, built by Werf Gusto (Firma A. F. Smulders), Schiedan, Holland.

Inspection. Things that the Crane Inspector Looks for and Some of the Hows and Whys, A. L. Gear. Elec. Rev. & Indus. Engr., vol. 80, no. , Mar. 1922, pp. 111–118, 152, 14 figs. Inspection report forms and things looked for in making inspection.

Wrecking. Ten-Ton Locomotive Steam Breakdown Crane. Engineer, vol. 133, no. 3457, Mar. 31, 1922, p. 357, 3 figs. partly on p. 360. Built by Bedford Engineering Co., Bedford, England, for Great Western of Brazil Ry., and designed to lift loads up to 10 tons at radius of 20 ft.

CRANKSHAFTS

Steel for. Steel for Crankshafts: Its Heat Treatment, H. C. Loudenbeck. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 181–183. Grades of steel that are being used for this purpose, and their heat treatment and physical properties to secure best results.

CUPOLAS

Charging Elevator, Combined with. An Improved Foundry Melting Plant. Engineer, vol. 133, no. 3457, Mar. 31, 1922, pp. 365–366, 3 figs. Describes plant designed by J. E. Hurst for regular production of high-grade cast iron for use in manufacture of castings by centrifugal-casting process. Consists of a cupola, an elevator charging arrangement and an oil-fired receiver.

Design and Operation. Iron and Foundry Cupola Management, J. J. McClelland. Foundry Trade Jl., vol. 25, no. 292, Mar. 23, 1922, pp. 209–213, 5 figs. Author's experience in cupola practice; describes layout of plant, construction of cupola, linings, charging, fans or blowers, etc. Paper read before Instn. British Foundrymen.

Iron Melting. Cupola Practice, J. Wood. Foundry Trade Jl., vol. 25, nos. 296 and 297, Apr. 20 and 27, 1922, pp. 288–290 and 304–306, 3 figs. Some difficulties that have to be overcome in melting iron by cupola process which, for quickness and cheapness, is not excelled by any other furnace. Details of lining and tuyeres. Paper read before Instn. British Foundrymen.

D

DIESEL ENGINES

Flexibility. Diesel Engine Flexibility, W. S. Burn. Steamship, vol. 33, no. 394, Apr. 1922, pp. 320–331, 9 figs. Investigation with view to its application to direct-driven Diesel locomotive. It is shown that principles governing flexibility are practically identical with those governing economy. Read before Graduate Section of North-East Coast Instn. Engrs. & Shipbuilders.

Generator Drive. Oil-Engine-Driven Ship Generators in the German Navy (Der ölmotorische Antrieb von Borddynamos in der deutschen Kriegsmarine), W. Laudahn. Schiffbau, vol. 23, nos. 13, 14, 15, 16, 19–20, 21, 23 and 25–26, Dec. 28, 1921, and Jan. 4, 11, 18, Feb. 8–15, 22, Mar. 15 and 22–29, 1922, pp. 363–369, 397–403, 429–435, 467–470, 565–573, 605–611, 745–752 and 777–780, 93 figs. Dec. 28: The 300-kw. Diesel engine built by Körting Bros., Inc., for liner, König. Jan. 4: Engine of Fried. Krupp Corp. Germania Shipyard for liner Kronprinz. Jan. 11 and 18: Engine of Benz & Co., Mannheim, for liner Bayern. Feb. 8: Engine of Vulcan Works, Inc., Hamburg for liner Wurttemberg. Feb. 22: Engine of Augsburg-Nürnberg Corp. for large cruiser. Lützow. Mar. 15 and 22: Engine of Görlitzer Machine Constr. & Iron Foundry Corp. for large cruiser Hindenburg.

Heavy and Low-Grade Oil. Using Heavy and Low Grade Oil in Motors of the Diesel Type (Mineria y Petróleo), Benigno Benigni. Ingenieria, vol. 26, no. 3, Mar. 1922, pp. 133–135, 1 fig. Some experiments with Ansaldo San Giorgio engines running on cotton-seed and palm oils.

Lighter. Use Diesel Unit for Lighter. Mar. Rev., vol. 52, no. 5, May 1922, pp. 215–217, 3 figs. Installation of unit on derrick lighter Worthington, owned by Worthington, Pump & Machy. Corp. develops 300 b.hp. at 275 r.p.m.

Locomotive. Industrial and Scientific Progress. Beama, vol. 10, no. 4, Apr. 1922, pp. 295–298. Description of air auxiliary cylinders with Diesel engine which give sufficient flexibility for use on locomotives; designed by W. S. Burn who presented paper on subject before N. E. Coast Instn. Engrs. & Shipbuilders.

Marine. A 1000-Hp. Marine Diesel Engine of the German Works, Inc. (Ein 1000 PS-Schiffs-Dieselmotor der Deutschen Werke A.-G.), P. Stephan. Motor u. Auto, vol. 19, no. 5, Mar. 15, 1922, pp. 65–68, 2 figs. Also Schiffbau, vol. 23, no. 27, Apr. 5, 1922, pp. 815–824. Describes engine recently completed in Kiel shipyard which is one of two engines to be installed in a tanker with 8000-ton displacement built for the Italian Government. It is 6.6 m. high and has six 4-stroke single-acting cylinders.

Injection and Combustion of Fuel-Oil—IX, C. J. Hawkes. Motorship, vol. 7, no. 5, May 1922, pp. 366–367, 4 figs. Experiments with solid-injection and air-blast in marine Diesel engines. (Concluded.)

The Beardmore-Tosi Diesel Engine. Steamship, vol. 33, no. 394, Apr. 1922, pp. 332–338, 9 figs. Presents table showing relative cost of fuel, oil, and personnel for two types of vessels, one steam-driven and the other Diesel-driven. Details of Beardmore-Tosi marine engines.

DRAFT

Equalized. The Significance of Equalized Draft (Wesen und Bedeutung des ausgeglichenen Zuges), Hch. Doevenspeck. Wärme, vol. 45, no. 9, Mar. 3, 1922, pp. 111–113, 2 figs. Discusses questions relating to natural and forced draft and advantages of equalized draft.

DRILLING MACHINES

Pneumatic. Pneumatic Drilling Machines and Hammers in Mining and Related Industries (Druckluft-Bohrmaschinen und -Hammer im Bergbau und in den verwandten Betrieben), R. Goetze. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 11 and 12, Mar. 18 and 25, 1922, pp. 245–251 and 278–280, 42 figs. History of development and description of most important modern types of drilling machines, hammers and picks. Prospects of future development.

DROP FORGINGS

Difficulties. How Drop Forgings are Made Perfect, J. H. G. Williams. Raw Material, vol. 5, no. 4, May 1922, pp. 140–143, 14 figs. Summarizes chief difficulties in production of faultless drop forgings. Paper presented at N. Y. Sectional Meeting of Am. Soc. for Steel Treating.

Modern Practice. Modern Drop-Forging Practice—II. Machy. (Lond.), vol. 10, no. 487, Jan. 26, 1922, pp. 508–511, 7 figs. Deals with trimming of forgings and correct forging heats, and gives typical examples of drop-forging work.

DRYING

Wood. Note on Drying (Note sur le séchage), P. Villain. Révue de l'Industrie Minérale, no. 31, Apr. 1, 1922, pp. 155–170, 10 figs. General principles of drying methods as applied in mining and metallurgy, especially of woods.

DURALUMIN

Properties and Commercial Possibilities. Duralumінum Properties and Commercial Possibilities. Brass World, vol. 18, no. 4, Apr. 1922, pp. 129–130. Characteristics of this material, one-third the weight of cold-rolled steel though with same approximate strength.

Welding. Welding Duralumin—Some Experimental Work and Its Results, Horace C. Knerr. Automotive Industries, vol. 46, no. 18, May 4, 1922, pp. 964–968, 10 figs. Account of experimental work done at Naval Aircraft Factory and results attained from this work and from weld made by private firm. Details of tensile and corrosion tests made on different types of welds.

E

EDUCATION, INDUSTRIAL

Electricians. Practical Training and Professional Courses in the Electric Industries (Role de l'École pratique et des Cours professionnels dans les industries électriques), E. Labbé. Révue Générale de l'Électricité, vol. 11, nos. 10 and 11, Mar. 11 and 18, 1922, pp. 367–372 and 405–414, 10 figs. Mar. 11: Kind of training best for practical industrial schools to train skilled electricians. Mar. 18: Machinery and apparatus necessary for instruction, and their practical operation.

ELECTRIC DRIVE

Changing from Steam. Changing From Steam to Electric Drive. Wood-Worker, vol. 41, no. 2, Apr. 1922, pp. 38–39, 1 fig. In case cited herewith a large plant changes from steam to electric drive, but instead of scrapping old power-transmission equipment, latter is retained in sections which now constitute motor-driven group drives.

ELECTRIC FURNACES

Aluminum Melting. Melts Aluminum in Electric Furnace, H. E. Diller. Foundry, vol. 50, no. 9, May 1, 1922, pp. 345–357, 10 figs. Daily and monthly operating reports indicate power required and other data. Core sand all reused; sand driers prove economical; patterns fitted in wooden matches.

Annealing. Regenerative Car Type Electric Furnace, A. D. Dauch. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 200–201, 4 figs. Describes annealing furnace of Fowler and Union Horse Nail Co., Buffalo, N. Y.

Electromagnetic Motion. Electromagnetic Motions in Electric Furnaces. Brass World, vol. 18, no. 4, Apr. 1922, pp. 117–119. Method of applying in practice forces suggested in paper by Carl Hering, read at Apr. 1921 meeting of Am. Electrochem. Society.

Non-Ferrous. Non-Ferrous Electric Furnaces, F. Kilburn and H. C. Dews. Foundry Trade Jl., vol. 25, no. 296, Apr. 20, 1922, pp. 281–282. Furnaces for low-melting-point alloys, below 800 deg. cent.; for medium-melting-point alloys, between 800 to 1,300 deg. cent.; and for high melting point alloys, above 1300 deg. cent. (Abstract.) Paper read before West Yorkshire Metallurgical Soc.

Operation. Changes in the Working of an Electric Furnace (Remarques au sujet des changements d'allure dans les hauts-fourneaux électriques), J. Seigle. Révue de Métallurgie, vol. 19, no. 2, Feb. 1922, pp. 86–89. Difference in blast and electric furnaces in reduction of oxides by carbon and formation of CO and CO_2.

Resistance-Type, Graphites for. Electric-Resistance Furnace for High Temperatures (Elektrisk motståndsugn for höga temperaturer), Bo Kalling. Teknisk Tidskrift (Utgiven av Svenska Teknologföreningen), vol. 52, no. 9, Mar. 4, 1922, pp. 146–148, 3 figs. Resistance of Acheson and Scandinavian graphites at various temperatures.

ELECTRIC LOCOMOTIVES

Chile Freight Service. Electric Freight Locomotives for Chile. Ry. Age, vol. 72, no. 17, Apr. 29, 1922, pp. 1005–1006, 2 figs. Work on fifteen for Chilean State Rys. nearing completion. Operated at 3000 volts d.c.; maximum speed, 40 m.p.h.; estimated weight, 226,000 lb.

Electric Locomotives for Chile Freight Service, F. E. Wynne. Elec. Ry. Jl., vol. 59, no. 16, Apr. 22, 1922, pp. 667–672, 15 figs. Details of road and switching locomotives soon to be delivered to Chilean State Rys. are given. Designs provide for incorporation into present railway system while not preventing further standardization.

Single-Phase, France. Single-Phase Electric Traction on the System of the Camargue R. R. Co. (Application de la traction électrique par courant monophasé sur le réseau de la Compagnie des Chemins de Fer de la Camargue), J. Reyval. Révue Générale de l'Électricité, vol. 11, no. 10, Mar. 11, 1922, pp. 351–359, 12 figs. Discusses recently electrified lines Nîmes-Arles Trinquetaille and Nîmes-Saint Gilles, and advantages derived; 6600 volts, 25 cycle.

ELECTRIC PLANTS

Hell Gate Station. Hell Gate—A Station of Many Features. Elec. World, vol. 79, no. 17, Apr. 29, 1922, pp. 821–827, 11 figs. Unusual features are turbine room next to river, phase isolation of all electrical equipment, alternating-current-driven auxiliaries.

Humanized. A Humanized Plant, R. C. Denny. Combustion, vol. 6, no. 5, May 1922, pp. 218–220, 4 figs. Cannon St. plant of New Bedford Gas & Edison Light Co. designed for best performance of man power and mechanical equipment and operating at 1.7 lb. of 14,000 B.t.u. New River Coal to the kw.

Winnipeg River. The Next Big Western Power Scheme. Contract Rec., vol. 63, no 17, Apr. 26, 1922, pp. 372–375, 6 figs. Manitoban Power Co. actively developing Great Falls, Winnipeg River. Contracts let for two complete 28,000 hp. units. Complete capital cost will be less than $80 per hp.

ELECTRIC POWER

Scientific Application to Factory Problems. Applying Electricity Scientifically to Factory Problems, Louis F. Leurey. Jl. Electricity & West. Industry, vol. 48, no. 9, May 1, 1922, pp. 343–345, 3 figs. Example of what can be done in adapting electricity to special needs of a factory as illustrated by modern equipment and carefully planned layout of California and Hawaiian sugar plant.

ELECTRIC RAILWAYS

Track and Wiring on Bridge. Track and Wiring on Large Bridge. Elec. Ry. Jl., vol. 59, no. 14, Apr. 8, 1922, pp. 587–591, 11 figs. Describes overhead wire and track construction on new bridge across Housatonic River, which has just been completed by Connecticut Co.

EMPLOYEES' REPRESENTATION

Works Councils. Industrial Representation and the Fair Deal. George H. Shepard. Indus. Management, vol. 63, nos. 2, 3, Feb., Mar. 1922, pp. 81–85, 185–188. Deals with fundamentals of contact with employees to stimulate production. Coöperation by managers and employees through works councils.

ENGINEHOUSES

Chesapeake & Ohio. New Locomotive Facilities at Clifton Forge, Va. Ry. Age, vol. 72, no. 16, Apr. 22, 1922, pp. 955–958, 13 figs. New 10-stall installation at Clifton Forge, Va., which includes power house capable of 1100 b.hp., storehouse and oil house.

EXECUTIVES

Functions and Methods of Chief. A Technique for the Chief Executive, John H. Williams. Taylor Soc. Bul., vol. 7, no. 2, Apr. 1922, pp. 47–68. Notes on responsibilities and duties of chief executive and a method through which he might function effectively.

Problem of Chief. The Problem of the Chief Executive, Henry P. Kendall. Taylor Soc. Bul., vol. 7, no. 2, Apr. 1922, pp. 39–46. From point of view of medium-sized enterprise.

EXPORT TRADE

Packing for. Packing for Export, P. J. Burns. World Ports, vol. 10, no. 6, Apr. 1922, pp. 69–75. Discusses prevention of pilfering and damage, marking and packing of shipments, and coöperation between exporters and transportation companies.

F

FANS

Mine. Selection of Fans for Pipe Ventilation, Walter S. Weeks. Eng. & Min. Jl.-Press, vol. 113, no. 119, May 13, 1922, pp. 816–818, 3 figs. Theory of operation and calculations to be made in choosing equipment for assuring proper supply of pure air and for fire fighting; computation of characteristic curves at different speeds; discussion limited to small fans.

FEEDWATER HEATERS

Locomotive. Locomotive Feed Water Heaters, H. B. Oatley. Southern & Southwestern Ry. Club, vol. 16, no. 7, Jan. 19, 1922, pp. 14–37 and (discussion) pp. 37–45, 19 figs. General discussion of development and prospects, with suggestions as to operation.

FIRE HOSE

Coupling Standardization. Progress in Hose Coupling Standardization, F. M. Griswold. Nat. Fire Protection Assn., vol. 15, no. 3, Jan. 1922, pp. 246–249. Discusses importance of standardization in fire-fighting equipment.

FIRE PREVENTION

Automatic Devices. Automatic Devices for Preventing Fires in Buildings (Dispositifs automatiques de protection des édifices contre l'incendie), Jacques Michaut. Génie Civil, vol. 80, no. 13, Apr. 1, 1922, pp. 295–299, 8 figs. Deals with sprinkler systems such as Grinnell type, automatic fire alarms, etc.

Fire-Alarm Code. Many Changes Planned for Fire Alarm Code, C. E. Beach. Fire & Water Eng., vol. 71, no. 18, May 3, 1922, pp. 727–728, 730 and 742. Comment on proposed changes in fire alarm code by former engineer of large fire alarm establishment.

Water Supply, Relation of. Fire Service as it Relates to Water Supply, Dow R. Gwinn. Mun. & County Eng., vol. 62, no. 4, Apr. 1922, pp. 148–154. Several features of water problem in this field.

FLIGHT

Soaring. Flying Without Engine (Étude théorique du vol sans moteur), Alayrac. Aeronautique, vol. 4, no. 34, Mar. 1922, pp. 75–78. Discusses theory of gliding and wind conditions, and reduces it to mathematical formulas.

The Velocity of Descent of Gliding Airplanes (Zur Sinkgeschwindigkeit von Segelflugzeugen) Erik Thomas. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 13, no. 6, Mar. 31, 1922, pp. 78, 4 figs. Gives mathematical determination of minimum velocity of descent for gliding plane whose area is constant, and for gliding plane whose spread of wings is constant.

FLOW OF WATER

Weirs. Experiments With Flow Over Weirs With End Contractions (Expériences sur des déversoirs a nappe libre avec contraction latérale), V.-M. Hegly. Annales des Ponts et Chaussées, vol. 6, Nov.-Dec. 1921, pp. 290–389, 43 figs. Gives results of measurements of flow for triangular, semicircular, multiple, and other discharges in connection with Marne-Saône canal.

FLYING BOATS

Amphibian. The Supermarine Single-Seater Fighting Scout "Sea King" Mark II. Flight, vol. 14, no. 16, Apr. 20, 1922, pp. 226–229 and 236, 13 figs. Description of interesting amphibian flying boat with 300-hp. Hispano-Suiza engine.

FOUNDRIES

Castings, Cost of. System Keeps Tab on Foundry Costs, H. C. Keller. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 308–310 and 315, 9 figs. Outlines simplified method for finding costs of castings; suitable for small shops.

Handling Products. Heavy Tonnage from a Small Floor. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 301–307, 10 figs. Discusses coördination of supply of materials and sequence of operation as essential to molding and pouring of castings.

Heating Units, Manufacture of. Heater Sections Made in Quantity. Foundry, vol. 60, no. 7, Apr. 1, 1922, pp. 267–274, 12 figs. System of providing large and continuous vents in cores automatically removes most dangerous factor in producing castings of this character.

FUELS

Automobile. See AUTOMOBILE FUELS.

Hogged. Hogged Fuel, Emery A. Morrison. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 407–410, 4 figs. Its heat-producing value; design and adaptability of furnace; means and method of handling fuel to furnace grates. From paper read before Western Section of Am.Soc.Mech.Engrs.

Low-Grade. Contributions to the Improvement of German Fuel Economy (Beiträge zur Verbesserung der deutschen Brennstoffwirtschaft), Otto Brandt. Wärme (formerly Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, nos. 4, 5 and 6, Jan. 27, Feb. 3 and 10, 1922, pp. 53–55, 68–71 and 81–83. Discusses use of peat, lignite and other low-grade fuels and design of furnaces for their use; distribution and efficient exploitation of high-grade fuels; utilization of German crude oil; water-power utilization, etc. Future prospects.

PreCarbonization. Precarbonization of Fuels (La carbonisation préalable des combustibles). Outillage, vol. 253, no. 13, Apr. 1, 1922, pp. 377–380, 4 figs. Low-temperature carbonization; tar distillation; low-grade fuels, etc.

[See also COAL; GAS; LIGNITE; OIL FUEL; PULVERIZED COAL.]

FURNACES, BOILER

Oil. New Oil Furnaces (Neue Oelfeuerungen), H. Pradel. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 10–12, 9 figs. Details of various types constructed by Körting Bros., Inc., near Hannover, Germany, including steam-jet centrifugal oil furnaces, low-pressure burners, etc.

FURNACES, FORGING

Heating Arrangements. The Need for Better Heating in Forging and Forming Practice. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 202–204, 2 figs. Typical arrangements of chambers and working openings in forging and heating furnaces to meet nature of process and material to be heated.

FURNACES, METALLURGICAL

Design. Possibilities of Improvements in the Design and Operation of Metallurgical Furnaces (Entwicklungsmöglichkeiten bei hüttentechnischen Oefen), Georg Bulle und H. Rosin. Stahl u. Eisen, vol. 42, no. 14, Apr. 6, 1922, pp. 529–532, 3 figs. Author demonstrates importance of taking radiation losses into consideration and points out that great saving in fuel can be effected through proper shape and size of furnace and adequate insulation. Practical examples.

Gas Firing. Modern Gas Firing (Neuzeitliche Gasfeuerungen), M. Schimpf. Glückauf, vol. 58, no. 15, Apr. 15, 1922, pp. 429–433, 5 figs. Discusses question of using surplus gas in mining districts, and describes experiments with Eickworth and Rodberg burners for burning furnace and excess gas.

Oil-Fired. Oil Firing of Open-hearth Furnaces in Steel Foundries (Le Chauffage à l'Huile des Fours Martin), P. Jolly. Fonderie Moderne, no. 3, Mar. 1922, pp. 78–79. Discusses advantages of oil, such as absence of sulphur, regulation of temperature, intermittent operation, etc.

Temperature Calculation. Calculation of Working Temperatures in Metallurgical Furnaces (Errechnung der Arbeitstemperaturen in metallurgischen Oefen), Hugo Bansen. Stahl u. Eisen, vol. 42; nos. 7, 8, 10 and 11, Feb. 16, 23, Mar. 9 and 16, 1922, pp. 245–253, 291–297, 370–375 and 423–426, 17 figs. Notes on drop in temperature as calculated and actually reached; pyrometric evaluation of fuels; dynamic conditions for flame formation; required workpiece temperatures; temperature pressure between workpiece and flame; heat transmission. Determination of most suitable fuel.

FURNACES, OPEN-HEARTH

Regenerative. Control of Heat Economy in Regenerative Furnaces (Ueberwachung der Wärmewirtschaft bei Regenerativefeuerungen), H. Berger. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 12–14. Includes heat balance of regenerative furnace and auxiliary

generator. Notes are given both on sources and prevention of losses.

G

GAS

B.t.u. Calculation. New Graphic B.t.u. Calculator, Minor C. K. Jones. Gas Age-Rec., vol. 49, no. 13, Apr. 1, 1922, pp. 393–394, 1 fig. Discusses use of chart for calculation of heating value in B.t.u. per cubic foot of a gas, by which lengthy and laborious calculations are avoided.

Fuel, Future Use. Gas—the Fuel of the Future, Thomson King. Am. Gas Jl., vol. 116, no. 14, Apr. 8, 1922, pp. 321–322 and 332–333. Deals with near future which can be plainly discerned, and more distant future which must be dealt with in more general terms.

Proper Utilization. Proper Utilization of Gas Important, Andrew M. Rowley. Oil & Gas Jl., vol. 20, no. 48, Apr. 27, 1922, p. 12, 1 fig. Domestic consumers waste 150 billion ft. annually, hastening depletion of supply and bringing closer day of costly substitutes.

Relative Usefulness of. Relative Usefulness of Gases, Floyd W. Parsons. Gas Age-Rec., vol. 49, no. 16, Apr. 22, 1922, pp. 483–484, 506. Results of investigation of different gases by U. S. Bur. of Standards. Proper burning conditions of air to gas and most economic heating value standards for gas.

GAS PRODUCERS

Glass Works. Gas-Producer Operation in Glass Works (Der Betrieb der Gaserzeuger in den Glashütten), Hubert Hermanns. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 14–17, 5 figs. Presents heat balance of a glass furnace and discusses losses in Siemens producers.

Outside. Outside Producers at Racine, H. R. Broker. Am. Gas Jl., vol. 116, no. 14, Apr. 8, 1922, pp. 325–329, 4 figs. Notes on installation of producer plant consisting of two high-pressure producers which can gasify at least one-half braize and one-half small or nut coke, and each of which is rated to gasify 25 tons of fuel per day. Saving effected in labor and fuel.

Reinforced-Concrete. Reinforced-Concrete Gas Producer. Engineer, vol. 133, no. 3457, Mar. 31, 1922, p. 364, 2 figs. Experimental producer built in Italy in accordance with patents of O. R. Verity. It is claimed that reinforced-concrete construction allows of economy in first cost of over 50 per cent, as compared with metal construction, and there is also economy in maintenance.

Transforming Solid Fuel into Gas. Gas Generator, Fusing Ash Type (Le gazogène à fusion des cendres), A. Fichet. Mémoires et Comptes Rendus des Travaux de le Société des Ingenieurs Civils de France, vol. 74, no. 10–12, Oct.-Dec. 1921, pp. 593–638, 8 figs. Development of Ebelmen gas producer for transforming solid fuel into gas and using this in metallurgical furnaces.

Types. Gas Producers (Les Gazogènes), Louis Garand. Chaleur et Industrie, vol. 3, no. 24, Apr. 1922, pp. 1157–1192, 3 figs. Reviews development and describes most recent types made in France.

GAS TURBINES

Thyssen-Holzwarth Oil and. Thyssen-Holzwarth Oil and Gas Turbines, W. Schüle. Motorship, vol. 7, no. 5, May 1922, pp. 351–355, 9 figs. Describes unique internal-combustion engine invented by Hans Holzwarth, and gives results of tests. (Extract.) Translated from German.

GASES

Combustion of Mixtures. The Combustion of Complex Gaseous Mixtures. William Payman and Richard Vernon Wheeler. Chem. Soc. Jl., vol. 121–122, no. 713, Mar. 1922, pp. 363–379. Concludes that during propagation of flame in mixture of several inflammable gases with air at given speed, gas which will monopolize most oxygen is that which when burning alone with same speed of flame is associated with most air.

GASOLINE

Substitutes. Gasoline Substitutes and Synthetic Products, Ernest Owen. Oil Trade Jl., vol. 13, no. 4, Apr. 1922, pp. 13–14 and 92. Development of cracking processes, methods designed to conserve fuel; using catalysts; oil-shale projects, and principal shale sources; alcohol a promising source.

GEAR CUTTING

Commercial Practice. Commercial Gear-cutting Practice. Machy. (Lond.), vol. 20, no. 498, Apr. 13, 1922, pp. 23–36, 20 figs. Spur gear-cutting machines of rotary-cutter type.

Commercial Gear-Cutting Practice. Machy. (Lond.), vol. 20, no. 500, Apr. 27, 1922, pp. 109–112, 6 figs. Describes automatic spur gear cutter by John Holroyd & Co., Ltd.

Multiple Shapers. Stevenson Multiple Gear Shaper. Machy. (Lond.), vol. 19, no. 496, Mar. 30, 1922, pp. 791–793, 5 figs. Describe new 6-A downstroke model.

GEAR DRIVE

Nodal Arrangements of. Nodal Arrangements of Geared Drives, J. H. Smith. Shipbldg. and Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 455–456. Illustration of violent effects of faulty arrangement on teeth of gear wheels.

GEARS

Hydraulic-Power Transmission. Hydraulic Power Transmission Gears, M. H. Sabine. Practical Engr., vol. 65, nos. 1828, 1831, 1832 and 1833, Mar. 9, 30, Apr. 6 and 13, 1922, pp. 151–154, 205–206, 221–222 and 235–236, 8 figs. Mar. 9: Discusses variable power transmission by oil in which a prime mover revolving in one direction at constant speed is coupled direct to a variable-delivery pump which delivers oil to a fluid motor, usually of fixed capacity. Mar. 30: Working of gear and features of Carey pump. Apr. 6 and 13: Carey pump cylinder action, pulsations and vibration; success of Hele-Shaw gear.

Involute. The Involute Gear Tooth XII, A. Fisher. Machy. (Lond.), vol. 20, no. 498, Apr. 13, 1922, pp. 55–58, 8 figs. Generation by pinions.

Latest Practice. Gear Makers' Convention of Much Technical Interest, P. M. Heldt. Automotive Industries, vol. 46, no. 17, Apr. 27, 1922, pp. 901–906, 5 figs. Papers presented on good hob practice, use of projection comparator in testing gear teeth, proportion of industrial gears, the grinding of gear teeth and new system of bevel gears.

One-Tooth Pinion. A Novel One-Tooth Pinion. Eng. Production, vol. 4, no. 82, Apr. 27, 1922, p. 396, 4 figs. Details of an interesting high-ratio gear.

Teeth Repairing. Repairing Broken Gear Wheel Teeth, G. H. Radebaugh. Brick & Clay Rec., vol. 60, no. 8, Apr. 18, 1922, pp. 617–620, 14 figs. Various styles of gears, four methods of repairing cast teeth, description of stud method which does not require commercial repair shop.

Worm-Reduction. Worm Reduction and Change-speed Gearing. Engineer, vol. 133, no. 3457, Mar. 31, 1922, pp. 352–354, 4 figs. Describes new invention the novelty of which consists of entire absence of usual spur wheels and use instead of worms and worm wheels.

GRINDING

Auger Bits. Auger Bit Grinding Operations, K. H. Lansing. Abrasive Industry, vol. 3, no. 5, May 1922, pp. 154–156, 7 figs. Wood boring augers and bits are finished almost entirely by manual operations involving solid and setup wheels.

GRINDING MACHINES

Planetary Spindle, with. Grinding Machine with Planetary Spindle, W. Pockrandt. Eng. Progress, vol. 3, no. 4, Apr. 1922, pp. 88–91, 10 figs. How planetary spindle works. Grinding machines with vertical and horizontal grinding spindle. Comparisons between the two types of grinding machines.

GUN MOUNTS

Christie Motor Carriages. Christie Motor Carriages, H. E. Pengilly. Army Ordnance, vol. 2, no. 11, Mar.-Apr. 1922, pp. 285–290, 6 figs. Describes new tractor type of carriage developed to meet need for mobile artillery capable of high speed on good roads of present Army Transport, and of negotiating most difficult terrain encountered in field maneuvers.

H

HANDLING MATERIALS

Car Tipping in Factory Yards. Modern Appliances for Tipping Wagons in Factory Yards, E. Krahnen. Eng. Progress, vol. 3, no. 5, May 1922, pp. 111–113, 6 figs. Electrically operated tippers with toothed segments or traction ropes; double-end tippers; swinging tippers.

Electrical Plants. Modern Electrical Handling Plant, H. H. Broughton. Beama, vol. 10, nos. 3 and 4, Mar. and Apr. 1922, pp. 210–216, 8 figs., pp. 325–332, 3 figs. Mar.: Gives examples of various types of cranes and bridge transporters and discusses grain handling. Apr.: Canadian and South African grain-handling installations. Data on use of grabs to increase unloading of ore into Great Britain. Buying cargo cranes.

Internal, Textile Finishing Plant. Internal Transportation in a Large Textile Finishing Plant, A. Hamilton Church. Management Eng., vol. 2, nos. 4 and 5, Apr. and May 1922, pp. 197–202 and 293–296, 14 figs. Describes transportation methods of plant of The Mount Hope Finishing Co., Taunton, Mass.

Methods. Handling Material in the Steinway Factories, Paul Bulhuber. Management Eng., vol. 2, no. 5, May 1922, pp. 263–268, 10 figs. Methods used for raw materials parts, and finished products.

HEAT

Economical Use. Economical Use of Heat (Sparsame Temperaturwirtschaft), K. Schreber. Dinglers Polytechnisches Journal, vol. 337, nos. 6 and 7, Mar. 25 and Apr. 8, 1922, pp. 51–54 and 61–65, 4 figs. Discusses relation of value of unit of work and value of unit of heat, and gives various illustrations of boilers.

Conservation. Control of Heat Consumption (Ergebnisse der wärmetechnischen Betriebsüberwachung), H. Berner. Wärme (Zeit. für Dampfkessel u. Maschinenbetriebe), vol. 45, nos. 1 and 2, Jan. 6 and 13, 1922, pp. 6–9 and 30. Fundamentals of control; operating tests; measuring devices; loss and utilization of waste heat; the heat pump; waste energy; furnace and other losses; savings effected through control.

HEAT TRANSMISSION

Building Materials. Temperature Study in a Wall of Undefined Thickness Whose Faces are Subject to a Uniform Periodical Variation of Temperature (Étude du Régime des températures dans l'épaisseur d'un mur indefini dont les duex faces sont soumises à une même variation périodique de la température), (J. Seigle. Révue de l'Industrie Minerale, no. 30, Mar. 15, 1922, pp. 135–145, 11 figs. Mathematical paper on heat transmission and heat conductivity of materials such as brick.

HEAT TREATING

Gas Firing. Gas Wins Out for Heat Treating, J. P. Lafore. Gas Age-Rec., vol. 49, no. 15, Apr. 15, 1922, pp. 451–452 and 456, 3 figs. Describes gas equipment of eastern metallurgical plant which was installed after considerable experience with coal, electricity, oil and gas.

Mediums. Fuels, Burners, and Quenching Mediums for Heat treatment, S. P. Rockwell. Machy. (Lond.), vol. 20, no. 500, Apr. 27, 1922, pp. 100–103, 3 figs. Advantages and disadvantages of different kinds of fuel, types of burners, and description of results obtained by various quenching baths.

HEATING

Flue-Gas Utilization for. The Heating of Factory Rooms and Halls through Utilization of Flue Gas (Neuzeitliche Grossraumheizung mittels Rauchgasausnutzung), Otto Brandt. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 4–6, 6 figs. Describes two systems and points out their advantages and economy.

HEATING, ELECTRIC

Losses. The Determination of Heat Loss, Walter W. Nobbs. Beama, vol. 10, no. 4, Apr. 1922, pp. 312–320, 2 figs. Fallacies in past heating determination in the formulas in coefficients and tables. Heating computations.

Residences, Tacoma, Wash. Electric Heating of Residences in Tacoma. Heat. & Vent. Mag., vol. 19, no. 4, Apr. 1922, pp. 41–45, 6 figs. Interesting features of installations in 795 residences, 54 apartments and 76 business and other buildings.

HEATING, HOT-AIR

Fan Furnace System. Fan Furnace Heating of a Theatre. Sheet Metal Worker, vol. 13, no. 6, Apr. 14, 1922, pp. 171–173, 5 figs. Describes heating and ventilating system of Rialto Moving Picture Theatre, Hamilton, Ohio, in which vertical sectional furnaces are used as air heaters, and fan is used to insure positive distribution and proper ventilation.

Leader Sizes, Figuring. Simplified Scientific Method of Figuring Leader Sizes, P. J. Dougherty. Sheet Metal Worker, vol. 13, no. 7, Apr. 28, 1922, pp. 209, 215. Two rules by which to determine heat losses from building as well as leader pipe sizes.

HEATING, STEAM

Central Stations. The Neukoelln Municipal Central Station for Distance Heating. Eng. Progress, vol. 3, no. 4, Apr. 1922, pp. 77–78, 2 figs. At present 14 individual buildings or groups of buildings in a Berlin suburb are supplied with heat from this common source. Heating plant was designed and executed by Körting Bros., Berlin Branch. Required heat supply amounts to 5,800,000 kg-cal. per hr., and it is intended to enlarge station to max. heat output of 15,000,000 kg-cal. per hr.

Report on Experiments With a Coke Economizer of the Zuppinger Type by the Thermotechnical Division of the Union of Central Heating Stations (Bericht über die Versuche der wärmetechnischen Abteilung im Verband der Centralheizungs-Industrie mit dem Kokssparer Bauart "Zuppinger"), A. Grossmann. Gesundheits-Ingenieur, vol. 45, no. 15, Apr. 15, 1922, pp. 193–201, 5 figs. Gives results of a number of evaporation tests confirming advantages of Zuppinger apparatus.

HELICOPTERS

Propeller Screws. Helicopters (Les hélicoptères), W. Margoulis. Aeronautique, vol. 4, no. 34, Mar. 1922, 16 pp. (supplement), 10 figs. Results of experiments carried out to determine mechanical functioning of propeller screws.

HIGHWAYS

Transportation Economics. Traffic Facts Shown by Highway Transportation Surveys. Automotive Industries, vol. 46, no. 17, Apr. 27, 1922, pp. 917–919, 1 fig. Overloading is prevalent in hauling all commodities. Trucks handle large percentage of manufactured products carried over route covered by surveys; 3.2 passengers per car is average determined; 2-ton trucks form 16 per cent of total. Census example of needed transport studies.

HOISTS

Portable Column. The Modern Column Hoist, F. A. McLean. Can. Min. Jl., vol. 43, nos. 11 and 12, Mar. 17 and 24, 1922, pp. 152–156 and 169–172, 15 figs. Mar. 17: Describes modern portable column hoist, its construction and use in mine and quarry operation. Mar. 24: Tugger slushing in metal and coal mines.

HOUSING

Location of Blocks of Dwellings. Location of Blocks of Dwellings by the Compass and Available Sunshine (Die Lagerung städtischer Wohnblocks zur Himmelsrichtung mit Rücksicht auf die Besonnungsverhältnisse), K. A. Hoepfner. Gesundheits-Ingenieur, vol. 45, nos. 12 and 14, Mar. 25 and Apr. 8, 1922, pp. 148–150 and 181–185, 14 figs. Shows by diagrams and curves amount of sunshine available during year for houses running east-west, north-south, northeast-southwest, etc.

HYDRAULIC MACHINERY

Engines. A New Hydraulic Engine (Eineneue

Wasserkraftmaschine "Aquapulsor"), R Winkel-Glasers Annalen, vol. 90, no. 6, Mar. 15, 1922, pp. 92 97, 21 figs. Describes new type known as aquapulsor, and its use for irrigation and drainage, and for filling and emptying of navigation locks.

HYDRAULIC TURBINES

Large Installations. Some Large Turbine Installations in Austria and Other Countries (Einige grössere Turbinenanlagen in Oesterreich und im Ausland), W. Hahn. Elektrotechnik u. Maschinenbau, vol. 40, nos 12 and 13, Mar. 19 and 26, 1922, pp. 133–139 and 147–149, 12 figs. History of development and examples of large turbine installations in America, Scandinavia, Japan, Germany, etc.

Molding 50-Ton Runner. Molding a 50-Ton Turbine Runner. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 318 321, 6 figs. Set of cores forming mold was assembled on an iron plate divided in two for convenience in setting last of vane cores.

HYDRODYNAMICS

Equations. Ambiguous Solutions of the Hydrodynamic Equations (Ueber mehrdeutige Lösungen der hydrodynamischen Gleichungen), George Jaffé. Physikalische Zeit., vol. 23, no. 6, Mar. 15, 1922, pp. 129–133, 4 figs. Presents example, similar to Villat example, of two-directional flow against a hollow space, thus forming a dead-water area of indeterminate size in the space.

HYDROELECTRIC DEVELOPMENTS

Belgium. Utilization of Belgian Hydroelectric Resources (Avant-Projet de captation des energies hydrauliques Belges), Herman Chauvin. Révue Universelle des Mines, vol. 11, nos. 1, 3, 4, 5, 6, Oct. 1, Nov. 1, 15, Dec. 1, 15, 1921, pp. 1–28, 261–277, 509–523, 629–644, 15 figs. on supp. plates. Oct. 1: Discusses general questions of river water supply and control for power purposes; and barrage work carried out in various rivers. Nov. 1: 15, Dec. 1 and 15: Describe work carried out on the Sambre and Meuse rivers.

Chippawa-Queenston. First 50,000 hp. Unit of Chippawa-Queenston Power Scheme. Elec. News, vol. 31, nos. 4, 5, 6, 7 and 9, Feb. 15, Mar. 1, 15, Apr. 1 and May 1, 1922, pp. 29–34, 28–33, 30–34, 27–34 and 32–35, 35 figs. Feb. 15: Series of articles describing work in connection with location of intake, canal and power house; also general design. Mar. 1: Details of hydraulic installation. Mar. 15: Excavation methods for moving 17,000,000 cubic yards of material and cutting through rock and earth; lining of canal; etc. Apr. 1: Design of power plant and specifications and installation of major apparatus May 1: Description of generators nos. 4 and 5 being completed by Can. Gen. Elec. Co.

Switzerland. The Silser Lake-Bergeller Power Plant Project (Die projektierten Silsersee-Bergeller Kraftwerke), Adolf Salis. Schweizerische Bauzeitung, vol. 79, no. 13, Apr. 1, 1922, pp. 161–164, 8 figs. Discusses present project for utilization of water power of Silser Lake in the Upper Engadine, Switzerland.

HYDROELECTRIC PLANTS

Germany. Supplying the Town of Passau with Electric Power and the Power Station Hals on the Ilz (Die Versorgung der Stadt Passau mit elektrischer Energie und das Kraftwerk Hals an der Ilz), Albert Sturm. Bauingenieur, vol. 3, no. 6, Mar. 31, 1922, pp. 170–173, 7 figs. Describes work of damming the Ilz and construction of buildings for machines; etc.

Italy. Thermoelectric Plant at Torre del Lago (Impianto termoelettrico di Torre del Lago Trazione elettrica). Revista Tecnica delle Ferrovie Italiane, vol. 21, no. 2, Feb. 15, 1922, pp. 33–42, 19 figs. Describes Italian thermoelectric plant worked under a concession supplying power to state railways, state participating in profits when over 7 per cent dividends are paid.

Norway. The Aust-Agder Power Station (Aust-Agder Kraftverk), Kr. T. Westbye. Elektrotecknisk Tidsskrift, vol. 35, no. 10, Apr. 5, 1922, pp. 73–76, 12 figs. Describes construction work and equipment, transmission lines, transformer stations, etc.

Switzerland. The Olten-Geosgen Hydroelectric Power Station (Centrale hydroélectrique suisse d' Olten-Goesgen), H. De Watteville. Houille Blanche, vol. 21, no. 174, Jan.-Feb. 1922, pp. 1–5, 5 figs. Describes construction work, including damming of the Aar; and equipment, including Brown-Boveri 7050 k.v.a. alternators at 7700–8400 volts, transformers, long-distance transmission at 70,000 volts.

I

ICE MANUFACTURE

Raw-Water Can System. Modern Systems for Manufacture of Raw Water Can Ice, Van Rensselaer H. Greene. Ice and Refrigeration, vol. 62, no. 4, Apr. 1922, pp. 287 288. Some details of method of obtaining clear ice by means of blowing air through it while freezing.

Sea Water. Using Sea Water in Ice Manufacture. Ice and Refrigeration, vol. 62, no. 4, Apr. 1922, p. 320. Experiments by Dyle and Bacalan demonstrating advantages of sea-water ice for some types of refrigeration.

ICE PLANTS

Electrically Operated. The Electrically Operated Ice Plant, H. J. Macintire. Ice and Refrigeration, vol. 62, no. 4, Apr. 1922, pp. 273 277. Some results of advance in use of electricity in last five years.

Japanese. A Japanese Ice Plant, L. H. Jenks, Jr. Refrig. World, vol. 57, no. 4, Apr. 1922, pp. 14–16, 8 figs. Recently completed installation on Island of Hikoshima for Imperial Ice Co.

INDICATORS

Optical. Optical Indicator. Eng. Progress, vol. 3, no. 5, May 1922, p. 114, 5 figs. Description of manograph indicator made by O. S. A. Apparatus Co. Ltd., based upon deflection of beam of light striking mirror by which it is reflected.

Planimetric. Planimetric Indicator (Planiketrierender Indikator), L. Gumbel. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 13, Apr. 1, 1922, pp. 298–299, 6 figs. Describes indicator developed by author, consisting of an indicator cylinder of usual dimensions with outside spring and without writing device. The gear is so arranged that the indicator records progressively.

INDUSTRIAL MANAGEMENT

Antagonism. The Inevitable Antagonism Between Employers and Employees. Management Eng., vol. 2, nos. 4 and 5, Apr. and May 1922, pp. 246–247, 308–309. Discussion by various authors of article by C. E. Knoeppel in March issue.

Charting, Authority and Responsibility. Charting Authority and Responsibility to Show Complex Management Relationships. Boyd Fisher. Management Eng., vol. 2, no. 5, May 1922, pp. 281–284, 2 figs. Lack of value of familiar organization charts and suggestions for an samples of worthwhile ones.

Cost-Control Committee. The Organization and Operation of the Cost Control Committee Plan, John H. Van Deventer. Indus. Management, vol. 63, no. 5, May 1922, pp. 267–272. Machinery of plant for building economic morale to reëstablish profit margins.

Cost Predetermination. The Determination of Costs, J. McD. Cronin. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 221–224. A system which will reveal true costs in time to control them.

Earnings, Interpreting Average. Interpreting Average Hourly Earnings on Semiautomatic Operations, Paul Faltin and Leon Blog. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 215–219, 1 fig. Adoption of piecework system of wage payment.

Executive Ability. Measuring Executive Ability, William E. Dunn. Indus. Management, vol. 63, no. 5, May 1922, pp. 292–295. Suggesting measure of value and deducing factors that compose it.

Foremen, Training. Foremen Training as a Factor in Cost Reduction, B. M. Nussbaum. Indus. Management, vol. 63, nos. 4 and 5, Apr. 1922, pp. 229–233, 297–302. Apr.: Analysis of lecture-class method, conference-discussion method and standard-group study course, and advantages and disadvantages of each. May: Means of getting and holding the foremen's interest.

Foundry Costs. Volumetric Efficiency as a Measure of Foundry Costs, Douglas T. Sterling. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 201–205, 3 figs. Relations between floor space, flask volume and weight of castings.

Happiness, Importance of. Making Happiness a By-Product of Industry, Geo. W. Hanley. Indus-Management, vol. 63, no. 5, May 1922, pp. 287–291, 8 figs. Restoring to business human interest and coöperation betwen employer and employee.

Incentives and Rate Setting. Incentives and Rate-Setting Applied to the Smaller Plant and Varied Product, E. Wadsworth Stone. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 205–208. Value of practical encouragement applied to smaller plant.

Production Cost Cutting. Cutting Production Costs by Combining Manufacturing Operations, C. B. Bartlett. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 198 200, 2 figs. Operations which can be combined substantially decreasing costs as well as reducing hazards.

Profits, Reëstablishing for Small Factory. Re-Establishing the Profits of the Small Factory, Ernest Cordeal. Indus. Management, vol. 63, no 4, Apr. 1922, pp. 251–254. Importance of vesting authority to hire and discharge employees in special department.

Scope. Looking Management Engineering in the Eye, Erwin H. Schell. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 233–236. High standards, assimilating new ideas, an art as well as science; present day demands.

University Training in Factory. Taking University Training to the Factory, Paul M. Atkins. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 239 242, 1 fig. Plan to increase receptivity of working force to new ideas, train employees for advancement and discover those best fitted for promotion.

Wastes. Searching Out the Invisible Wastes, C. J. Morrison. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 196–197. Some prominent points of attack for cost cutting campaign.

[See also EXECUTIVES; SAFETY ENGINEERING; TIME STUDY; WASTE.]

INDUSTRIAL TRUCKS

Electric. Electric Vehicles. Gen Elec. Rev., vol. 25, no. 4, Apr. 1922, pp. 200–259, 62 figs. Special issue containing articles by various authors on the battery vehicle in England; electric trucks in express service and in automotive field; electric passenger vehicle; operation; design and application of motors; controllers and resistances for storage-battery-driven vehicles; charging systems; advantages of gasoline and electric trucks with interchangeable parts; etc.

INSPECTION

Methods. Inspection Methods that have Proved Successful, H. Alton. Can. Machy., vol. 27, no. 17, Apr. 27, 1922, pp. 17–19 and 21. See that specifications are correct. Incoming material should be carefully inspected before going into stores. Where gaging is most effective. Coöperation of departments.

INSTRUMENTS

Precision. Practical Application of Precision Instruments, H. Alton. Can. Machy., vol. 27, no. 16, Apr. 20, 1922, pp. 24–26, 6 figs. Construction of different gages; improved design increases efficiency; reducing weight of larger sizes; combining blocks for checking dimensions; testing micrometers for wear.

INSULATION, HEAT

Thermoconductivity of. Heat Insulators. Refrig. World, vol. 57, no. 4, Apr. 1922, pp. 21–22. Abstract of special report of Food Investigation Board of G. B. on thermal conductivity of insulating materials usually employed.

INTERCHANGEABLE MANUFACTURE

Tolerance System. Tolerance System in Interchangeable Manufacture, C. W. Ham. Sibley Jl. of Eng., vol. 36, no. 4, Apr. 1922, pp. 66–67, 74. Definitions of terms; examples of their use; undesirability of specifying closer tolerances than necessary.

INTERNAL-COMBUSTION ENGINES

Alcohol for Fuel. Alcohol for Motor Fuel. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 364–365. Possibilities of more general use and points in favor of and against it.

Castings. Castings for Internal Combustion Engines, Ben Shaw and James Edgar. Foundry Trade Jl., vol. 25, no. 293, Mar. 30, 1922, pp. 236–239, 14 figs. Discusses production of pistons, their heat treatment and molding details. Also discusses castings for crank-case bottom, water inlet, front cover, and gear boxes.

Combustion Process. Combustion Process in Explosion Engines (Forbraendingsprosesser i eksplosjonsmotorer), W. Holwech. Teknisk Ukeblad, vol. 69, nos. 9, 10 and 12, Mar. 3, 10 and 24, 1922, pp. 78–80, 87–91 and 116–118, 12 figs. Mar. 3: Mixing of gases; compression; ignition; combustion; expansion. Mar. 10: Discusses velocity of propagation of combustion, limits of explosions, and gives curves for various combustibles, such as methane, ethane, water gas, acetylene, etc. Mar. 24: Discusses results of new investigation, including heat of combustion and heat balance.

Cooling. Improvements in the Cooling of Internal-Combustion Engines (Neuerungen in der Kühlung der Verbrennungsmotoren), H. Praetorius. Motorwagen, vol. 25, no. 9, Mar. 31, 1922, pp. 165–171, 12 figs. Discusses recent patents on the subject.

Design. Modern Tendencies in Internal-Combustion Engine Construction (Tendances modernes dans l'étude et la construction des moteurs), Edmond Bruet. Outillage, Tome 251, 252 and 253, nos. 11, 12 and 13, Mar. 18, 25 and Apr. 1, 1922, pp. 326–328, 353–356 and 374–377, 23 figs. Mar. 18: Combustion of gaseous mixtures; propagation of flame. Mar. 25: Kerosene, in internal-combustion engines (Bellem and other engines). Apr. 1: Deals with Diesel engines. Construction and operation of Sulzer two-stroke engine, the Ruston high-pressure engine, and compound Diesel engine.

Friction Losses. Friction Losses in Internal-Combustion Engines (Étude des pertes par frottements dans les moteurs à combustion interne), André Planiol. Comptes Rendus des Séances de l'Académie des Sciences, vol. 174, no. 13, Mar. 27, 1922, pp. 860–863. Gives results of experiments with four-stroke single-cylinder engine running on town-gas and develops formula for friction.

Fuel-Introduction Systems. Fuel Introduction Systems for Internal Combustion Engines. Pacific Mar. Rev., vol. 19, no. 5, May 1922, pp. 285–286, 9 figs. Description of high-pressure system developed for use with engines using accumulated type of fuel injection.

Molecular Movements During Combustion. Molecular Movements During Combustion in Closed Systems, Thomas Midgley, Jr. Soc. Automotive Engrs. Jl., vol. 10, no 5, May 1922 pp. 357–361 and (discussion) 362–363, 11 figs. Theoretical analysis of experimental work of Woodbury, Canby & Lewis published in Mar. 1921 Jl.

Photographic Recording of Data. Photographic Recording of Engine Data, Augustus Trowbridge. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 351–356, 368, 12 figs. Outline of history of photographic recording apparatus and description of how it can be used to overcome difficulties with ordinary indicated diagrams.

Research. Recent Research Work on the Internal-Combustion Engine, Harry R. Ricardo. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 305–328 and (discussion) 328–336 and 347, 42 figs. Discussion of fuels as to mean volatility, detonation, turbulence, stratification, and comment on benefits of weak fuel mixtures.

Still System. The Still System of Internal Combustion, F. Leigh Martineau. Can. Shipg. & Mar. Eng. News, vol. 12, no. 4, Apr. 1922, pp. 17–19. Shows that Still system can be applied to any type of internal-combustion engine without any radical alteration. Mechanical features also dealt with.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; MARINE ENGINES; SEMI-DIESEL ENGINES.]

IRON

Melting, German Practice. Melting Iron in a German Foundry, Hubert Hermanns. Foundry, vol. 50, no. 9, May 1, 1922, pp. 367–370, 7 figs. Elabo-

rate equipment and precautions to insure suitable metal characterize methods of big Rhineland cylinder plant. Cast cylinders for original Otto gas engine.

IRON AND STEEL

Gases in. Determination of Gases in Iron and Steel (Bestimmung der Gase in Eisen und Stahl), A. Vita and Eduard Maurer. Stahl u. Eisen, vol. 42, no. 12, Mar. 23, 1922, pp. 445-452 and (discussion) pp. 452-456, 3 figs. Two reports from Chemical Committee of Assn. German Iron Met. Engrs. on process for determination of gases by means of chemical changes, and comparison of results with those obtained in extraction process by physical means.

Properties and Uses. Iron and Steel Classified for Designers, Wm. J. Merten. Blast Furnace & Steel Plant, vol. 10, no. 4, Apr. 1922, pp. 230-234, 12 figs. Survey of wrought iron, malleable iron, cast iron, and semi-steel, with special reference to physical properties, characteristics, uses and heat treatment.

IRON CASTINGS

Engines. Engine Castings Requirements Rigid, H. J. Young. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 311-314, 18 figs. Micrographs show variation in iron in same castings, heat tends to cause Diesel-engine cylinder liners and pistons to grow: study of requirements urged. (Abstract.) Paper read before British Inst. Mar. Engrs.

Liquid Fracture in. Liquid Fracture in Iron Castings, S. G. Smith. Foundry Trade Jl., vol. 25, no. 296, Apr. 20, 1922, pp. 283-285, 7 figs. An occurrence which takes place in a casting before whole of casting has become solidified, sometimes being only microscopic and sometimes so large that it separates casting in two pieces.

IRON, PIG

Casting Methods. Questions Pig Iron Casting Methods, Robert E. Newcomb. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 316-317. Advantages and disadvantages for foundry use of sand-cast pig iron, compared with those of pig iron made by machine casting process.

L

LAPPING

Hand and Machine. Hand and Machine-lapped Surfaces as seen through a Microscope. Machy. (Lond.), vol. 20, no. 500, Apr. 27, 1922, pp. 113-114, 6 figs. Comparison of two types of finish magnified 250 times.

LIGHTHOUSES

Aerial. Powerful Lighthouses in Aerial Navigation (Les phares à grande portée en navigation aérienne), A. Volmerange. Aeronautique, vol. 4, no. 34, Mar. 1922, pp. 67-74, 7 figs. Development of marine lights and lenses; principles of new powerful aerial lights, such as Barbier-Bénard and Sautter-Harlé; visibility of light; etc.

LIGHTING

Effective, Planning and Installing. Planning and Installing Effective Lighting, John. T. Scott. Can. Machy., vol. 27, no. 16, Apr. 20, 1922, pp. 19-20, 2 figs. Suggestions on distribution, adapting existing equipment, and reflecting surfaces by engineer in charge of standardization work at Sunbeam Lamp Wks.

Industrial. Choice of Fixtures for Industrial Lighting, John T. Scott. Can Machy., vol. 27, no. 17, Apr. 27, 1922, pp. 20-21, 3 figs. Type of reflector depends on work. Softening shadows and eliminating glare. Keep globes and lamps free from dirt. Good light prevents accident.

LIGNITE

Burning on Chain Grates. Burning Canadian Lignite on Chain Grates. Power House, vol. 15, no. 8, Apr. 20, 1922, pp. 27-28, 2 figs. Mention of several installations of Saskatchewan and Manitoba districts in which satisfactory results have been obtained. Describes typical furnace arrangement.

Deposits and Industries. Lignites and Brown Coals and Their Importance to the Empire, William Arthur Bone. Royal Soc. Arts Jl., vol. 70, no. 3619, Mar. 31, 1922, pp. 342-355 and (discussion) 355-359, 1 fig. Origin and classification, characteristics and properties, geographical distribution; brown-coal industries in various countries.

Drying. Drying of Brown Coal for Boilers and Furnaces (Rohbraunkohletrocknung für Dampfkesselfeuerungen und industrielle Oefen), W. Viebahn. Braunkohle, vol. 20, no. 51, Mar. 25, 1922, pp. 801-806, 1 fig. Discusses heat loss due to water content in brown coal and preheating of brown coal to deprive it of its water.

Gasification. Past Efforts and Future Prospects in Lignite Gasification for the Heating of Open-Hearth Furnaces (Die bisherigen Bestrebungen und die zukünftigen Aussichten der Braunkohlenvergasung für die Beheizung von Siemens-Martinöfen), Hubert Hermann. Braunkohle, vol. 20, nos. 22 and 23, Sept. 3 and 10, 1921, pp. 337-341 and 358-362, 8 figs. Economic and technical aspects of lignite gasification.

LOCKS

Manufacture. The Mechanical Principles of Modern Locks and a Consideration of their Manufacture. Machy. (Lond.), vol. 20, no. 498, Apr. 13, 1922, pp. 49-54, 12 figs. Combined lever and warded lock, with double locking bolt; function of wards and levers; automatically operated deadlock; double keyhole locks; etc.

LOCOMOTIVE BOILERS

Design. Designing Locomotive Boilers for Maximum Efficiency, J. T. Anthony. Boiler Maker, vol 22, no. 4, Apr. 1922, pp. 107-108. Air and gas areas and ratio of tube length to diameter important factors to be considered.

Standard for 2-8-0 Type. Standard Boiler for 2-8-0 Type Mixed Traffic Locomotives, Great Western Railway. Ry. Gaz., vol. 36, no. 14, Apr. 7, 1922, pp. 600-601, 3 figs. Has coupled wheels 5 ft. 8 in. in diam.; boiler is No. 7 Swinton type, barrel tapers from 6 ft. diam. outside at throat plate to 5 ft. 6 in. diam. outside at smokebox, length of barrel 14 ft. 10 in.

Tubes. Installing and Maintaining Charcoal Iron Locomotive Tubes, G. H. Woodroffe and C. E. Lester. Boiler Maker, vol. 22, no. 4, Apr. 1922, pp. 102-106, 13 figs. Use of welding in tube work and proper methods to be followed in maintenance and repair.

LOCOMOTIVES

Baldwin 2-8-0. "Consolidation" Locomotives for the Andalusian Railway, Spain. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, pp. 553 and 556, 2 figs. Describes new Baldwin 2-8-0 type locomotive, which has unusually low coal consumption.

British and American Practice. British and American Locomotive Practice. Ry. Engr., vol. 43, no. 507, Apr. 1922, pp. 126-127. Abstract of paper presented at recent meeting of I.M.E. by P. C. Dewhurst, Loco., Carriage, and Wagon Supt. of Jamaica Govt. Rys. Closely reasoned comparisons and criticisms well worth considering.

Compound 2-8-0. New 2-8-0 Type Compound Locomotives for the Buenos Ayres Western Railway. Ry. Gaz., vol. 36, no. 16, Apr. 21, 1922, p. 676, 1 fig. Description of two-cylinder compound engine.

Design. Modern Tendencies in Locomotive Design, James Partington. Ry. Age, vol. 71, no. 15, Apr. 15, 1922, pp. 909-910 (includes discussion). Need of increased economy in use and production of steam; possibility of turbine and internal-combustion locomotives. (Abstract.) Paper presented at Newport News meeting of Am.Soc.Mech.Engrs.

Drifting Valve. Roberts Automatic Drifting Valve. Ry. & Locomotive Eng., vol. 35, no. 4, Apr. 1922, pp. 94-95, 2 figs. Object of valve is to automatically open small flow of steam to engine cylinders when throttle valve is closed, and to utilize exhaust of stoker and air pump for filling main engine cylinders as well as oil that has been fed to these auxiliaries for lubrication of cylinders.

Freight, Maximum Pull. Maximum Pull of Freight Locomotives (Essai sur les remorques maxima des locomotives à marchandises), L.-E. Creplet. Annales des Travaux Publics de Belgique, vol. 23, Feb. 1922, pp. 7-30. Describes tests with Pienlo locomotives on Kaifeng-Loyang line in China, including resistance at starting, effect of curves, etc.

Gasoline. A Gasoline Locomotive (Une locomotive a essence). Ach. Delamarre. Outillage, vol. 252, no. 12, Mar. 25, 1922, pp. 359-360, 2 figs. Describes new Renault locomotive for shunting and similar purposes in factories.

Lentz Hydraulic Transmission. "Lentz" Hydraulic Transmission for Crude-Oil Locomotives, Wittfeld. Eng. Progress, vol. 3, no. 5, May 1922, pp. 105-108, 4 figs. Internal-combustion engine burning heavy crude oil is to be adapted for locomotive service by means of Lentz hydraulic transmission. First crude-oil locomotive on this system has just been put in commission. Results of trials with this locomotive.

Steam-Electric Condensing-Turbine. New Development in Locomotive Practice. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, pp. 557 and 564, 4 figs. partly on p. 558. Describes Ramsay condensing-turbine electric locomotive, built by Armstrong, Whitworth & Co., Ltd., tractive force, 22,000 lb.

Thermic Siphons. Thermic Syphons Save 19 Per Cent in Fuel. Ry. Age, vol. 72, no. 16, Apr. 22, 1922, pp. 977-978, 1 fig. Improved performance of ten-wheel locomotive enables Spokane International to haul heavier trains.

Test of Syphon-Locomotive on Spokane International Ry. Ry. Rev., vol. 70, no. 15, Apr. 15, 1922, pp. 522-524, 3 figs. Application of single thermic siphon enables increase in tractive effort and improves efficiency of locomotive.

Valve Gear. The Calculation and Graphical Representation of the Walschaerts Valve Gear for Locomotives, S. E. W. Westrén-Doll. Ry. & Locomotive Eng., vol. 35, no. 4, Apr. 1922, pp. 88-92, 10 figs. Describes valve and method of calculating its proportions.

The Young Locomotive Valve Gear. Ry. Jl., vol. 28, no. 4, Apr. 1922, pp. 16-21, 13 figs. Notes on original and subsequent applications, and part this valve gear is playing in successful operation on railways in United States, Canada and Mexico in passenger, freight and switching service.

LUBRICATING OILS

Crankcase Oil Dilution. Crankcase Oil Dilution Problem and Its Solution, William F. Parish. Eng. World, vol. 20, no. 5, May 1922, pp. 307-314, 11 figs. Effect upon viscosity of lubricant; viscosity limits for lubricating oils established; relation between viscosity of lubricant and efficiency of engine shown graphically in tabular form. See also Oil News, vol. 10, no. 9, May 5, 1922, pp. 33-34 and 44-46, 1 fig.

Reconditioning Crankcase. Reconditioning Crankcase Lubricating Oil by a New Method. Automotive Industry, vol. 46, no. 17, Apr. 27, 1922, pp. 910-911, 3 figs. Fuel diluent and water automatically removed from crankcase lubricating oil by simple refiner which also filters out sediment.

LUBRICATION

Uniflow Engine. Lubrication of the Uniflow Engine. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 477-479. Some of features which make lubrication different for this type of engine and suggestions for proper solution. (Abstract.) Lubrication, pub. by Texas Co.

M

MACHINE GUNS

Barrels, Life of. Life of Machine-Gun Barrels, W. W. Sveshnikoff. Army Ordnance, vol. 2, nos. 9 and 11, Nov.-Dec. 1921 and Mar.-Apr. 1922, pp. 161-165 and 304-307 and 316, 24 figs. Nov.-Dec.: Abrasive action of bullet and gases. Principal factors which affect life of a machine gun. Mar.-Apr.: Cracking of surface of bore. Extracts from Technologic Papers Bur. Standards, No. 191.

Carriages and Mountings. Ordnance and Machine-Gun Carriages and Mountings. Abridgments of specifications, Period 1909-15, Class 92 (i), 1922, 277 pp. Patents for inventions.

MACHINE SHOP

Field Shop. A Field Shop in the Oil District, Frank A. Stanley. Western Machy. World, vol. 13, no. 4, Apr. 1922, pp. 120-122, 8 figs. Description of well-equipped shops maintained in Signal Hill Oil fields by Shell Co.

MACHINE TOOLS

Chain Drive. The Chain Drive and Machine Tools, Hubert Bentley. Mech. World, vol. 71, nos. 1838 and 1839, Mar. 24 and 31, 1922, p. 215 and pp. 235-236, 3 figs. Mar. 24: Compares chain with belt and gear drives; advantages of chain drive. Mar. 31: Types of chains and wheels; chain driving and installation and maintenance of chain drives.

German Construction. Progress in German Machine-Tool Construction (Fortschritte im deutschen Werkzeugmaschinenbau), Werner v. Schütz, G. Schlesinger and Max Kurrein. Werkstattstechnik, vol. 16, nos. 4a and 5, special no. and Mar. 1, 1922, pp. 1-62 and 129-156, 121 figs. Metal-working machines, including lathes, grinding, planing and slotting, boring and milling machines. Mar. 1: Hammers, shears, presses, bending machines and saws. Woodworking machines. Special machines. Tools, devices and finishing processes.

MALLEABLE IRON

Structure. Structure of White-Heart Malleable, Rudolph Stotz. Foundry, vol. 50, no. 7, Apr. 1, 1922, pp. 286-290, 25 figs. Principal characteristics shown by micrographs which indicate over or under annealing; carbon contents determine structure of unannealed iron.

MARINE BOILERS

Economy. Possibilities of Further Economy in Marine Boilers, John Reid. Shipbldg. & Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 461-465, 7 figs. Suggestions of remedies for heat losses and result of boiler trials at St. Peters Works, Hawthorne, Leslie & Co.

Possibilities of Further Economy in Marine Boilers, John Reid. Steamship, vol. 33, no. 395, May 1922, pp. 365-368, 4 figs. Data acquired from instruments installed in steamers suggests possibilities of new economies. Paper read at Spring Mtg. of Inst. of Naval Architects.

MARINE ENGINES

Sulzer Two-cycle. The Sulzer Two-Cycle Marine Engine, L. J. Le Mesurier. Oil Eng. & Finance, vol. 1, no. 2, Mar. 25, 1922, pp. 372-373. Advantages of two-cycle type above 1000 b.hp. (Abstract.)

MARINE STEAM TURBINES

Economy. Modern Marine Steam Turbine Economy. Mar. Engr. & Naval Architect, vol. 45, no. 535, Apr. 1922, pp. 165-167, 4 figs. Land and marine turbines compared. Direct drive versus reduction-geared turbines. Effect of higher gearing ratio and increased turbine revolutions on efficiency.

MATTER

Molecules, Space Between. The Space Between Molecules (Ueber den Abstand der Molekeln), Richard Gans. Physikalische Zeit., vol. 23, no. 5, Mar. 1, 1922, pp. 108-113, 4 figs. Derivation of equations for determining average space between molecules.

MEASURING INSTRUMENTS

Aircraft. Aircraft Measuring Instruments (Messgeräte für Flugzeuge), E. Everling and H. Koppe. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 13, Apr. 1, 1922, pp. 322-326, 29 figs. Points out that vibrations, quick change of flight and air conditions, and effect of wind necessitate special arrangement and construction of instruments, which is demonstrated by examples of indicating and recording instruments for pressure, change of altitude temperature, and for inclination and turning speed.

Precision. Precision Work in the National Physical Technical Institute (Die Feinmechanik in der Physikalischen-Technischen Reichsanstalt), F. Göpel. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 13, Apr. 1, 1922, pp. 293-298, 5 figs. Review of work in laboratory for precision measuring, with special regard to technically important work. Deals with equipment and measuring methods, especially of technical gage blocks, pass bolts and gages, guide screws and standard threads, revolution counters, tuning forks, etc.

METAL SPRAYING

Schoop Process. Metal Spraying, An Anti-Rust Prophylactic. Raw Material, vol. 5, no. 4, May 1922, pp. 147–149, 4 figs. By Schoop process iron, steel, and non-metallic materials are given non-ferrous metal coatings through device resembling machine gun that bombards objective surface with minute plastic particles of metal.

METALS

Protection from Air and Heat. Protecting Metal From Air and Heat—Calorizing (La protection des metaux contre les agents atmospheriques et la chaleur—La calorisation ou protection par l'aluminium), R. Levatel. Outillage, vol. 254, no. 14, Apr. 8, 1922, pp. 412–413. Reviews the Bower-Barff, Gesner, Lohman, Schoop and sherardizing processes. Bibliography.

Polishing. Motion Study in Metal Polishing, E. Farmer and R. S. Brooke. Metal Industry (N. Y.), vol. 20, no. 4, Apr. 1922, pp. 133–136, 3 figs. Experiment with wattmeter on process of roughing.

Tempering. The Tempering Phenomena and Their Generalization (Les phénomenes de trempe et leur généralisation), De Perdiguier. Chimie et Industrie, vol. 7, no. 2, Feb. 1922, pp. 211–243, 32 figs. Discusses critical points in temperature diagrams, including the cases of, eutectoids, line of transformation separating zone of one constituent from zone of two constituents, and zone of two constituents with two irregular lateral boundaries.

Tempering Phenomena and Their Generalization (Les phénomènes de trempe et leur géneralisation), Léon Guillet. Révue de Métallurgie, vol. 19, no. 3, Mar. 1922, pp. 162–168, 13 figs. On basis of diagram discusses the three cases of (1) eutectoid, (2) line of transformation separating zone of one constituent from zone of two constituents, and (3) zone of two constituents bounded laterally by two irregular lines.

MILLING MACHINES

Vertical, Economy of. Examples Where Vertical Milling Saved Money, J. H. Moore. Can. Machy., vol. 27, no. 16, Apr. 20, 1922, pp. 17–18, 46, 5 figs. Suitable fixtures facilitate production; multi-tooth cutters replace single point tool; particularly adapted to die-sinking; special attachments for continuous milling.

MOLDING MACHINES

Portable Hand-Operated. Exhibits a German Molding Machine. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 324–325, 5 figs. Describes portable, hand-operated machine of Vereinigte Schmirgel & Maschinenfabriken, A. G., recently exhibited at Liege, Belgium.

MOLDING METHODS

Production. Fittings Made on Production Basis. Foundry, vol. 50, no. 9, May 1, 1922, pp. 359–365, 9 figs. Adoption of simple and precautionary molding devices in shape of lifting plates and core prints reduce molding costs and insure more uniform product.

MOLYBDENUM STEEL

Automotive Industry. Use of Molybdenum Steel in the Automotive Industry, John D. Cutter. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 340–342 and (discussion) 342–344 and 347, 2 figs. Advantages in connection with light-weight car including reports and statements of metallurgists and manufacturers.

MONEL METAL

Properties and Uses. Monel Metal, a Natural Nonferrous Alloy, Morris A. Hall. Brass World, vol. 18, nos. 3 and 4, Mar. and Apr. 1922, pp. 76–79, 107–111, 18 figs. Appearance and properties; proper methods of melting and casting; uses and advantages.

MOTOR BUSES

Easy-Riding Tires. Easy Riding on Heavy Motor Vehicles. Bus Transportation, vol. 1, no. 5, May 1922, pp. 277–280, 15 figs. How tire and felloe construction provide comfort for passengers and longer life for bus mechanism.

High-Speed Design. High-Speed 'Bus Design. Motor Transport, vol. 34, no. 895, Apr. 24, 1922, pp. 500–501, 5 figs. Unusual body and chassis features embodied in vehicle built for Inter-city work in California, where high speeds are possible.

Trolley. Some Details of the "Rail-less" Car. Bus Transportation, vol 1, no 5, May 1922, pp. 268–269, 5 figs. Two-motor trolley bus with series-parallel control, seating capacity is thirty persons, with provision for liberal space and conveniences for several standees.

Trolley Bus Line Material and Current Collectors, G. W. Bower. Bus Transportation, vol. 1, no 5, May 1922, pp. 281–282, 6 figs. Result of experience shows that design of suspension and collectors must coördinate.

MOTOR TRUCKS

Gas Producers. The Cazes Gas Producer for Motor Trucks (Le gazogène "Cazes" pour camion automobile), E. Weiss. Nature, no 2501, Mar. 11, 1922, pp. 145–147, 3 figs. Describes producer-gas generator of 30–40 hp. consuming 483 gr. charcoal per hp. and pulling trucks of nearly 12 tons.

Tipping. New Motor Trucks for Conveying Quantity Goods (Neuere Lastkraftwagen für die beförderung von Massengütern), L. Ptaczowsky. Allgemeine Automobile Zeitung, vol. 23, no 9, Mar. 4, 1922, pp. 38–40, 9 figs. Describes various types of Krupp tipping trucks; unloading sideways, on all sides, into railroad cars; etc.

MOTORCYCLES

Engines. Motor Cycle Engines. Automobile Engr., vol. 11, nos. 154 and 155, Sept. and Oct. 1921, pp. 299–300, 10 figs. and pp. 353–355, 4 figs. Sept.: Describes power units of Indian "Scout" Engine built by Hendee Mfg. Co. Oct.: Power units of J. A. Prestwich single cylinder and twin engines.

Single Sleeve-Valve Engine. The Barr and Stroud 3 Hp. Cycle Engine. Automobile Engr., vol. 12, no. 162, Apr. 1922, pp. 115–117, 7 figs. Features of recently developed Knight type motor.

N

NATURAL GAS

Combustion Tests. Natural Gas Combustion Tests, I. V. Brumbaugh and G. W. Jones. Gas Age-Rec., vol. 49, no. 16, Apr. 22, 1922, pp. 495–498, 2 figs. Associate Gas Engr. and Asst. Chemist of U. S. Bur. of Standards give, with permission, advance information on their tests of natural gas used in domestic gas burners.

NICKEL ALLOYS

Cooperite. Cooperite, a High-Speed Cutting Material. Raw Material, vol. 5, no. 3, Apr. 1922, pp. 110–112, 4 figs. Discusses properties of and tests made with cooperite, a non-ferrous alloy containing nickel as basic metal with various amounts of zirconium, aluminum, silicon, tungsten and molybdenum.

Nickel-Silver. Some Mechanical Properties of the Nickel-Silvers, F. C. Thompson and Elwin Whitehead. Metal Industry (Lond.), vol. 20, nos. 11 and 12, Mar. 17 and 24, 1922, pp. 249–254 and pp. 276–277 and (discussion) p. 280, 17 figs. Effect of conditions of annealing on tensile properties of hard-rolled alloys; temperature of heating and rate of cooling of three alloys containing 10, 15 and 20 per cent of nickel; results of tests. Paper read before Inst. Metals.

NOTCHED-BAR TESTS

Investigation of. The Notched-Bar Test (Die unerforschte Kerbschlagprobe), R. Stribeck. Stahl u. Eisen, vol. 42, no. 11, Mar. 16, 1922, pp. 405–408, 1 fig. Desiderata for new development. Notched-bar test for testing of workshop material. Author advises precaution in judging materials tested in this manner. Suggestions for a new regulation.

O

OIL FUEL

Laundry Power Plant. Oil Burning in Laundry Power Plant, Charles L. Hubbard. Nat. Engr., vol. 26, no. 5, May 1922, pp. 192–196, 9 figs. Oil substituted for coal and shows decided advantages; equipment details.

Naphtha, Calorific Power of. Indirect Determination of Calorific Power of Naphtha as a Fuel (Determinazione indiretta del potere calorifico della nafta per uso di combustibile), Giulio Morpurgo. Giornale di Chimica Industriale ed Applicata, vol. 4, no. 1, Jan. 1922, pp. 15–17. Discusses new method for analyzing liquid fues, which requires no complicated apparatus, and gives rational basis for evaluating naphtha.

Pools, Beds, or Streams. Pools or Beds, Streams of Oil? J. von Gal Scale. Petroleum Times, vol. 7, no. 172, Apr. 22, 1922, p. 560. Pointing out misleading character of term pool.

OIL INDUSTRY

Bergin Treatment. The Bergin Treatment of Mineral Oils and Coal, F. Bergin. Petroleum Times, vol. 7, no. 172, Apr. 22, 1922, p. 516. Description of process by which mineral oils and coal can be converted into benzine, motor spirit, and fuel oil. Presented at Assn. of German Chemists' recent meeting.

OILS

Specifications for Fats and. Oils, Fats, Lubricants, Candles, and Soaps. Abridgments of Specifications, Period 1909–15, Class 91, 1922, 151 pp. Patents for inventions.

OPEN-HEARTH FURNACES

Operation. Efficient Arrangement of Open Hearth Labor, P. S. Young. Blast Furnace & Steel Plant, vol. 10, no. 4, Apr. 1922, pp 215–219. Reduction of forces by better distribution of men and occupations in operating modern open-hearth shop.

Valves, Reversing. New Reversing Valves for Open Hearth Furnaces, Hubert Hermanns. Blast Furnace & Steel Plant, vol. 10, no 4, Apr 1922, pp 228–229, 4 figs. Describes new bell valve, consisting of two parts which are separated by water-cooled partition wall.

OXY-ACETYLENE WELDING

Railway Shops, In. The Oxy-Acetylene Process in Railway Shops, F. S. Tinder. Car Foremen's Assn. of Chicago. Official Proc., vol 17, no. 6, Mar. 1922, pp. 16–39 and (discussion) pp. 40–57, 2 figs. Notes on properties of acetylene and oxygen; development of process. Experience in welding on Virginian railway.

Safe Handling. Gas Welding and Cutting. Am. Gas Jl., vol 116, no. 14, Apr. 8, 1922, pp. 328–330 and 336–338. Rules for safe handling of apparatus.

P

PAINTS

Protection for Wood. Paint Protection for Wood, Cornelius R. Myers. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 348–350, 2 figs. Report of investigation resulting from complete lack of data on protection of wood against moisture.

Specifications. Why Paint Specifications Present a difficult Problem, F. P. Ingalls. Ry. Rev., vol. 70, no. 17, Apr. 29, 1922, pp. 597–600, 1 fig. Effect of character of pigment on drying and durability of paint; effect of size and shape of pigment particles on character of paint. Satisfactory specifications cannot be based on composition but on what paint will do. From paper presented at Nat. Expos'tion of Chem. Industries, in N. Y.

PAPER MANUFACTURE

Deodorizing Digester Blow. Removal of Odors from Digester Blow in Sulphate Mills, Gustaf F. Enderlein. Paper Mill, vol. 45, no. 16, Apr. 29, 1922, pp. 4, 1 fig. Suggestions as to means of avoiding poluting atmosphere by condensing odoriferous steam.

Developments. Recent Developments in Paper-making, T. D. Nuttall. Paper, vol. 30, no. 6, Apr. 12, 1922, pp. 7–11 and 16. Forming sheet and felting fibers on high speed machines of great width. From Proc. Technical Section of Papermakers' Assn. Great Britain and Ireland.

Explosion of Drying Cylinder. Explosion of a Drying Cylinder (Zerknall eines Trockenzylinders). Zeit. des Bayerischen Revisions-Vereins, vol. 26, no. 7, Apr. 15, 1922, pp. 51–52, 4 figs. Describes explosion at cellulose factory in Silesia; cylinder was part of a paper-making machine running 300 days of 24 hr. per year; exact cause has not been ascertained.

Latex. Making Paper with Latex, Frederick Kaye. Rubber Age, vol. 3, no. 2, Apr. 1922, pp. 67–68. Comparison of quality of product with and without this rubber derivative.

PAPER MILLS

Ventilation. Moving Air in Paper Mill Work, Paper, vol. 30, nos. 4, 5 and 7, Mar. 29, Apr. 5 and 19, 1922, pp. 7–11, 8–11 and 128–131. Mar. 29: Altering pressure of air; overcoming moisture from wet machines; types of finishing rooms to be ventilated; maintaining even humidity conditions; heating system for machine room; distributing the air. Apr. 5: Utilization of waste heat; use for air in plants making coated paper; regulating temperature of press rooms. Apr. 19: Methods of conditioning gummed paper; dryers; conditioning air in storage buildings.

PATENT LAWS

Germany. Inventions and Patent Rights (Maschinenerfindungen und Patentrecht). Dinglers polytechnisches Journal, vol. 337, no. 7, Apr. 8, 1922, pp. 65–66. Discusses requirement of novelty for German patents as laid down by recent legal decisions.

PATTERNS

Foundry, Design. Pattern Design Presents Problems, Joseph Horner. Foundry, vol. 50, nos. 7 and 8, Apr. 1 and 15, 1922, pp. 275–278 and 326–328, 25 figs. Apr. 1: Coöperation between heads of manufacturing enterprise will prevent annoying and costly mistakes. Apr. 15: Pattern construction costs from pattern-shop viewpoint and from foundry and machine-shop viewpoint.

PIPE

Threading and Cutting Machine The Landis Twelve-Inch Pipe Threading and Cutting Machine. Ry. & Locomotive Eng., vol. 35, no. 4, Apr. 1922, pp. 83–85, 6 figs. Length of machine is 11 ft., its extreme width, 5 ft. and it weighs 13,000 lb.; it has single-pulley drive, and variations in speed, which are eight in number, are obtained by means of speed box, located beneath main spindle.

PIPING

Losses, Calculation of. Calculating Losses in Air and Steam Conduits According to New Research on the Coefficient of Resistance to Flow (Calcul des pertes de charge dans les conduites d'air, de vapeur et d'eau d'après de nouvelles recherches sur le coefficient de résistance à l'écoulement), V. Leveau. Révue Universelle des Mines, vol. 12, no. 4, Feb. 15, 1922, pp. 301–327, 10 figs. partly on supp. plate. Reviews literature on subject, calculates pressure losses, classifies pipe by roughness, and gives examples of applying new formulas.

PISTONS

Aluminum Alloys for Motor. Some Experiences of Aluminium and Its Alloys for Motor Pistons. Metal Industry (Lond.), vol. 20, no. 14, Apr. 7, 1922, p. 321. Advantages obtained from pistons of this type and analyses of more suitable combinations.

Cast Iron, Production. Methods Used in Specialized Production of Cast Iron Pistons, J. Edward Schipper. Automotive Industries, vol. 46, no. 17, Apr. 27, 1922, pp. 914–916, 6 figs. Some original processes. Foundry cores are machine-made. Description of aging process, machining and inspection methods. Claimed that pistons are held to tolerance of plus or minus 0.0005 in.

PLANERS

Spur-Gear. Planing Large Spur Gears. Machy. (Lond.), vol. 20, no. 498, Apr. 13, 1922, pp. 37–39, 5 figs. Application of gear planers which cut gear teeth by reproducing shape of a templet.

PLATES

Deflection. The Deflection of Continuous Plates and the Rectangular Plate with Free Edges (Ueber die Biegung durchlaufender Platten und der rechteckigen Platte mit freien Rändern) A. Nadai. Zeit. fur angewandte Mathematik u. Mechanik, vol 2, no. 1, Feb. 1922, pp 1-26, 24 figs. Calculations to determine singularities of plate deflection.

POWER PLANTS

British Practice. Notes on British Power Plant Practice, C. H. S. Tupholme. Power Plant Eng., vol 26, no. 8, Apr. 15, 1922, pp. 416-418. Experiments with peat, discussion of methods of improving internal-combustion engine efficiency.

Construction, Far East. Dredge and Power Plant Construction in the Far East, P. R. Parker. Eng. & Min. Jl.-Press, vol. 113, no. 119, May 13, 1922, pp. 807-812, 7 figs. Equipment purchased in U. S., modeled on California gold practice, a success in dredging for stream tin in Malay states, difficulties of transportation and installation solved.

Cost Cutting in Industrial. Cost Cutting for Industrial Power Plants, David Moffat Myers. Indus. Management, vol. 63, nos. 3, 4 and 5, Mar., Apr. and May 1922, pp. 140-142 and 170, 234-237, 304-309, 4 figs. Mar.: How to discover and correct boiler-plant wastes. Apr.: Determining present results and possible improvements. May: Methods of improving performance.

Design. Developments in Power Station Design. Engineer, vol. 133, no. 3457, Mar. 31, 1922, pp. 347-350, 9 figs. Describes condensers and their auxiliaries put on market by G. & J. Weir, Ltd., Glasgow, Scotland.

Five Pacific Coast Projects. Five Pacific Coast Water-Power Projects Licensed by Commission. Elec. World, vol. 79, no. 17, Apr. 29, 1922, pp. 850. Plants at Kaweah River outside Sequoia Nat. Park, on San Joaquin River in Fresno and Madera Counties, on Snow Creek, Riverside County, at Delta, Cal., and on Clackamas River, Clackamas County, Oregon, to be developed.

Industrial, Layout for. Laying Out a Power and Heating System for an Industrial Plant, Chas. L. Hubbard. Southern Engr., vol. 37, no. 3, May 1922, pp. 47-51, 7 figs. Piping layout from boiler to engine and pumps, heating system, supply and return and fire protection.

Operation. Higher Steam Pressures or Pulverized Coal? Frederick A. Scheffler. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 5, May 1922, pp. 346-350, 1 fig. Assumes a hypothetical power or public service steam plant of 100,000-kw. nominal capacity and compares cost of operation of such a plant oo basis of 250 lb. pressure and 600 deg. fahr. total steam temperature, and 400 lb. pressure and 700 deg. fahr. total steam temperature, when fired by stokers aod pulverized coal.

Sweden. Swedish State Power Plants (Die Kraftwerke des schwedischen Staates). Elektrotechnischer Anzeiger, vol. 39, nos. 57-58 and 59, Apr. 12 and 13, 1922, pp. 491-492 and 501-502, 6 figs. Construction and equipment of Motala power station recently opened, which, in conjunction with power stations at Trollhättan, Alfkarleby and Porjus, supplies power to state railways and various industries.

Utica State Hospital. Power and Heating Plant of Utica State Hospital. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 449-456, 12 figs. Description of central installation to supply heat, light, water, and power for institution approaching proportions of a city.

POWER TRANSMISSION

Oil. Power Transmission by Oil (Elaulic Gear), H. S. Hele-Shaw. Oil Eng. & Finance, vol. 1, no. 1, Jan. 14, 1922, pp. 59-68, 16 figs. Description of oil-variable-gear which is newest of special type.

Rope Drive. Power Transmission by Rope Drive, A. D. Wilkinson. Southern Engr., vol. 37, no. 3, May 1922, pp. 35-37, 5 figs. Many textile mills are driven by means of rope-drive system. Multiple drive is dealt with in this article.

Types of Drives. Progress and Problems in Mechanical Transformation of Energy (Fortschritte und Probleme der mechanischen Energie-Umformung), K. Kutzbach. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 7 and 8, Feb. 18 and 25, 1922, pp. 154-159 and 183-185, 26 figs. Deals with indirect converter types. Status of belt and rope drive for long-distance conversion; increasing use of stretching pulleys for safe control of external tensions, problem of slip and friction, durability and bending losses. The Föttinger and the Lentz converters and their use for all kinds of vehicles.

PRESSES

Inclinable. The Use of Inclinable Power Presses. Machy. (Lond.), vol. 19, no. 496, Mar. 30, 1922, pp. 737-738, 3 figs. Inclination of presses; classes of work readily performed on inclinable presses.

PULLEYS

Driving for Hydro-Extractor. Driving Pulley for Hydro-Extractor. Textile World, vol. 61, no. 16, Apr. 22, 1922, p. 41, 3 figs. Centrifugal clutch pulley which does not put load on motor until it has attained good speed.

PULVERIZED COAL

Combustion. The Carrying of Dust by a Current of Air (Etude de l'entrainement de poussièrepar un courant d'air), R. Audibert. Annales des Mines, vol. 1, no. 3, Mar. 1922, pp. 153-191, 3 figs. Discusses question of pulverized coal, especially arrangement of combustion chamber so as to assure complete combustion of dust.

Office-Building Heating. Powdered Fuel. Nat. Engr., vol 26, no. 5, May 1922, pp 219-221, 1 fig. Results from installation in 42-story L. C. Smith building, Seattle, Wash.

Power Plants. Lakeside Power Station at Milwaukee. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 397-406, 12 figs. Mechanical, electrical and construction features of world's largest pulverized fuel burning power plant.

Steam Boilers for. Powdered Coal under Steam Boilers, H. D. Savage. Coal Trade Jl., vol. 52, nos. 36, 37, 38, 39, 40 and 41, Sept. 7, 14, 21, 28, Oct. 5 and 12, 1921, pp. 1003-1004, 1028-1029, 1049-1051, 1074, 1094-1095 and 1116-1117, 5 figs. Progress made in making powdered coal for steam production thoroughly reliable and efficient, and economic possibilities of this method of combustion.

Treatment and Use. A New Pulverised Fuel Plant. Iron & Coal Trades Rev., vol. 104, no. 2821, Mar. 24, 1922, pp. 418-419, 2 figs. Describes coal drier, conveyance and distribution of pulverized fuel, hopper and controller system.

PUMPS

Semi-Solid Handling. A Pump that Handles Semi-Solids. Elec. News, vol. 31, no. 9, May 1, 1922, p. 51, 2 figs. Particularly designed to pass unscreened sewage; rags, cotton waste, fiber and all kinds of pulp and trade effluent from textile works in general. Made in England.

PUMPS, CENTRIFUGAL

Balancing, Automatic Method. Centrifugal Pumps, E. T. Keenan. Southern Engr., vol. 37, no. 3, May 1922, pp. 40-43, 7 figs. Automatic method of balancing; efficiency and losses.

PYROMETERS

Non-Ferrous Foundry. Pyrometry in the Non-Ferrous Foundry. Eng. Production, vol. 4, no. 81, Apr. 20, 1922, p. 365, 1 fig. Notes on thermo-electric, resistance, radiation and optical pyrometers.

R

RAILS

Russian 95-lb. The New 47 kg/m Rails of the Russian State Railways (Neue 47 kg/m schwere Schiene der russischen Staatsbahnen), C. Oppenheim. Organ fur die Fortschritte des Eisenbahnwesens, vol. 77, no. 3, Feb. 1, 1922, pp. 38-39, 2 figs. Describes in detail profiles of these new rails intended for very heavy traffic, and compares with rails in other countries.

Deformation, Measuring. Measuring Rail Deformation by Moving Picture Photography. Ry. Rev., vol. 70, no. 14, Apr. 8, 1922, pp. 483-484, 6 figs. partly on p. 485. Describes method for making observations of rail depression under a moving load by means of moving picture camera, and gives results of series of tests made on St. Louis-San Francisco Ry.

Steel, Rolled Manganese. Rolled Manganese Steel Rails. Ry. Gaz., vol. 36, no. 14, Apr. 7, 1922, pp. 597 and 601, 2 figs. Advantages claimed for built-up railway track work. Discusses layout of "Imperial" patent rolled manganese steel rails of Waterloo Station, Lond. & South Western Ry.

RAILWAY ELECTRIFICATION

Inductive Interference and Electrolysis. The Question of Inductive Interference and Electrolysis Relating to Railroad Electrification, Chas. F. Scott. Elec. Jl., vol. 19, no. 4, Apr. 1922, pp. 146-149. Consideration of various ways in which telephone service has been interfered with and pipe lines corroded, and means of overcoming difficulties.

Italy. Electrification of the Italian Railways (L'Elettrificazione delle Ferrovie Italiane), C. Vita-Finzi. Elettricista, vol. 4, nos. 5 and 6, Mar. 1 and 15, 1922, pp. 37-38 and 44-46, 1 fig. Discusses electric traction, and necessity for Italy to electrify; new law for electrification of railroads. Gives list of trunk lines already electrified and list of lines to be electrified.

Single-Phase Overhead System. The Lancaster-Morecambe-Heysham Electric Railway. Electrician, vol. 88, nos. 2281 and 2282, Feb. 3 and 10, 1922, pp. 124-129 and 155-156, 8 figs. Experiences of 14 years' working with single-phase overhead system. Failures and modifications which have been necessary in various parts of apparatus during the 14 years.

RAILWAY MOTOR CARS

New Features. New Features in Service Railway Motor Coach. Ry. Age, vol. 72, no. 18, May 6, 1922, pp. 1069-1070, 3 figs. Service Motor Truck Co., Wabash, Ind., produces coach in which power plant and transmission follow regular motor truck practice but running gear is unique.

Operating Costs. Motor Trucks Operate on Rails in City and Interurban Passenger Service. Mun. & County Eng., vol. 62, no. 4, Apr. 1922, pp. 18-22, 1 fig. City and Interurban Ry. Co., Manhattan, Kansas, has recently scrapped heavy electric cars and now operate four FWD railway cars.

Problems. Modern Motor Rail Cars and the Local Passenger Problem, L. G. Plant. Ry. Rev., vol. 70, no. 15, Apr. 15, 1922, pp. 519-522, 2 figs. General problems involved in successful adaptation of modern rail car to steam railway service.

RAILWAY OPERATION

Auxiliary Train Control. The Sprague System of Auxiliary Train Control. Ry. Age, vol. 72, no. 16, Apr. 22, 1922, pp. 963-967, 9 figs. Apparatus undergoing daily test on section of New York Central operates on normal danger plan and leaves engineer practically undisturbed while on duty.

Reversible Steam Train. "Reversible" Steam Train, London & North Western Railway. Ry. Gaz., vol. 36, no. 17, Apr. 28, 1922, pp. 697-699, 5 figs. Describes push-and-pull train which has been working satisfactorily on local service in England.

Train Control. Automatic Train Control in America. Ry. Gaz., vol. 36, no. 16, Apr. 21, 1922, pp. 658. Some observations on Interstate Commerce Commission suggestions in accordance with Sec. 26 of Transportation Act advising full equipment over one passenger division by July 1, 1924.

Railroads Argue Against Automatic Stops at I. C. C. Hearing. Ry. Signal Engr., vol. 15, no. 4, Apr. 1922, pp. 151-158. Railroads claim that no automatic train stop or train control device has been sufficiently developed to warrant installation on such extensive scale as is outlined in proposed order of Interstate Commerce Commission and that Am. Ry. Assn. is working for development of a practical device.

RAILWAY REPAIR SHOPS

Freight Cars. Rip Track Equipment and Methods on Ft. D. D. M. & S. Ry. Rev., vol. 70, no. 14, Apr. 8, 1922, pp. 491-495, 11 figs. Equipment and management of new freight-car repair yard and methods of repairing.

RAILWAY SHOPS

Equipment. What Shop Equipment Means to a Railroad, V. Z. Caracristi. Central Ry. Club Official Proc., vol. 30, no. 2, Mar. 1922, pp. 1156-1167 and (discussion) 1168-1182, 2 figs. Discusses expenditures necessary to take care of locomotives and cars coming immediately under jurisdiction of motive power department; gives charts and tables.

RAILWAY SIGNALING

Belgium. Signaling on the Belgian State Railways (La signalisation des chemins de fer de l'état Belge), Lucien Pahin. Génie Civil, vol. 80, no. 11, Mar. 18, 1922, pp. 253-255, 3 figs. Describes fixed signal system, positions of arms, colored lights, and shows how dangerous points are guarded by signals.

Facing Points, Long-Distance Operation. Long-Distance Operation of Facing Points. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, p. 561, 3 figs. Relates how colliery company has been first in England to work facing points 500 yards distant direct from signal box electrically by primary batteries, providing ready and comparatively cheap means towards converting refuge sidings into running loops.

Unlocking by Tablet. Unlocking the Starting Signal for Entering a Single Line Section by the Tablet. Ry. Engr., vol. 43, no. 507, Apr. 1922, pp. 133-139, 1 fig. Only railway company which consistently unlocks all single line starting signals by tablet is London & South-Western. Description of original and present method employed.

RAILWAY TIES

Tamping Machine. Tamping Machine for Railroad Ties (Machine para soccar o lastro sob os dormentes). Revista Brasileira de Engenharia, vol. 3, no. 2, Feb. 1922, pp. 79-80, 2 figs. Describes machine made by Serva & Cia., S. Paulo, consisting of a hammer for tamping ballast and a gasoline engine for driving hammer.

RAILWAY TRACK

Construction. Adjusting Track Construction to the Lightweight Car, R. G. Taber. Elec. Ry. Jl., vol. 59, no. 18, May 6, 1922, pp. 755-756, 1 fig. Account of two track jobs recently completed in Fort Worth, in which advantage was taken of light weight of Birney cars operated there in cheapening construction. (Abstract.) Paper read before Southwestern Elec. & Gas Assn.

Curves. The Design of Transition Curves for Railway Tracks (Zur Konstruktion des Uebergangsbogens fur Eisenbahngleise), K. Lachmann and R. Rothe. Zeit. fur angewandte Mathematik u. Mechanik, vol. 2, no. 1, Feb. 1922, pp. 45-78, 8 figs. It is claimed that methods of practical mathematics permit accurate solution of problem, not only for flat curves, but for transition curves for any given differences in direction.

Rack Type. Rack Wheel and Branch Lines (Zahnradanschlussbahnen), A. Wichert. Schweiz. Elektrotechnischer Verein Bul., vol. 13, no. 3, Mar. 1922, pp. 98-106, 6 figs. Describes cog-wheel electric locomotive of Oker Metal and Color Works, in Harz Mountains, and loading and unloading arrangements at works with a difference in levels of 24 meters.

Shifting Machine. Track Shifting Machine, Friedr. Hübener. Eng. Progress, vol. 3, no. 4, Apr. 1922, p. 87, 2 figs. Describes Arbenz-Kammerer type, consisting essentially of portable bridge resting on two bogies; center of bridge carries frame which may be shifted over laterally.

RAILWAYS

Czechoslavakia. The Railways of Czechoslavakia (Trois années d'existence des chemins de fer Tchécoslovaques), Paul Koller. Révue Générale des Chemins de Fer et des Tramways, vol. 41, no. 4, Apr. 1922, pp. 276-290, 1 fig. Discusses post-war situation, rolling stock, workshops, coal shortage, finances, etc.

Chinese Government. Administration of Chinese Government Railways, Ching-chun Wang. Ry. Rev., vol. 70, no. 17, Apr. 29, 1922, pp. 600-605, 2 figs. Railway developments in China and details of Central Administration controlling them. From Jl. Assn. Chinese & Am. Engrs.

Italy. Italian Railways. Ry. Gaz., Special Italian Railway Number, Apr. 18, 1922, pp. 5-32, 102

figs. partly on pp. 33–69. (In Italian and English.) Detailed description of state railways, including administrative management and staff, passenger fares and train service, freight traffic, engineering questions, rolling-stock, etc.

Russia. Present State of Railroad Transportation in Russia, U. I. Lebedeff. (In Russian.) Supp. to Eng. News of Scientific and Technical Council of Russian Eng. Assn., Jan. 1919, 8 pp., 12 figs. Statistical data on Russian railroads as they were at end of 1918.

REFRACTORIES

Softening Temperature, Determining. A New Device for Determination of the Softening Temperature of Refractory Materials under Load (Eine neue Vorrichtung zur Bestimmung der Erweichungstemperatur von feuerfesten Materialien unter Belastung), W. Steger. Berichte der Deutschen Keramischen Gesellschaft, vol. 3, no. 1, Feb. 1922, pp. 1–4, 1 fig. Describes press and heating device developed by author for use in Chemical-Technical Experimental Station of the State Porcelain Mfg. Works, Berlin-Charlottenburg.

REFRIGERATING MACHINES

Carbon Dioxide. The Operation of CO_2 Marine Refrigerating Machines in Warm Seas (Du fonctionnement des machines frigorifiques marines a acide carbonique dans les mers chaudes). Bul. Technique du Bureau Veritas, vol. 4, no. 2, Feb. 1922, pp. 43–44, 1 fig. Difficulties arising from fact that critical point of CO_2 is 31.35 deg. and temperature in warm seas sometimes is above 30 deg., and describes Le Blanc method of overcoming difficulties, consisting simply of cooling condensing water by installing between sea and condenser of CO_2 machine, a vacuum evaporator.

REFRIGERATING PLANTS

Ammonia Fittings, Standardization of. Standardization of Ammonia Fittings Necessary, Erwin Bunzel. Power, vol. 55, no. 15, Apr. 11, 1922, p. 581. Pointing out necessity of early adoption of code covering standardization of flanges for refrigerating systems.

REFRIGERATION

Meat Industry. Refrigeration and the Meat Industry, W. H. Medcalf. Cold Storage & Ice Assn. Proc., vol. 18, no. 1, 1921–22, pp. 69–83 and (discussion) pp. 84–90. Indicates general uses to which refrigeration is applied at present time.

ROLLING MILLS

Electric Drive Troubles. Where to Look for Things that Cause Trouble in Reversing-Roll Electric Drives, Arthur J. Whitcomb. Elec. Rev. & Indus. Engr., vol. 80, no. 2, Feb. 1922, pp. 63–66, 103, 8 figs. Maintenance practice in reversing roll electric drives.

RUBBER

Machinery, Developments in. Modern Developments in Rubber Machinery, J. W. Howie. India-Rubber Jl., vol. 63, nos. 15 and 16, Apr. 15 and 22, 1922, pp. 17–25 and 13–18 and (discussion) 18–19, 40 figs. Apr. 15: Some recent improvements. Apr 22: Vulcanizing, type making, hose covering and special plant. Paper read before Instn. Rubber Industry, at Royal Soc. Arts.

Magnesium Carbonate Compounded with. Some Physical Properties of Rubber Compounded with Light Magnesium Carbonate, H. W. Greider. Jl. of Indus. & Eng. Chem., vol. 14, no. 5, May 1922, pp. 385–395, 22 figs. Data showing increase in tensile strength, hardness and resilient energy and probability of eliminating principal disadvantages by compounding filler in amorphous form.

Transparent. Rubber Glass—A New Product of Great Interest. India Rubber World, vol. 66, no. 2, May 1, 1922, pp. 538–539. Description of invention of Fordyce Jones, giving its advantages and limitations.

Vulcanization. Cold Vulcanization of Rubber, S. J. Peachey. Rubber Age, vol. 3, no. 2, Apr. 1922, pp. 61–66. Paper read before Inst. of Rubber Industry, London, on this method of determination with gases and advantages of same.

S

SAFETY ENGINEERING

Graphic Charts. Obtaining and Presenting Safety Statistics for the Busy Executive, A. M. Underhill. Safety Eng., vol. 43, nos 4 and 5, Apr. and May 1922, pp. 131–134, 199–204, 7 figs. Apr.: Methods of presenting statistics for determining what steps may be taken to prevent repetition of accidents in such form that they become intelligible to executives not familiar with work. May: Use of logarithmic paper for curve charts clearly shows accident increase or decrease.

SAND BLAST

Plants and Methods. Sand Blasting, E. L. Samson. Foundry Trade Jl., vol. 25, nos. 287 and 288, Feb. 16 and 23, 1922, pp. 115–118 and 143–144, 19 figs. High- versus low-pressure plants; abrasive power considerations; cost of sand blasting; sand-blast rooms, cabinets and tumbling barrels; sand-blast conveyors; dust collecting; etc. Paper read before Instn. British Foundrymen.

SAND, MOLDING

Dressing. The Dressing of Moulding Sand, Heinz Kalpers. Eng. Progress, vol. 3, no. 4, Apr. 1922, pp. 79–81, 5 figs. Notes on dressing of fresh sand, used sand and coal dross; drying furnaces for fresh sand; shaking sieves; sand-crushing mills with magnetic rollers; automatic dressing plants.

Preparation. Sand Offers Field for Improvement, Eugene W. Smith. Foundry, vol. 60, no. 7, Apr. 1, 1922, pp. 264–265. Factors besides physical characteristics and chemical analysis entering into preparation, classification and grading of sand used in preparation of molds into which metal is poured. From paper read before Chicago Foundrymen's club.

SCRAP

Deleading. Removing Lead from Scrap Metals (Das Entbleien von Altmetallen) Metall—Technik, vol. 48, no. 10, Mar. 4, 1922, pp. 92–93. Discusses wet and dry methods and describes operations.

Metal, Dezincification. Dezincing of Scrap Metal (Das Entzinken von Altmetallen, B. Haas. Zeit. für die gesamte Giessereipraxis, vol. 43, no. 12, Mar. 25, 1922, p. 154. Thermal and chemical processes used. Concludes that dezincification is more reliable and simpler than deleading.

SEAPLANES

Facilities on Atlantic Coast. Seaplane Facilities on the Atlantic Coast. Aviation, vol. 12, no. 18, May 1, 1922, pp. 506–507. Thirty-nine landing places for seaplanes listed in survey issued by Nat. Advisory Com.

SEMI-DIESEL ENGINES

Two-Cylinder Marine. New Two-Cylinder Semi-Diesel Marine Oil Engine. Oil Eng. & Finance, vol. 1, no. 2, Mar. 25, 1922, pp. 369–370, 1 fig. Design for small commercial vessels two-cycle hot-bulb developing 30 b.hp. at 425 r.p.m.

SHERARDIZING

Factors Influencing Process. Factors Influencing the Process of Sherardizing, Leon McCulloch. Elec. Jl., vol. 19, no. 4, Apr. 1922, pp. 156–160, 4 figs. Experiments in features not hitherto definitely known. .Growth of coating, effect of iron in zinc dust; effect of other metals in zinc dust; composition of coatings.

SMOKE ABATEMENT

Water Grates. Abatinga Smoke Nuisance, R. R. Hillman. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 463–465, 3 figs. Treatment of an unique case in department store in Buffalo where water grates also increased circulation of boiler water.

SOOT BLOWERS

Steam Consumption. Steam Used for Soot Blowing, Robert June. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 414–415, 4 figs. Method of calculating steam consumption when time valve is open is known. See also Power House, vol. 15, no. Apr. 5, 1922, pp. 30–31, 4 figs.

SPECIFIC HEAT

Gas. The Specific Heats of Gas From the Point of View of Their Industrial Application (Sur les chaleurs spécifiques des gaz envisagées au point de vue de leur application aux problèmes industriels), Emilio Damour and D. Wolkowitsch. Révue de Métallurgie, vol. 19, no. 3, Mar. 1922, pp. 145–161, 2 figs. Reviews in detail literature on subject, and shows that there is no agreement between the various authorities.

SPRINGS

Impact, Absorption of. Graphic Representation of Absorption of Impact by Springs. Machy. (Lond.), vol. 20, no. 499, Apr. 20, 1922, pp. 93–94, 2 figs. Description of graphic method to determine energy absorbed under certain simple conditions.

Laminated. General Theory of Laminated Springs (Allgemeine Theorie der Blattfeder), Y. Tanaka. Zeit. für angewandte Mathematik u. Mechanik, vol. 2, no. 1, Feb. 1922, pp. 26–34, 6 figs. Deals with equilibrium of laminated springs under influence of an inclined load, taking into consideration friction and initial pressure between the plates, differing strength and shape of plates and curvature of spring.

STACKS

Venturi. New Stack Type, A. W. H. Griepe. Am. Gas Jl., vol. 116, no. 15, Apr. 15, 1922, pp. 343–346, 18 figs. New type similar in shape to a venturi tube combined with blower has advantage of flexibility of operation, and low cost of installation and maintenance.

STANDARDIZATION

Reducing Cost. Reducing the Cost of Standardization, W. O. Lichtner. Management Eng., vol. 2, no. 5, May 1922, pp. 275–280. Need and possibilities of handbook of times for performing manufacturing operations including charts and tables showing elementary operations analyzed to simplest items.

STAYBOLTS

Failure. Defective Staybolts Cause Locomotive Disaster, A. G. Pack. Boiler Maker, vol. 22, no. 4, Apr. 1922, pp. 97–99, 3 figs. Report of failure of Pennsylvania R. R. locomotive, submitted to Interstate Commerce Commission. Explosion partly due to heavy grooving of back head at mud ring.

STEAM

Generation, Distribution and Use. The Generation, Transmission and Use of Steam (Dampferzeugung, Dampfforteitung und Dampfverwendung), H. Lasser. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 1–3. Notes on economic steam generation; steam distribution and conduction; and use of steam for generation of power and of steam for cooking and heating purposes.

High-Pressure. Higher Steam Pressures, Joseph Jares. Combustion, vol. 6, no. 5, May 1922, pp. 221–223, 1 fig. Consensus of opinion of most writers favors higher pressures and temperatures. Advantages. Letters from C. J. Stover, Sec'y of Magnesia Assoc. of Am., and W. S. Lockwood, of Johns-Manville, Inc.

The Properties of Steam under High Operating Pressures (Bemerkungen zu den Eigenschaften des Wasserdampfes bei hohen Betriebsdrücken), G. Eichelberg. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 12, Mar. 25, 1922, pp. 275–277, 6 figs. Differences in the values for heat of evaporation obtained by Schüle and Eichelberg. Possibility of indirect measurement of specific heat of saturated steam based on relation between exponent of the adiabatic curve, heat of evaporation and specific heat.

Metering of. The Metering of Steam, John L. Hodgson. Shipbldg. & Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 466–468, 5 figs. Steam meters developed by author and his firm, Geo. Kent, Ltd., during last twelve years.

Specific Heat of Superheated. The Specific Heat of Superheated Steam for Pressures of 20 to 30 Atmos. (Die spezifische Wärme des überhitzten Wasserdampfes für Drucke von 20 bis 30 at.), Osc. Knoblauch. Zeit. für technische Physik, vol. 3, no. 2, 1922, pp. 39–40. Results of tests carried out in conjunction with E. Raisch.

STEAM ENGINES

Heat Economy. Using the Heat of Piston Steam Engines to Best Advantage (Die Wärmeausnutzung der Kolbendampfmaschine), W. Schmidt and R. Wolf. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 14, Apr. 8, 1922, pp. 345–350, 4 figs. Discusses increase of pressure from 18 to 55 atmos., increase in expansion of steam, intermediate superheating, etc., on basis of latest experiments by W. Schmidt and R. Wolf.

Indicator Diagrams. Indicator Diagrams. Power, vol. 55, no. 15, Apr. 11, 1922, pp. 574–576, 28 figs. Contains diagrams from Corliss, uniflow and non-releasing four-valve engines.

Uniflow. Uniflow Blooming-Mill Engine. Eng. Progress, vol. 3, no. 4, Apr. 1922, pp. 69–71, 6 figs. Effect of inlet condensation; different principles of uniflow action. The Demag uniflow engine with two rows of slits. Comparisons with long-piston engine.

STEAM PIPES

High-Pressure. Safety in High-Pressure Piping of Steam Power Plants (Die Sicherheit beim Betrieb von Hochdruckrohrleitungen in Dampfkraftanlagen), H. Menk. Wärme, vol. 45, no. 4, Jan. 27, 1922, pp. 56–59, 11 figs. Discusses measures and devices employed for increasing safety in use of such pipes.

STEEL

Defective Points, X-Ray Examination. Fundamentals for Determination of Defective Points in Steel by Means of X-Rays (Grundlagen für die Feststellung von Fehlstellen in Stahl mittels Röntgenstrahlen), E. H. Schulz. Stahl u. Eisen, vol. 42, no. 13, Mar. 30, 1922, pp. 492–496, 19 figs. Describes apparatus for examination with X-rays, and results obtained; depth of irradiation; investigation of welding points.

Molybdenum. See MOLYBDENUM STEEL.

Structural. See STRUCTURAL STEEL.

X-Ray Examination. X-Ray Investigations of the Structure of Steel Ingots and Billets (Röntgenstruktur-Untersuchungen an Blöcken und Knüppeln), Fr. Heinrich. Stahl u. Eisen, vol. 42, no. 14, Apr. 6, 1922, pp. 540–542, 6 figs. Results of tests carried out according to the Laue process. X-ray photographs are presented and described. In a second article by R. Glocker, the technical application of process is described (pp. 542–543, 2 figs.) Discussion of both articles, pp. 543–545.

[See also IRON AND STEEL; METALS.]

STEEL, HEAT TREATMENT OF

Ball Bearings. Ball Bearing Steel and its Heat Treatment, Carl T. Hewitt. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 196–198, 4 figs. Use of steels of from 0.60 to 1.50 per cent chromium content to meet extreme service demands. Methods of annealing and of hardening.

Hardening in Tempering Furnace. The Hardening of Steel Parts in Tempering Furnace (Das Härten von Eisenteilen im Härteofen). Zeit. für die gesamte Giessereipraxis, vol. 43, nos. 10 and 11, Mar. 11 and 18, 1922, pp. 129–131 and 142–144. Notes on proper design of furnace and methods of hardening.

Problems. Heat Treatment Problems—II, Leslie Aitchison. Metal Industry (Lond.), vol. 20, no. 5, Feb. 3, 1922, pp. 113–115, 3 figs. Deals with problems of cooling.

Tests. Relation of Time for Heating Round Sections to Surface per Lb. of Steel Exposed, E. J. Janitzky. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 179–181, 2 figs. Discusses experiments carried on by M. E. Leeds, results having been presented in paper, "Some Neglected Phenomena in the Heat Treatment of Steel," before Am. Soc. for Testing Mtls. and published in A.S.T.M. Proc., vol. 15, 1915.

STEEL MANUFACTURE

Basset Process. Blast Furnace Eliminated from Steel Making. Indian Industries & Power, vol. 19, no. 7, Mar. 1922, pp. 235–236. Some unsubstantiated reports of process discovered by Basset for producing steel direct from ore. Being tried out in Sheffield.

STEEL WORKS

British. Famous British Works. Eng. Production, vol. 4, nos. 77 and 78, Mar. 23 and 30, 1922, pp. 266–268 and 290–292, 9 figs. Describes works of Arm-

Important Announcement

to Users of

Standardized Bearings in Quantity

The A. W. Cadman Manufacturing Company has completed arrangements to furnish its metals, BEARITE, lead-base, and ACORN BRAND, tin-base, in bearings finished to size by a new process.

The bearings may be either straight babbitt, bronze back, steel back, or aluminum back.

This process, in conjunction with the unique properties of Cadman Metals, offers the following advantages:

(1) Perfect adhesion between babbitt and supporting shell.
(2) Complete elimination of "piping" and blow-holes.
(3) Sixty per cent. greater rate of heat dispersion.
(4) Guaranteed freedom from breakage of either babbitt or shell, when such guarantee is desired.
(5) Guaranteed double life of bearing.
(6) Favorable cost as compared with production by any other method.

The attached coupon, together with blue prints and statement of quantity used, brings prices and a copy of the enlarged, and completely rewritten, Engineering Bulletin M1, which is now on the press.

(Clip the coupon or simply enclose your card in an envelope)

A. W.
Cadman
Manufacturing Co.
Pittsburgh
Pa.

Master Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletin M-1, samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:.. Position:........................

Company Name:..

Address:..

strong, Whitworth & Co., Ltd., shipbuilders and manufacturers of locomotives, marine engines, brass and non-ferrous metals, steel products, pneumatic tools, etc. Mar. 23: The Openshaw works devoted chiefly to manufacture of steel, armor plate, machine tools, etc. Mar. 30: The North Street works, representing later extensions to Openshaw works, and including large steel departments.

Electric, Southern Pacific Shops. Electric Steel Plant at the Southern Pacific Shops, Larry J. Barton, Chem. & Met. Eng., vol. 26, no. 18, May 3, 1922, pp. 838–840, 2 figs. Six-ton Heroult furnace produces all steel castings for large western railway as a side line. For a year it produced rivet steel from miscellaneous scrap, and now is working on order for 1,000,000 tie plates.

Power Plant. Power Plant Designed for Steel Mill Conditions. Power, vol. 55, no. 15, Apr. 11, 1922, pp. 566–570, 7 figs. Describes Inland Steel Co.'s plant no. 2, Indiana Harbor. Boilers are equipped with underfeed and forced-draft chain-grate stokers. Coke breeze,coal and coke-oven and blast-furnace gas used as fuel. Combination of four feedwater heaters operated in parallel.

STREET RAILWAYS

Controlling Excavations in Roadbed. Controlling Excavations Through Right-of-Way, R. B. Genest. Elec. Ry. Jl., vol 59, no. 17, Apr. 29, 1922, pp. 703–707, 17 figs. Montreal, Que., system wherein railway sanctions digging operations affecting its track and is compensated for expense therewith.

France. Present State of the Tramway Industry (Etat actuel de l'Industrie des Tramways), Roger Vente. Révue Industrielle, vol. 52, no. 6, Apr. 1922, pp. 183–189, 13 figs. Describes present practice in Paris, construction of tracks, rails, rolling stock, first and second class cars.

France. Present Technical State of Tramways. Industrie des Tramways, vol. 15, no. 177–178/179–180, Sept.-Oct./Nov.-Dec. 1921, pp. 149–355 (contains figs.). A series of reports presented before 2nd General Technical Meeting of Tramways Association in France, on rail profiles, frogs and crossings, track laying, curve construction, standardization of rolling stock, safety and comfort, power transmission, electrification of local railroads, etc.

Track. Expediting Track Construction in Toronto. Elec. Ry. Jl., vol. 59, no. 13, Apr. 1, 1922, pp. 551–558, 31 figs. Describes work in connection with relaying of tracks; gives standards of Toronto Transportation Commission.

STRUCTURAL STEEL

Wheels from I Beams. Fabrication of First Structural Steel Wheel, W. R. Ward. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 184–188, 13 figs. Difficulties encountered and problems solved in early experimental stage of construction of "I"-beam structural steel wheel.

SPARK PLUGS

Weaknesses. Sparking Plugs. Automobile Engr., vol. 12, no. 162, Apr. 1922, pp. 105–106, 6 figs. Five points to be considered in designing.

STANDARDIZATION

Domestic and European Movements. Recent Domestic and European Standardization Movements. Automotive Industries, vol. 46, no. 17, Apr. 27, 1922, pp. 912–913. Chains, tires and rims, petroleum, varnish and lumber.

STOKERS

Correcting Troubles in. Draft, Joseph G. Worker. Combustion, vol. 6, no. 5, May 1922, pp. 232–234, 240, 4 figs. Main points from forthcoming book, Mechanical Stoker, by J. G. Worker and T. A. Peebles. Draft one of most important features in correcting stoker troubles.

Mechanical. The Principal Types of Mechanical Stokers. Power House, vol. 15, no. 8, Apr. 20, 1922, pp. 19–21, 6 figs. Discusses chain-grate, underfeed, and overfeed stokers. Choice of stokers.

Multiple Underfeed. A New Type of Multiple Underfeed Stoker, Robert June. Power House, vol. 15, no. 8, Apr. 20, 1922, pp. 35–37, 7 figs. Many advantages described and curves of both calculated and actual performance given.

Sprinkler. Sprinkler Stokers in a Mill Power Plant. Power House, vol. 15, no. 8, Apr. 20, 1922, pp. 24–25, 2 figs. Small type requiring practically no special brick work; readily applied to any style boiler without structural alterations.

SUBWAYS

New York. Subways for City Transportation with Important New York Details, Robert Ridgway. Elec. Ry. & Tramway Jl., vol. 46, no. 1125, Apr. 7, 1922, pp. 161–164, 7 figs. Review of development of system and comparison with other forms of transportation.

T

TERMINALS, RAILWAY

London & South Western. Royal Opening of Waterloo Station, London & South Western Railway. Ry. Gaz., vol. 36, no. 12, Mar. 24, 1922, pp. 519–527, 13 figs. Describes station as reconstructed, including platforms, road approaches, general offices, and traffic working details.

TESTING MACHINES

Metal, Resistance of. New Method of Testing Wear in Metals (Nouvelle méthode d'essai des métaux a l'usure), L. Jannin. Révue de Métallurgie, vol. 19, no. 2, Feb. 1922, pp. 109–116, 11 figs. Describes machine for testing resistance of axle and bearing metals to wear. Pages 117–119, article by Leon Guillet on some friction tests carried out with the Jannin wear-testing machine.

Modulus of Elasticity. A New Testing Machine Giving the Elastic Limit and the Modulus of Elasticity (Nouvelle machine de traction donnant la limite élastique et le module d'élasticité), R. Guillery. Révue de Métallurgie, vol. 19, no. 2, Feb. 1922, pp. 101–108, 7 figs. Describes apparatus and its operation.

TESTS AND TESTING

Turbines. Equipment for Testing Turbines and Generators, C. O. Schooley. Elec. Jl., vol. 19, no. 4, Apr. 1922, pp. 163–166, 4 figs. Description of what is said to be model test floor for both steam and electrical equipment at S. Phila. plant of Westinghouse Elec. & Mfg. Co.

TEXTILE INDUSTRY

Lime, Use of. Use of Lime in Textile Industry. Cement, Mill & Quarry, vol. 20, no. 8, Apr. 20, 1922, pp. 45–47. Bleaching or "chemicking" process; boiling-out process with lime; dying; Kier liming; Renewed interest shown by textile industry.

TEXTILE MILLS

Power Plant. Economics of the Power Plant, Leo Loeb. Textile World, vol. 61, no. 18, May 6, 1922, pp. 193, 197 and 199, 3 figs. Analysis of problems. Address delivered at Symposium on Textile Manufacture and Economics held in Philadelphia.

Steam-Turbine Mechanical Drive. A Steam-turbine Mechanical Drive for Textile Mills. Mech. World, vol. 71, no. 1843, Apr. 28, 1922, pp. 307–309, 4 figs. Description of steam-turbine type of drive made possible by perfection of reduction-gears.

TIDAL POWER

Experimental Station. Project of an Experimental Tidal Power Station (Idées générales et pratiques pour l'établissement d'un avant-projet de station marémotrice avec usine régulatrice), M. Bare. Annales des Ponts et Chaussées, vol. 6, Nov.-Dec. 1921, pp. 252–289, 15 figs. Discusses proposed station at Aber-Wrac'h, near Brest; design and calculation of works, power control, etc.

TIME STUDY

Motion Study and. Time and Motion Study—VI, Eric Farmer. Eng. & Indus. Management, vol. 7, no. 12, Apr. 20, 1922, pp. 361–365, 7 figs. Experiments in bottling sweets and covering and packing chocolates. (Concluded.)

TOOL STEEL

Selection and Heat Treatment. Selection and Heat Treatment of Tool Steel, S. C. Spaulding. Blast Furnace & Steel Plant, vol. 10, no. 4, Apr. 1922, pp. 224–227. Discusses the various factors to be considered in selection of proper steel for a tool.

TOOLS

Fine. Engineers' Fine Tools. Machy. (Lond.), vol. 20, no. 497, Apr. 6, 1922, pp. 1–7, 21 figs. Methods and equipment used in quantity production by C. A. Vandervell & Co., Ltd., including various types of calipers, V-blocks, and clamps.

Manufacture of Small. A Small Tools Factory. Eng. Production, vol. 4, no. 78, Mar. 30, 1922, pp. 307–311, 14 figs. Describes equipment in works of C. A. Vandervell & Co., Ltd.

TRANSPORTATION

Freight, Railway and Automobile. Railroads or Automobile Routes? (Jernbaner eller automobilruter?). Teknisk Ukeblad, vol. 69, no. 12, Mar. 24, 1922, pp. 114–115. Comparative cost of railroad and automobile door-to-door delivery for freight transportation.

Trolley Car and Automobile. What the Trolley Car Has to Learn from the Automobile, H. L. Andrews. Gen. Elec. Rev., vol. 25, no. 5, May 1922, pp. 280–284, 3 figs. Analysis of preference of public for automobile over trolley car and suggestions for reclaiming of patronage by latter.

TUBES

Automatic Seam Welding. Automatic Seam Welding and the Manufacture of Tubes, J. L. Anderson. Acetylene Jl., vol. 23, no 10, Apr. 1922, pp. 483–489, 13 figs. Describes process of manufacturing welded tubing which, it is claimed, makes possible production of thin-walled tubing at fraction of cost of seamless steel tubing.

V

VALVES

Engine, Setting. Setting Valves by Elliptical Diagram, Arthur O. Gates. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp 410–413, 1 fig. New method employed on marine engine when time for shutdown was limited.

VENTILATION

Automatic. Recent Tests on Automatic Ventilators, A. J. Mack and C. J. Bradley. Heat. & Vent. Mag., vol. 19, no. 4, Apr. 1922, pp. 36–38, 1 fig. Results of tests at Eng. Experiment Station, Kan. State Agri. College.

Present-Day Practice. Where We Are At in Present-Day Ventilating Practice, Nelson S. Thomson. Heat & Vent. Mag. vol. 19, No. 4, Apr. 1922, pp. 27–32, 1 fig. Comments on conditions how sought through installation and operation of properly designed air-supply system.

W

WASTE

Industrial, Measuring. Measuring Waste in Industry, C. E. Knoeppel. Taylor Soc. Bul., vol. 7, no. 2, Apr. 1922, pp. 69–76 and (discussion) pp. 76–80. Examination of method employed by Committee on Elimination of Waste in Industry of Federated Am. Eng. Societies.

WASTE PREVENTION

Boiler Refuse. Boiler Refuse Yields Unburned Fuel, Thomas Fraser and H. F. Yancey. Coal Trade Jl., vol. 53, no. 18, May 3, 1922, pp. 400–401. Recovery by washing approximates 20 per cent of total weight of waste material treated. Prepared by U. S. Bur. Mines in coöperation with Univ. of Ill. and Ill. Geol. Surv.

WATER PIPES

Metal, Corrosion of. The Corrosion of Metal Water Pipes (Die Korrosion metallener Wasserleitungsröhren), Hugo Kühl. Gas- u. Wasserfach, vol. 65, no. 7, Feb. 18, 1922, pp. 99–102. Discusses corrosion of lead, copper, zinc, and iron pipe, its injurious effects, and preventive measures.

WATER POWER

Canada. Installed Water Wheel Capacity in Canada Totals 2,763,000 hp. Contact Rec., vol. 63, no. 16, Apr. 19, 1922, pp. 344–346. Résumé of water power resources of Dominion, brought up to date by Water Power Branch, Dept. of Interior, shows 300,000 hp. added during 1921.

Canadian Resources. Water Power Resources of Canada. Eng. World, vol. 20, no. 5, May 1922, pp. 284–285. Installed water wheel capacity now totals 2,763,000 hp and many further enterprises are in prospect.

Chemical Industry, Development. Water Power Development and Progress in the Chemical Industries (Le developpement de la houille blanche et le progres des industries chimiques), Georges Kimpflin. Vie Technique et Industrielle, vol. 3, no. 30, Mar. 1922, pp. 479–486, 18 figs. Discusses hydroelectric plant of Cie d'Electricite Industrielle, with a head of 95 m. water storage; pressure conduits; electric equipment; 120000-volt transmission; cyanamide, calcium, carbide, etc. manufacture.

WELDING

Autogenous. See AUTOGENOUS WELDING.

Non-Ferrous and Dissimilar Metals. Welding Non-Ferrous and Dissimilar Metals, Fred E. Rogers. Can. Machy., vol. 27, no. 10, Mar. 9, 1922, pp. 26–28, 2 figs. Welding of aluminum and aluminum containers; welding of copper; brass and bronze; nickel; monel metal; etc.

Motor-Generator Repairs. Welding Reduces Cost of Repairing Motor Generators. Elec. World, vol. 79, no. 18, May 6, 1922, pp. 885–886, 1 fig. Account of repairs at Bryant St. Sub-station of Market St. Rys. of San Francisco, by use of welding.

Oxy-Acetylene. See OXY-ACETYLENE WELDING.

Pipe Construction. Possibilities of the Art of Welding in Pipe Construction, Frederick K. Davis. Heat. & Vent. Mag., vol. 19, no. 4, Apr. 1922, pp. 33–36, 12 figs. Few of typical methods including autogenous or local fusion by which manufacture has been greatly simplified.

WIRE DRAWING

Process. Fascinating Romance of Wire Drawing, John Kimberly Mumford. Raw Material, vol. 5, no. 3, Apr. 1922, pp. 91–94, 4 figs. Discusses wire drawing methods of J. A. Roebling's Sons Co. and R. L. Stillson Co.

WOOD PRESERVATION

Theory. Theory on the Mechanism of Protection of Wood by Preservatives, Ernest Bateman. Wisconsin Engr., vol. 26, no. 5, Feb. 1922, pp. 79–84 and 98, 5 figs. Experimental work of obtaining a non-toxic or "barren" oil from coal-tar creosote; a mathematical treatment to point out existence of a solubility partition. Presented before Am. Wood-Preservers' Assn. (Concluded.)

Z

ZINC ALLOYS

Research. Research Work on Zinc and Zinc Alloys, Wallace Dent Williams. Can. Foundryman, vol. 13, no. 4, Apr. 1922, pp. 24–26, 9 figs. Influence of copper, aluminum and iron additions; influence of temperature upon defects of castings, etc.

ZINC

Extraction. New Methods for Extracting Zinc From Its Ores (Nuovi processi di estrazione dello zinco dai suoi minerali), Gaetano Castelli. Rassegna Mineraria Metallurgica e Chimica, vol. 56, no. 2, Feb. 28, 1922, pp. 21–24, 3 figures. Discusses new method using a reverberatory furnace and an improved bisulphite method, and gives diagrams of operations.

Research. Research Work on Zinc and Zinc Alloys, Wallace Dent Williams. Can. Foundryman, vol. 13, no. 3, Mar. 1922, pp. 26–27 and 30, 8 figs. Discusses alloys with high percentage of zinc replacing brass with favorable results.

MECHANICAL ENGINEERING

Volume 44 August, 1922 Number 8

Material-Handling Equipment as Used in the Iron and Steel Industry

By F. L. LEACH,[1] JAMSHEDPUR, INDIA

This paper describes the handling machinery and apparatus used in the manufacture of steel. From the time that the ore leaves the mines until the steel goes through the last process at the mill it is moved about exclusively by different types of heavy machinery designed especially for the purpose. The author expresses the hope that through his description, weak points in present-day practice will show themselves and means of improvement be suggested.

THE iron and steel industry probably requires a greater diversity of material-handling equipment than any other type of manufacturing, because of the enormous bulk and weight to be handled. From the time the material leaves the mines until it is turned out of the mills as finished product it is constantly being moved by heavy conveying machinery of all descriptions. It is the intention of the author to describe this equipment with the idea of bringing out weak points in present-day practice, and possibly open the way to strengthen the weakest links in the conveying methods used.

As the principal object of this paper is to describe the machinery used about the industrial plant, just a brief description will be given of the handling methods before the material reaches the plant.

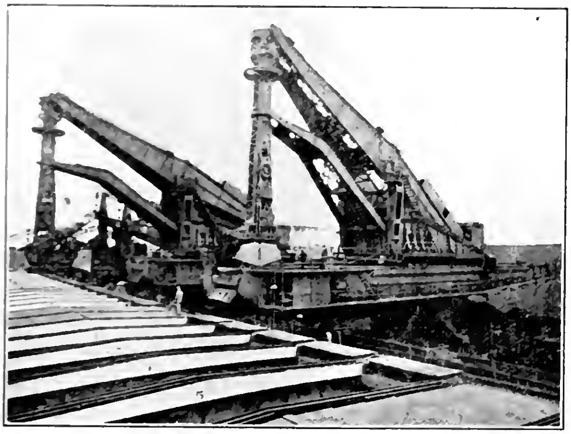


Fig. 1 Hulett Ore Unloader at Ashtabula Harbor

At the present time ore handling on the Great Lakes is carried on by a fleet of vessels unequaled anywhere in the world. Some of these vessels are capable of handling a cargo of 15,000 tons, and are over 600 ft. long. During the year 1916, 66,658,466 tons of ore were carried by the vessels from the upper Great Lakes to southeastern ports.

Vessels equipped for self-unloading have been developed for handling stone and ore. The hold in such cases is divided into bins, which deliver the material by gravity to a belt conveyor running lengthwise of the vessel; this conveyor delivers the material to an elevator which hoists it to another belt conveyor suspended in a horizontal position from the masts of the vessel and capable of being moved radially and vertically like the boom of a derrick. This belt conveyor delivers to the storage pile on the dock, and it is possible to distribute the material on the dock at any point or height desired within the scope of the boom conveyor.

Ore-unloading equipment has probably been developed to the highest point of efficiency at the ports on the Great Lakes. An example of this is Ashtabula harbor on Lake Erie, where there are eight Hulett ore unloaders having a capacity of 15 tons each. They have a record of unloading seven boats of a total capacity of 70,000 tons in 22 hours' actual time.. Four 17-ton-capacity machines of this type have unloaded a cargo of 13,000 tons in 3 hours and 25 minutes. Fig. 1 shows a view of these machines in operation.

These unloading machines remove the ore from the boat and dump it directly into railroad cars for shipment to inland plants, or they place it in a bin located at the rear of the machine where it may be picked up by a traveling ore bridge and placed in storage piles.

Ore shipped to inland plants in bottom-dumping cars may be unloaded directly into bins by gravity. However, the modern method is to use a traveling rotary car dumper as shown in Fig. 2, which can be spotted at any point in the length of the ore yard. The cars of ore are placed one at a time on the dumper, turned upside down and the ore dumped into a concrete pocket that extends the full length of the ore yard. An ore bridge similar to the one shown in Fig. 3 distributes the ore to the storage pile in the yard. Rotary car dumpers have been developed so that three men can unload about 20 cars per hour. Cars of 240,000 lb. capacity have been designed with a total dead weight of 78,800 lb., giving a ratio of revenue load to total weight of 75.4 per cent.

The traveling ore bridge is another valuable link in material-handling equipment and is used in many different ways in handling the ore at unloading docks. One of the largest bridges of this type ever built is 612 ft. long overall, and is used at the Western Pennsylvania Dock Company at Cleveland, Ohio. This bridge handles a 15-ton bucket and covers an ore storage of over a million tons.

Fig. 3 shows how these bridges may also be used to place the ore and limestone in bins, preparatory to sending them to the blast furnace. Several different types of bins are used, although the principle is the same in each. The ore is placed in the bin, either by the ore bridge or by gondola-type hopper cars, and it passes down through the bin by gravity as required, through a shut-off gate into a lorry car. From the bins an electrically driven weighing lorry car is used to convey ore, limestone and coke to the blast-furnace skip hoist.

Fig. 3 shows how material is conveyed from the stock yard and bins to the top of the blast furnace, dumped into the bell hopper by the skip car, and finally deposited inside by the well-known double bell system. Two of the products of the blast furnace are pig iron and slag, which are drawn off at the base in a molten state. Both iron and slag were formerly allowed to run from the furnace into sand molds and handled after cooling. Most plants today, however, run the molten iron and slag directly into ladles supported on special cars. In this way the iron is transported either to a pig-casting machine where it is cast into pigs, or to a mixer at the open-hearth plant where it is kept in the molten state, or further refined before it is placed in the bessemer converter for

---

[1] Asst. Wks. Mgr., Agricultural Implements Co., Ltd. Assoc-Mem. Am. Soc.M.E.

Abstract of a paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

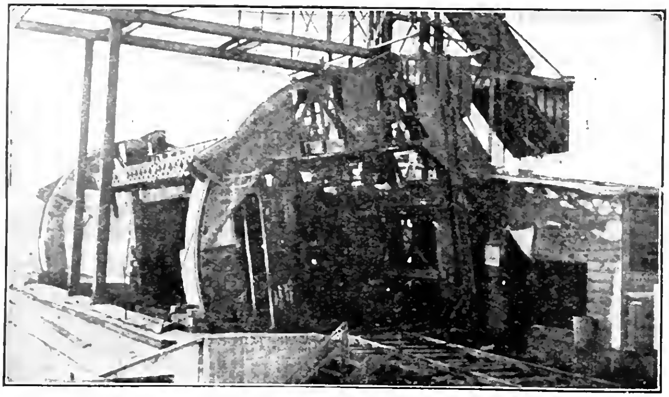


Fig. 2 View of Rotary Car Dumper

the duplex process. The molten pig iron may also be conveyed direct to the open-hearth furnace for the straight open-hearth process.

The slag is disposed of in various ways, since it has become of considerable commercial value in the last few years. After having been allowed to cool it is crushed to various sizes and then used in the place of crushed stone.

A new design of car known as the Pugh mixer-type hot-metal car, shown in Fig. 4, has recently been developed for handling hot metal from the blast furnace. This car, built in capacities ranging from 70 to 150 tons, is claimed to have many advantages over the ordinary type, chief among which are the heat-saving feature, which allows the hot metal to stand in the car for a period of 36 hours without "freezing." It is also a labor saver because, due to its large capacity, it requires fewer runners to distribute the metal from the furnace to the cars, thereby eliminating considerable scrap.

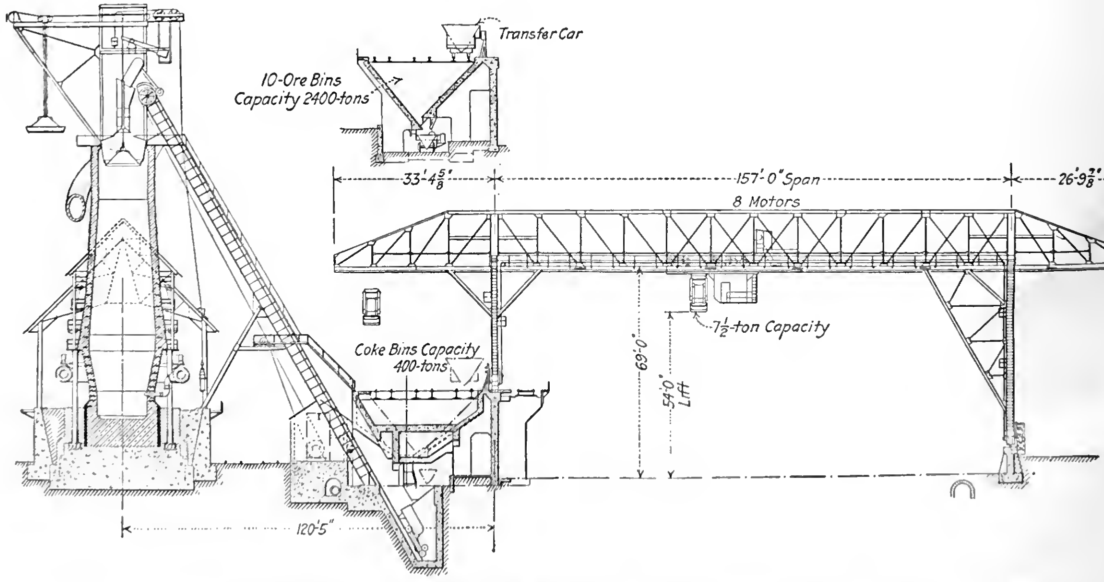


Fig. 3 Section Through Blast Furnace and Ore Yard Showing Relation of Ore Bridge, Bins and Furnace

Fig. 5 shows a view of a typical slag car for conveying the molten slag away from the blast furnace. It is dumped pneumatically.

The Duplex System for Making Steel

Fig. 6 shows the plan of a modern duplexing system for manufacturing steel. The machinery in this department of steel making must stand the most severe treatment of all, as the steel is handled at temperatures ranging as high as 2900 deg. fahr. It can therefore readily be understood how important it is to have such machinery and equipment designed as perfectly and as safely as possible.

The hot metal from the blast furnace is brought to the mixers by ladle cars. In Fig. 6 this car is shown in position before a 1300-ton capacity mixer into which the content is poured by lifting the ladle free from the car with the aid of a 100-ton ladle crane.

The hot metal is removed from the mixer as required by tipping it so that metal will run out of a spout opposite the receiving side. Another ladle supported on a ladle car is used to transfer the hot metal from the mixer to the bessemer converter. This ladle is tilted by a jib crane and the contents poured into the top of the converter already tilted to a receiving position.

The next step for the hot metal in the process of refinement is to convey it from the converter to the open-hearth furnace. This is done very much as was the previous operation, except that the hot metal is poured from the converter into another ladle mounted on a ladle car and is transferred by steam or electric locomotive to a point before the open-hearth furnace. Here, it is hoisted free of the car and poured into the furnace by means of an overhead crane. The track over which this car travels is indicated in Fig. 6 by the note "Hot Metal to Open-Hearth Furnaces."

Fig. 7 shows a 65-ton ladle car that may be used for this transferring operation.

Open-Hearth Furnaces

Scrap, ore and limestone are conveyed to the open-hearth furnace in cast-steel boxes called charging boxes, three or four of which are moved on a specially built car. The scrap is placed in the boxes by means of the overhead crane and a magnet. The ore and limestone are handled either by the crane and a grab bucket in cases where it is necessary to move them from storage piles to the boxes, or they are placed in the boxes direct from bins by means of chutes, when the plant is so provided. The cars are then hauled in trains to the charging floor of the open-hearth furnace building.

It occurs to the writer that the ore and limestone used in open-hearth practice could be handled more economically if they were either stored in bins under the approach trestle to the open-hearth

building and discharged by chutes into the charging-box cars, or if they were stored in bins under the open-hearth floor and removed by means of a grab bucket, or possibly by the application of mechanically operated proportioning devices used in conjunction with compartment bins discharging them to the charging floor of the open hearth.

In the methods now in vogue the train of loaded charging boxes is transferred from the storage yard to the open-hearth charging floor in front of the furnaces by means of an electric or steam locomotive. The material in the charging boxes is then dumped into the furnace by an electric charging machine. This machine lifts the charging box into the furnace where it dumps its contents by turning the box through a complete revolution. The operator of one of these machines sometimes takes a loaded box and uses it as a means of leveling the charge within the furnace much as a fireman would use a poker to level the coals in the firebed of his boiler.

The products of the open hearth are steel and slag. The steel is drawn off from the furnace and run into a ladle of a size consistent with the capacity of the furnace. In the Talbot system only half of the charge is drawn from the furnace at one time. After the ladle is filled it is transferred by an overhead crane to a position over the first mold of a train of ingot molds.

The slag which flows off at the time that the steel is tapped is run into a slag ladle mounted on a special car by which the ladle is carried to a suitable point for dumping. The position of this car is indicated on Fig. 6 by the letter (A). It is placed there to receive the slag during the tapping of the furnace and is hauled away afterward on the track indicated by the nete.

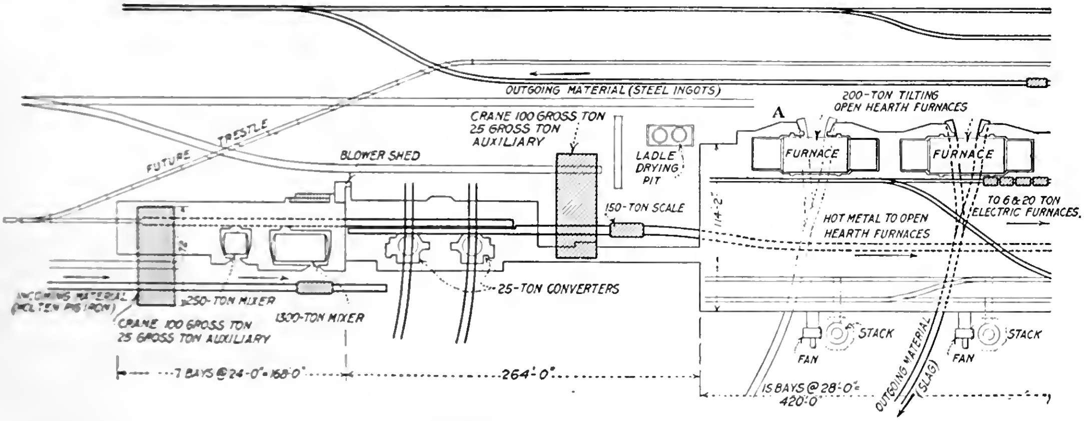


Fig. 6 General Plan of Duplex Plant

The molds in which the steel is cast are mounted on cars, usually three or four molds to the car. These cars are heavily constructed as they must withstand having molten metal splash on all parts of them or the dropping of an ingot from a height of several feet when the mold is being stripped from it.

The direction of travel of these ingot cars is indicated by arrow heads and notes as they travel from the open-hearth pit to the stripping yard.

Fig. 4 Pugh Mixer-Type Hot-Metal Car

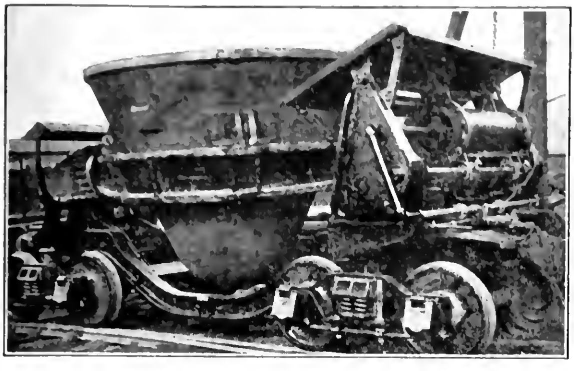


Fig. 5 Slag Car and Ladle

The stripping process simply means removing the molds from the cast ingots after the metal has hardened sufficiently. Fig. 8 shows an ingot stripper and indicates how the hooks of the stripper engage the ears of the mold, lifting it clear of the ingot car and leaving the ingot on the car. When the mold has been used for a long time it may become slightly pitted, causing the ingot to stick when it is being stripped from the mold. Under these circumstances it is necessary to drive the ram down into the opening at the top of the mold to force out the ingot.

The train of stripped ingots is now moved from the stripper yard to the soaking-pit furnaces, or to a suitable storage yard.

A Modern Rolling Mill

Fig. 9 shows a plan of a modern rolling mill in which nearly all the different types of material-handling machinery that have been developed to the present time for this industry are used.

This plant includes a 40-in. two-high reversing blooming mill, a 24-in. and 18-in. sheet-bar and billet mill, and a 28-in. rail and structural mill. Provision has been made for serving a 12-in. and 8-in. merchant mill with billets from this sheet-bar and billet mill. All mills are electrically driven. The different types of conveying machines are indicated by letters, in the order in which the material travels.

The blooming mill is served by six 4-hole soaking pits, in which the ingots are placed by an overhead electric tong crane. This crane handles the ingot on a principle similar to that of a pair of ice tongs. The operator's cage rides with and above the tongs, enabling him to place the ingots in the proper position in the pits.

The next step in moving the material is to serve the blooming mill with hot ingots from soaking pits. The soaking-pit crane delivers the ingot to a tilting buggy, places the ingot on roller table

(B), and it is directed properly for entering the rolls of the blooming mill by manipulator (C).

Fig. 10 shows a general view of the soaking-pit furnaces and the end of a roller table, to which an ingot is being delivered by the traveling tilting buggy. This buggy travels back and forth in front of the soaking pits, operated either by a remote-control switch which places the buggy at any desired position on the track, or motivated by an electric tractor—man-operated. In case of breakdown of the ingot tilting buggy the cranes can place the ingot directly on the table.

As previously stated, the manipulator is a machine used to place the ingot in the proper position for entering the rolls, and to turn or shift it for the next pass after passing back and forth through them. The modern manipulator is hydraulically operated. Its pushing arm has both a vertical and horizontal movement and is provided with a movable side guard on each side with tilting heads on one side for turning the section being rolled. This enables the operator to place the material at any desired position before the rolls.

Many mills are equipped with manipulators on both the entering and delivery sides of the mill, but when they are placed on the delivery side the tilting heads are omitted.

After the ingots have been reduced to blooms, slabs, or blanks by the blooming mill they are carried to the shear by another electrically driven roller table indicated in Fig. 9 as table (D). The shear cuts the blooms to required lengths, removing the fan tail end or crop end, as it is termed in the mill. This crop end is dropped down a chute at the shear to conveyor (E) which conveys it to a bloom-butt car located on the track next to the mill building. This conveyor is usually very heavily constructed, and, due to the irregular shapes handled, it is built so that the billets are pushed along on a smooth surface of plates by a traveling scraper conveyor which will handle any size or shape likely to be produced by the mill.

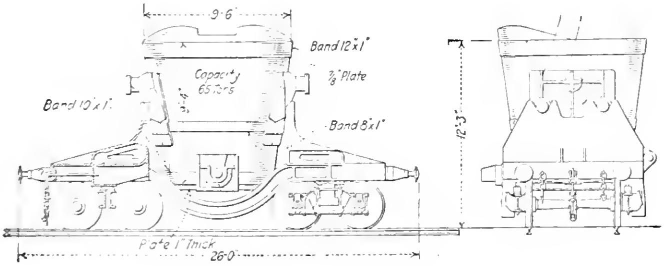


Fig. 7 65-Ton Transfer-Ladle Car

In some plants open-hearth charging boxes are placed on a charging car and the crop ends are loaded directly into the boxes by the crop-end conveyor. This is desirable where the distance between the blooming mill and the open-hearth is not great. If the distance is too far, too much money is tied up in charging boxes, due to the quantity necessary to provide for delays in transportation, etc.

The mill layout shown in Fig. 9 provides for distribution of blooms and blanks to the rail and structural mill by means of conveyor (F) and slabs and blooms to the hot hole or shipping yard by means of conveyors (G) and (H). It also provides for distribution of blooms and blanks to reheating furnaces or to rail mill by means of conveyor (F), table (J) and charging cranes (K) when reheating for rail mill, or for blooms and slabs direct to the sheet-bar and billet mill by table (L). Conveyor (F) shown in Fig. 11 is constructed with a surface of heavy tee rails, on which the billets are skidded along by rapidly traveling dogs. The dogs run on tracks between the rails and are attached to wire ropes running around an idler pulley at one end of the bed and a driving drum at the other end. This conveyor must handle the blooms rapidly as they are sometimes passed from the blooming mill direct to the rail and structural mill without being reheated.

Fig. 12 shows another type of these conveyors and also the grasshopper type of pusher, a machine used for removing material from a roller table to a conveyor placed at right angles to it.

The feature of this machine is the peculiar path which the ram describes in passing through one cycle of operation. The levers are arranged to cause the ram to travel in practically a horizontal straight line in the forward stroke, while on the return stroke it describes an arc in an upward direction, clearing material that may be traveling out from the shear.

When it is desired to deliver material to the hot hole it is removed from the shear table by means of the grasshopper pusher, to either conveyor (G), Fig. 11, in the case of slabs, or to conveyor (H) in case of blooms or blanks.

When slabs are delivered to conveyor (G) it transfers them to a slab piler which arranges them in piles of four or five. They are then removed by the overhead crane to be stacked in the hot-hole yard and allowed to cool.

The same procedure takes place when blooms are delivered to conveyor (H), except that the blooms are delivered to a cradle from which they are removed to the hot-hole yard for cooling and storage.

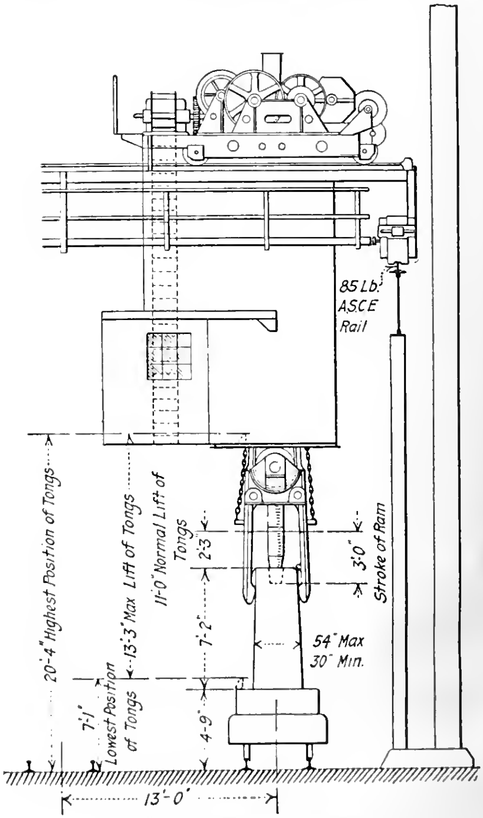


Fig. 8 200-Ton Ingot Stripper

The roller table indicated by reference (L), Fig. 9 is the ordinary type of electric-driven table.

Many types of machines have been developed to replace the old-style hand methods of replacing heavy billets, bars, etc., in the furnace for reheating, preparatory to rerolling. Reference (K), Fig. 9, indicates the location of two of these machines which travel on girders above the furnaces. They are designed so that the tongs may be placed in any position necessary to serve the furnaces on either side of the charging floor.

In the plant shown by Fig. 9 the charging crane (K) can pick up the material from the skids at the end of table (J) and place them in the furnace; store material at the end of the runway for future use; remove hot material from furnaces, and serve either the sheet-bar and billet mill or rail and structural mill. This arrangement allows many methods of operation between the different mills.

Sheet-Bar and Billet Mill

When it is desired to reduce the blooms to billets or flat bars they are conveyed direct from the blooming-mill shear to the 24-in.

mill by table (L) and rolled in the 24-in. mill without reheating. Some few sections, however, require reheating and the blooms for these are taken from table (L) by charging crane (K), placed in reheating furnaces, then returned to table (L), and to the 24-in. mill. After passing through the 24-in. mill they are delivered to the 18-in. mill by table (M), where the cross-sectional area of the bar is still further reduced. If it is not necessary to pass the bars through the 18-in. mill they are delivered to the stockyard or cars by means of a cooling-bed transfer conveyor (N), roller table (O) and transfer (P).

If it is necessary to pass the bars through the 18-in. mill they are conveyed to same by table (M). This table is designed with the axis of the rollers set at an angle of about 102 deg. with the center line of the table instead of 90 deg. for the purpose of throwing the bar off the table on to transfer conveyor (N). If it is desired to deliver the material to the 18-in. mill instead of placing it on transfer table (N) it is guided into a groove which is on the circumference of each roller, these grooves being in line on the table. Naturally this causes the material to follow a straight course to the 18-in. mill instead of being thrown off the table by the skewed arrangement of the rollers. After passing through the 18-in. mill the bars are cut to size by a rapidly operating shear, the knives of which move forward with the bar, cutting it as it rolls along. This type of shear is called a flying shear. The bars are then conveyed to cooling bed (Q), where they are allowed to cool, and transferred by the cooling-bed conveyor to a bar piler at the end of the conveyor. The bundles of steel bars or billets are then transferred to the billet storage yard, or to the merchant mill for further reduction to small shapes, or directly into cars for shipment by overhead crane (R).

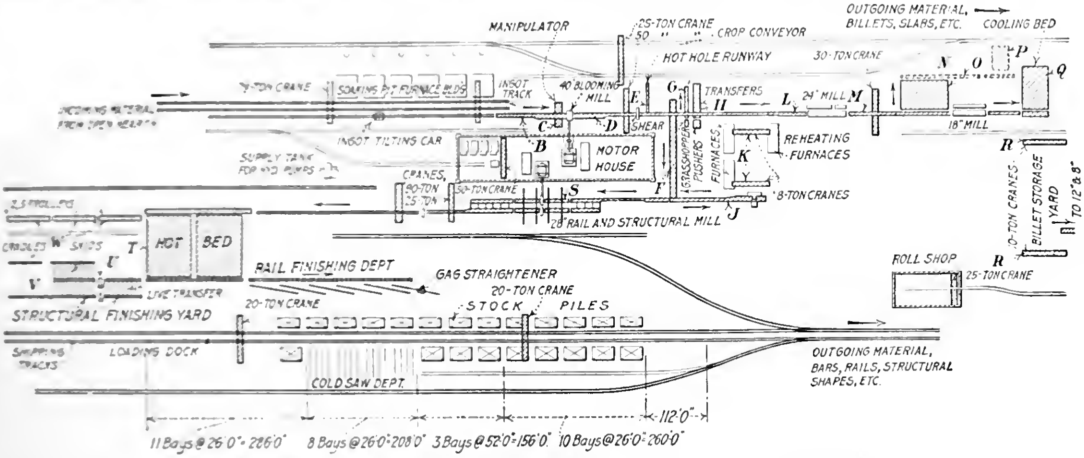


Fig. 9 General Plan of 40-in. Blooming Mill and Sheet-Bar and Billet Mill

28-inch Rail and Structural Mill

As previously mentioned, it is possible to deliver blooms from the blooming mill direct to the rail and structural mill by means of conveyor (F), thereby continuing the reduction of the bloom in the rail and structural mill without reheating. If it is desired to reheat the bloom, it is carried by means of conveyor (F) and roller table (J) to the end of table (J), where it is pushed on to the skid table, picked up by a charging machine (K), and charged into the reheating furnace. When properly heated it is returned to roller table (J) by charging machine (K).

Table (J) is designed with a double set of rollers so that blooms delivered to it may pass in either direction on both sides at once. The advantage of this can easily be understood; for example, conveyor (F) may be delivering material to the furnace on one side of the table and at the same time material may be transferred from the furnace to the rail and structural mill on the other side. This arrangement is shown on Fig. 11 by a light outline of the cross-conveyor at the delivery end of the conveyor.

If the bloom is to be rolled on the 28-in. mill it is carried to the mill by table (J) and a traveling tilting table (S). Two of these traveling tables are located on either side of the 28-in. mill and serve the purpose of catching the bloom as it travels back and forth through the mill. When the cross-sectional area of the bloom has been reduced to as small as is desired on the first stand, it is pushed over to the second stand by means of rope-propelled dogs which travel back and forth between the skid rails of a stationary transfer. The traveling tilting table (S) moves the material from pass to pass in either the top or bottom pass, as required. In event of either table breaking down, provision is made for removing the table beyond the face of the rolls where repairs can be made, and one table is used for both stands, which of course lessens production. When the roughing out is completed on the second stand of the 28-in. mill the material is passed to the finishing stand of the 28-in. mill. Here it is given one finishing pass of either a rail or structural shape and passed on to the saws by another power-driven roller table.

If the finished material is a rail it is generally cut into three pieces of standard length simultaneously by four drop hot saws, the two end saws being used to remove the crop ends of the rail. If a structural shape, it is cut by the sliding saw indicated to lengths desired. The material is then delivered to the cooling bed (T), on which it is drawn across by dogs attached to wire ropes or some other of the many methods of propulsion that have been designed for this purpose.

Rails are delivered in one direction to a rail-finishing department and structural shapes in the opposite direction to a department for finishing I-beams, channels, angles, etc.

When finishing structural shapes they must be straightened and the ends cut true. Fig. 9 shows a modern arrangement for transferring shapes from the cooling bed to the straightener (U) and thence to the shears, by means of transfers (V). When shapes have passed through this last stage of finishing they are removed from the shear cradle by means of overhead cranes (W) and placed in piles for storage or directly in railroad cars for shipment.

Rails pass through a similar process of straightening and end finishing and are also drilled. They are conveyed from the cooling bed on roller tables, and transferred to the different finishing machines on idler rollers supported on individual stands.

The writer is of the opinion that the methods of handling rails in the finishing department can be materially improved and more of the manual labor eliminated by plant arrangements different from those used at the present time. Not enough power-driven machinery is used in this work. This problem could be studied with beneficial results.

The foregoing description gives a general idea of the types of material-handling machinery used in a steel mill, but of course does not cover all the variations that would naturally be required in manufacturing different forms of steel. For example, there are several types of mills which have not been mentioned, all of which require material-handling equipment suited to the type of material handled.

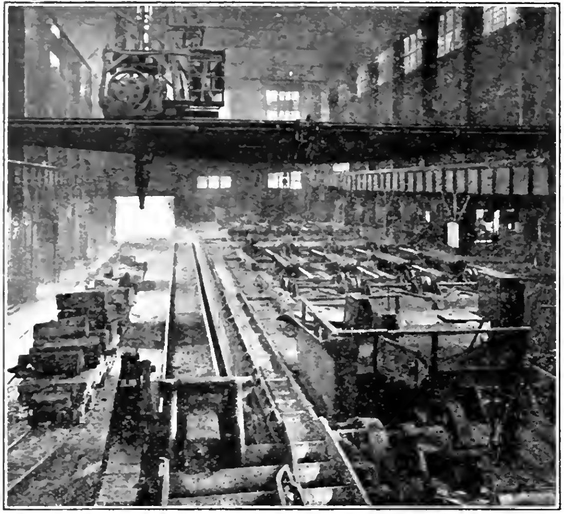


Fig. 10 General View of Soaking Pits, Ingot Tilter and Tong Crane

The mill for manufacturing steel plates requires lighter but broader tables, and toward the finishing end chain conveyors are used to handle the plates. At the shears an arrangement of castors set up on spindles is used, allowing the plate to be placed at any desired relation with the shear. This arrangement is known as a castor bed.

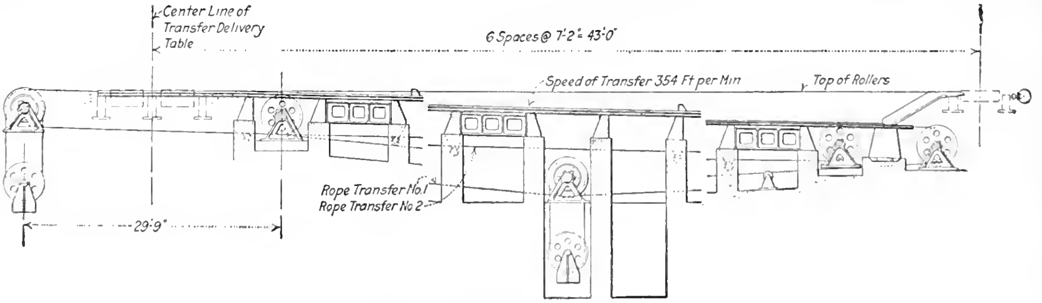


Fig. 11 145-ft. Bloom Transfer

The skelp and rod mill requires light tables and conveyors which will handle the rolled material rapidly, as the mills used for this work are small and run at a high rate of speed. They also require long cooling beds that will handle the material in such a manner that it is straightened while cooling. The Edwards escapement bed is a good example of this type, and is shown by Fig. 14. The rods are delivered to the top of the bed by a conveyor having a set of cone-shaped rolls. These throw the rod to the small end of the roll, which retards the speed of the rod and allows a set of fingers to pick it up and place it on the first of a series of spurs on an inclined bed. As each rod passes out from the mill it is picked up and placed on this inclined bed, and as each is dropped on the bed the preceding rods are dropped down one spur at a time until they reach the bottom. This intermittent dropping from one spur to the other straightens the rapidly cooling rod, so that when it reaches the bottom it is straight enough for ordinary purposes. The rod is then pushed out on to a roller table at the bottom of the cooling bed, and conveyed to the shear where it is reduced to the desired length. In some cases where the rods are small in diameter, for example $^1/_4$-in. and $^5/_{16}$-in., they are passed from the mill direct to coiling reels, where they are coiled into bundles and placed on a slow-moving coil conveyor. This allows the bundles to cool before being placed in storage piles or on cars for shipment.

Sheet and Tube Mills

Although material-handling equipment in sheet mills has improved considerably in the last few years, it is the opinion of the writer that there is greater chance for improvement in handling equipment in this type of mill than any other, as a vast amount of work is still done by hand.

Continuous furnaces for heating sheet bars have been developed to replace the old reverberatory hand-charged type. These furnaces are fed by a special pusher arrangement, which places the sheet bars in the furnace in piles. Before they are removed these piles must be scattered, which is done on a hearth at the outlet of the furnace, thereby allowing thorough heating, and facilitating the removal of the bars from the furnace to the mills for rolling. The bars are transferred to the mill by hand, except in the case of jobbing mills handling bars for making light plates, where a mechanical arrangement is used. It is the opinion of the writer that some such method could be used to advantage on most sheet mills, especially where long sheets are made requiring a maximum-sized sheet bar to begin with.

The mechanical doubler used for doubling the sheets in rolling to finer gages, is one recent improvement which eliminates the disagreeable task of doing this work by hand or by the old-style cylinder-operated clamping machine.

This point of steel manufacturing is sadly lacking in material-handling equipment, and is a fertile field for development. Material is moved by hand to and from furnaces, to and from shears, and through the finishing processes of sheets, to an extent which should be eliminated by roller tables, chain conveyors, or even overhead monorail trolleys, any one of which properly installed would lighten the load now placed on human shoulders.

It might be said that the tube mill is a continuation of the plate or skelp mill, where tubes are made by bending up and lap-welding the plate or drawing the smaller-sized skelp through a bell-shaped die to be butt-welded. Material-handling machinery for this type of work is well developed, and through the use of overhead cranes, conveyors, special pushers, etc., the manual handling of material is almost entirely avoided.

Forgings

Heavy forging is another branch of the steel industry that requires special handling machinery. Fig. 13 shows a manipulator

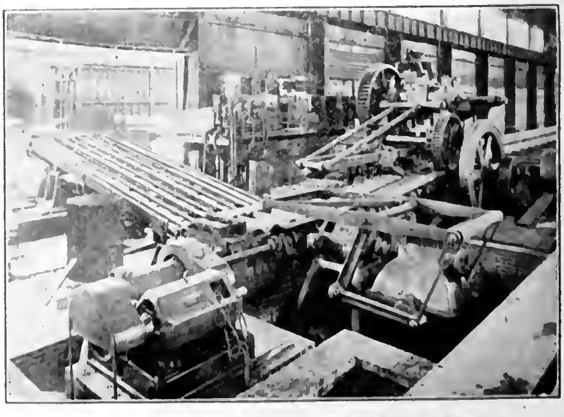


Fig. 12 Billet Conveyor and Grasshopper Pusher

which when controlled by a skillful operator can handle a 3-ton forging with as great dexterity as a blacksmith handles a horseshoe. Such a machine may also be used to feed material into rolling mills of different types. Primarily, it is operated by three motors. The first controls the vertical travel of the end of the peel, the second rotates it on its own axis and the third moves it laterally by turning the car body on the truck. A hand wheel controls the height of the rear or pivotal end of the ram so that it can be kept as nearly horizontal as possible. Two sets of springs are provided to give flexibility in both a vertical and horizontal direction and the tongs are operated with compressed air furnished by a compressor mounted on the frame. The whole machine is moved on its track by two motors on the truck.

Miscellaneous Equipment

Many types of conveyors are used in steel-plant auxiliary equipment, such as gas-producing plants, power plants, coal-pulverizing units, etc.

Among the most novel of these is one type of modern plant for pulverizing coal, in which the pulverized coal suspended in air is conveyed about the plant in pipes. The lump coal is delivered to this plant by gondola cars, dumped into a track hopper, passes to a crusher by means of a reciprocating feeder, and from the crusher is conveyed to an overhead storage bin by a gravity-discharge bucket conveyor. At the base of the storage bin is a belt conveyor which delivers the crushed coal to a drier. In some cases the coal is delivered from the drier to the pulverizers by an enclosed bucket elevator and in others by a chute, depending on the relation of the driers to the pulverizers. This is the point where the system of using air to convey the coal is employed. A blower is used to induce a current of air into the pulverizer, blowing the fine coal dust out of the top of the pulverizer through a pipe up into a cyclone collector. Here the coal dust is allowed to settle into a bin, the air being drawn out of the top of the collector by the same fan, which again passes it through the pulverizer to pick up more coal.

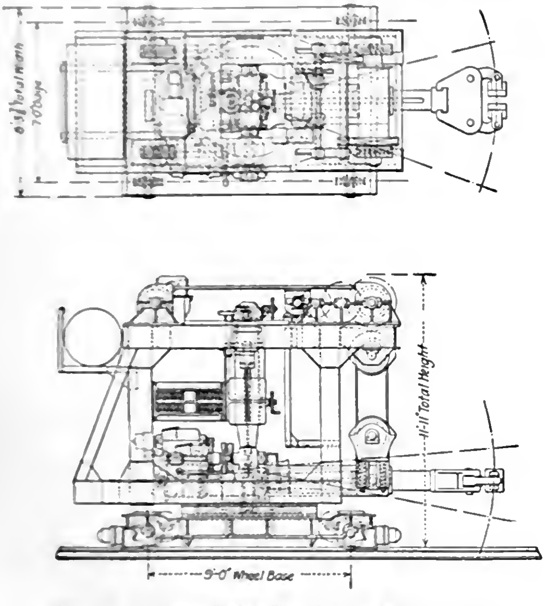


Fig. 13 Alliance Three-Ton Forging Manipulator

The pulverized coal is conveyed from the storage bin by means of screw conveyors to a heavily designed, powerful blower, which blows the coal through a circuitous system of piping to the points where it is to be burned, the surplus coal returning to collectors, which again allow it to settle into the storage bin. This system has been successfully installed in several large steel plants where the pulverized coal has been used for open-hearth furnaces, reheating furnaces and boilers.

The many types of conveyors, such as bucket elevators, scraper conveyors, etc., which are used about a gas-producing plant are too numerous to mention and too well known to require description.

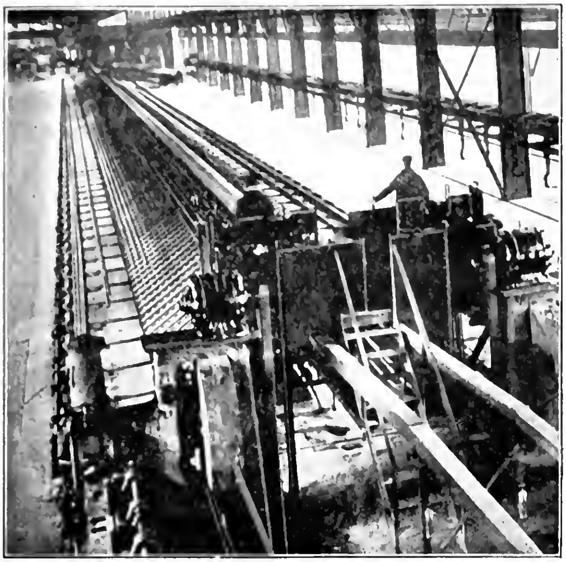


Fig. 14 Edwards Double-Escapement-Type Cooling Bed

Power

Nearly every known type of power has been adapted to material-handling machinery about a steel plant. Steam and hydraulic power have been used quite extensively, but are both being gradually replaced by electricity. Air under various pressures has also been adapted to many types of pneumatic machinery. Hydraulic pressure is used on heavy slow-moving machines, tilting open-hearth furnaces, ingot tilting pots, manipulators, shear-depressing and tilting tables, etc. Most of these types of machinery are now being handled by electrically driven cranks or racks.

General

To summarize the problem of material handling in the iron and steel industry, it is quite apparent that there are many gaps in handling material from the ore mines to the finished steel which can be improved, even with the present methods of manufacturing. Notably among these are the methods of conveying raw materials to the open-hearth furnace, and the many steps required from the blast furnace to the finished steel ingot. In other words, they include the rehandling of material several times to obtain the desired refinement of steel, which is especially important where most of the material is handled in a molten condition with its consequent high cost. It is the author's opinion that this refining process will change materially in the next few years through the medium of electricity, and as central power plants become more highly developed and more of our natural resources are put into use to obtain cheap electrical power, furnaces will be developed that will operate by a continuous process. They should be able to take the ore at one end of the furnaces, and with the addition of material at different points obtain the alloy desired at the pouring end, thereby eliminating the handling now required from one furnace to the other by miscellaneous containers, ladles, etc.

In reducing ingots to the finished steel product, improvements should be made which will increase the safety of working conditions and eliminate as much as possible by proper ventilation at the mills and well-ventilated operating pulpits located at a distance from hot work, the disagreeable conditions arising from heat. Machinery should also be developed, wherever possible, to eliminate the necessity of handling hot steel with tongs around bar mills, rod mills, sheet mills, etc.

There is without a doubt a vast field for research and improvement in this industry, as there is in all others, and it is for us, as engineers, to continue our endeavors and bring out these improvements.

Centrifugal Casting

A Résumé of the Development and a Discussion of the Design and Operating Problems of Centrifugal-Casting Processes and Their Field of Application

By LEON CAMMEN,[1] NEW YORK, N. Y.

In this paper the author describes the process of centrifugal casting of hollow metal objects. He first deals with the field of centrifugal casting and the history of the development of the art and then discusses the mechanics of the problem and describes the operation of the casting machine. Following this he takes up the thermal conditions in the mold and the field of application of hot-mold centrifugal casting, closing with a discussion of the manufacture of plates by the centrifugal-casting process.

THE centrifugal casting of metals is an old art, but it did not assume commercial importance until the last decade. Since then, however, while it has not attracted much public notice, its progress has been very rapid. It has already become an important factor in such work as the manufacture of paper-mill rolls and railroad car wheels. It is today the most vital problem before the makers of cast-iron pipe in the United States, and, with its recent developments, promises to revolutionize the two most profitable lines of the great steel industry, namely, tubular goods and plate manufacture. In the present paper it is intended to describe the process of centrifugal casting of hollow metal objects. The field of centrifugal casting is, however, far more extensive. The process has been successfully applied in the production of non-metallic tubes, such as concrete pipe (Hume process and others), in the production of solid castings by locating the molds around the rim of a spinning wheel, and also to a limited extent in the production of solid ingots by a largely similar process.

The field of application of centrifugal casting is far more extensive than is generally realized and the process is already being worked on a large scale. In the first place, centrifugal casting is a cheap method of producing goods of certain shapes, namely, those having a hollow interior symmetrical about an axis passing through the body of the casting, whether concentrically or eccentrically. The advantage of such methods lies in the fact that with proper equipment a very large number of units can be produced with comparatively little labor and without the use of cores, and that a greater homogeneity of metal is obtained than is possible with the ordinary method of casting. During the war several concerns employed this method, for example, for the production of piston rings for automobile engines, and even now establishments like the Ford Motor Company continue to use it for that purpose.

The Sandusky Foundry and Machine Company, Sandusky, Ohio, employs centrifugal casting to produce bronze paper-mill rolls and propeller sleeves, which would be much more expensive and probably less satisfactory if cast in a stationary mold. The Stokes Casting Co., Ltd., Mansfield, England, has used the same method for making cast-iron liners for aluminum cylinders of internal-combustion engines of such a small thickness and high grade of metal that they could not be duplicated by any other process except machining, and at a price only a small fraction of what a machined tube would have cost.

In the field of cast-iron pipe centrifugal casting is in a fair way to displace sand-molded pipe entirely. The method of centrifugal casting of cast-iron pipe has been primarily developed by a Brazilian engineer, Dimitri Sensaud DeLavaud, and has been extensively employed in England, Canada and Japan. Some months ago the United States Cast Iron Pipe and Foundry Co., of Burlington, N. J., one of the largest manufacturers of cast-iron pipe in the world, acquired the DeLavaud patents for America and are going into the manufacture of centrifugally cast cast-iron pipe on a large scale. It is stated that they can make 600 lengths a day with 25 men and the centrifugal process, as against 400 lengths with 80 men by sand molding, in addition to which centrifugally cast pipe is roughly 15 per cent stronger than sand-cast.

Another development in centrifugal casting in this country which has already become of commercial importance is the manufacture of railroad wheels. The idea itself is not new and there are English patents describing it dating back to the early sixties. As cast centrifugally by the American Steel Foundries, the wheel has a manganese-steel rim and a soft-steel hub and spokes, the depth of penetration of manganese in the rim being regulated at will.

Of late, centrifugal casting has acquired a further importance in the development of a method by which tubes and hollow billets may be successfully cast of such metals as monel metal and alloy steels, which can neither be cast into thin-walled tubes nor pierced by the ordinary methods. Recent developments in the art are such as to open really great possibilities for the future, a matter which will be discussed in a later part of this paper.

The art of centrifugal casting of hollow metal objects is quite old and has been practiced on a commercial scale since the beginning of the last century. The earliest English patent (Eckert) dates as far back as 1809, and the earliest American patent to Lovegrove was issued in 1848. At about the same time Andrew Shanks, in London, England, began to make cast-iron pipe 12 ft. long and 3 in. in diameter by pouring molten metal into a spinning wrought-iron mold. His process was described in America in the *Scientific American* of December 1, 1849, and it is of interest to note that in its basic features of design the Shanks machine does not differ in any way from the great majority of machines working with a cold mold at the present day.

Attempts were made at an early date to apply centrifugal casting to ingot making with the view to improving the quality of the metal and, for example, M. Tresca, in a paper before the Institution of Mechanical Engineers,[1] stated that the most remarkable instance he had met with of freedom from air bubbles was in the case of a bessemer rail manufactured at the Imphy Iron Works near Nevers in the Department of Niévre, France; and he had ascertained that the method adopted at this plant was to pour the molten metal into a revolving vessel driven at a considerable speed so as to clear the steel of air by rapid rotation. This method proved very effective in practice in freeing the steel from the minute air bubbles which it contained on leaving the converting vessel or the melting pot.

A survey of the literature and of the numerous patents issued on centrifugal casting in this country and in Europe would indicate that practically all the essential features were covered by patents issued prior to the beginning of the twentieth century, with the exception, however, of those dealing with the temperature control of the metal, which is a new feature. It would appear, therefore, that with the exception of minor details and one or two features in special casting processes, there is no reason why any good engineer cannot design and operate a successful casting machine with a non-heated or non-cooled mold without running into legal complications. At the same time, it might be well to realize that the very fact that the basic features of the general process are already free makes those who have developed some of the few minor features particularly anxious to protect their patent rights in them. Because of this a general familiarity with the patent situation is desirable to avoid involuntary infringement by using some minor detail that has been covered by a patent.

Mechanics of Centrifugal Casting

In the first place, a clear distinction should be made between casting about the horizontal and about the vertical axis and also the intermediate case of an inclined axis. In casting about a horizontal axis the metal is distributed symmetrically about the axis of rotation, and if the axis of rotation coincides with the axis of the spinning unit, a tube of uniform thickness is produced for

---

[1] Associate Editor, MECHANICAL ENGINEERING.

Abridgment of a paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

[1] Proc. Inst. M. E., 1867, pp. 149–150.

the entire length of the mold. If a vertical axis is used it is obvious that the external wall of the casting follows the shape of the mold, while the interior of the casting forms a paraboloid of revolution. In casting with an inclined axis the same general principles apply, with the further complication that the elements of the inside paraboloid of revolution are also affected by the angle of inclination of the axis to the true horizontal.

The usual way of casting is by introducing molten metal into the spinning mold. Where the chilling of the metal is extremely rapid, as, for example, in casting cast-iron pipe against a water-cooled chilled mold, it is imperative to use a movable spout, the latter sliding at a certain predetermined rate so that by the time the nozzle discharging the metal comes out of the mold the entire pipe is completed. This is the process employed by DeLavaud. Other manufacturers working with the cold mold have attempted to secure the same results by what is known as a trough spout, which is really a trough into which the entire metal of the casting is poured at a rapid rate. The trough is then tipped and discharges the metal suddenly, the metal falling on to the walls of the mold at such a rapid rate that a pipe forms before the metal has had time to chill. Hitherto this process has met with only indifferent success.

A better result has been achieved on comparatively short castings, however, by the use of a ledge spout, the spout ending in a flat ledge along which the metal can flow the entire length of the casting. Finally, where a hot mold is used an ordinary short spout is employed, the metal distributing itself throughout the mold longitudinally under one of the components of centrifugal pressure or pressure produced by centrifugal action. This arrangement cannot be used with a cold mold.

In centrifugal casting the distinction should be clearly made between jobbing work and mass production. For the former, clay molds in iron cases have been used practically exclusively, as it would not pay to make a permanent mold for only a few castings. When it comes, however, to production on a tonnage basis, such as tubing or pipe, a permanent mold is practically the only feasible way. Crucible graphite or zirconium tubes have been successfully used for castings not in excess of 3 ft. in length, but when it comes to longer ones, metal molds are to be preferred. Fairly successful results have been obtained with chrome-nickel alloys, though it is not expected that this will be the material finally adopted, as enough work has been done already on the production of cast tungsten to make it certain that a mold of this still rather mysterious material will be available within a comparatively short time.

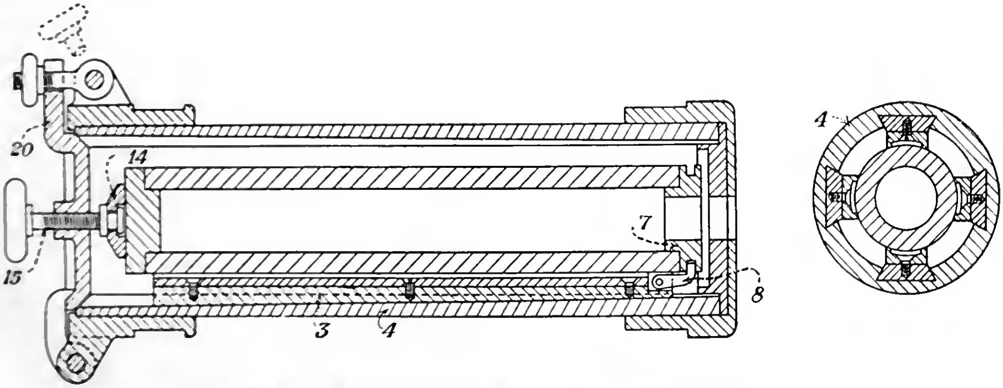


Fig. 2 Spinning Machine for Use With Removable Molds, Heavy Type

There are several ways of supporting the mold in the spinning bench, depending on whether the mold is a permanent fixture or removable and also on its size. Where the mold is a permanent fixture—as it is today wherever a cold mold is used, any kind of bearings, provided they are substantial enough, may be used. With removable molds the conditions are somewhat different, especially where the mold is heated to a high temperature. Where extremely hot molds have to be used, the arrangement must be such that the stresses on the mold can be reduced to a minimum, and that the mold can be rapidly and easily inserted into the machine and extracted therefrom. The matter of stresses is of very great importance in view of the fact that, especially in large machines, the bursting stresses due to the action of centrifugal force are of such magnitude as to require the most serious consideration.

The spinning bench for removable molds such as shown in Fig. 1 works on a comparatively simple principle, the mold being held in a barrel rotating on rollers, on which the pressure is adjusted by the wheel and screw shown at the top of the A-frame. This figure does not show the method of supporting the mold, and moreover, except for the very small sizes, three rollers are not sufficient.

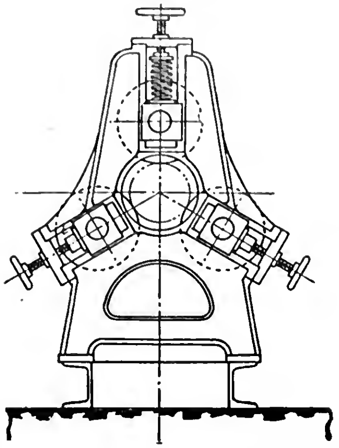


Fig. 1 Spinning Bench for Removable Molds (Suitable Only for Short and Light Molds)

The barrel construction shown in Fig. 2 is far more suitable for use with hot molds. Here the barrel consists of a steel shell, 4, which may be an extra heavy steel pipe, but in sizes above 12 in. has to be made as a special casting. At four to six places symmetrically spaced along the inner circumference of the shell, steel strips tapered at 39 and 40, Fig. 3, and with faces machined to the same radius as that of the internal surface of the shell, are screwed on or riveted on. The strips are provided with truncated slots as shown in the figure, and in these slots move the keys or gibs 51, the cross-section of which is shown by 37 and 36, which indicates that the face 36–37 is of the same width from one end of the gib to the other but the height of the trunk varies.

It is obvious that as long as the four gibs move through the same distance longitudinally in their tapered beds the faces of the gibs will remain parallel to each other, but the enclosed cylinder tangent to those faces will vary in diameter with the position of the gibs.

The operation of the machine is therefore as follows: The head 20 is opened and the gibs pulled out a little way until the tangent

cylinder is, say, a quarter of an inch larger than the external size of the mold. The mold is then inserted, preferably without touching the gibs, until it comes to bear against the abutment ring 7, to which all the gibs are attached (for example, by hooks 8). As the mold presses against the abutment the latter recedes and carries with it the gibs, which by moving in their tapered beds gradually close in until they grip the mold; and they may be made to grip it as hard as desired simply by exerting sufficient pressure on the abutment 7, which may be done by means of the block 14 and the screw 15.

The great advantage of this construction lies in the facts that, first, the mold automatically finds its own center, and, second, that it is supported all along its length, a matter of great importance when we come to deal with the bursting stresses in the mold. Whether a solid or a split mold should be used is a matter determined primarily by the shrinkage conditions of the metal of the castings and the metal of the molds. Where these are such that the casting comes out of the mold easily, that is, where it contracts quicker than the mold, a solid mold may be used, but where the shrinkage conditions do not guarantee easy extraction of the casting, or where they are non-uniform, the use of a split mold has been found advisable. Such molds are usually split longitudinally and the question of the best method for holding the two parts together is far less simple than it appears at first sight. There are numerous patents showing the two split parts of the mold held together by bolts. In actual construction, however, the use of bolts for this purpose is entirely unsuitable, for it can be shown that either bolts of prohibitive size would have to be used or the operation of a split mold held together by bolts would be extremely dangerous.

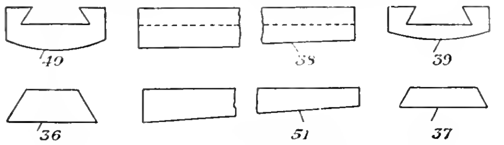


Fig. 3 Gibs and Beds of the Spinning Machine Shown in Fig. 2

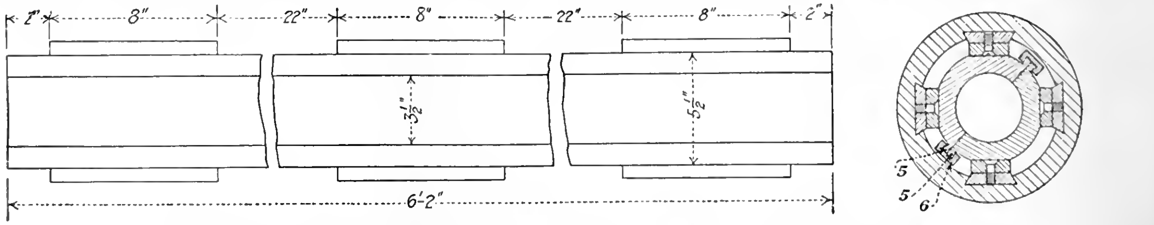


Fig. 4 Variation of Fig. 2, With Split Mold Held Together by Tapers and Dovetails

To meet this condition the mold shown in Fig. 4 has been developed. This mold has side lugs machined in such a manner that when the two parts are put together a tapered structure, such as 6, is obtained, and dovetail pieces 5 are provided to engage with the taper 6. It is obvious that when the dovetail piece 5 is driven hard over the lug taper 6, it will hold it tight. Furthermore, both the lugs and the dovetails can be made within reason practically as heavy as desired, so that a good factor of safety can be provided to take care of bursting stresses in the mold. To close or open the mold it is only necessary to apply pressure to the dovetail piece or give a light blow, and by means of a simple jig the blow or pressure can be applied to all the dovetail pieces on the mold at once.

It is obvious, however, that the presence of the lugs makes the machining of the mold to a true cylinder expensive, if not impossible. Because of this, instead of machining the mold to a cylinder, a number, such as four, of flat faces are planed on the mold, the location of the faces being such that they will be distributed symmetrically around the longitudinal axis of the mold and that they will be tangent to a circle described with the point on the axis of the mold as a center. Such an arrangement is comparatively easy to carry out and it gives an excellent support for the mold, besides providing a structure with good dynamic-balance properties.

As regards the foundations and bearings for centrifugal-casting machines no special design need be described here, but it should be most clearly and strongly emphasized that both the bearings and the foundations should be of very generous proportions and most substantial design. The machine in centrifugal casting is subject to quite violent strains and unless it is properly built it is apt to get into vibrations which sooner or later may have a dangerous effect.

Up to about two years ago very little work, as far as the author knows, had been done successfully on the problem of casting centrifugally comparatively thin sections, say, under $^3/_8$ in., in such metals as steels or monel metal and in lengths of over 3 ft. On the other hand, large castings in brass, bronze, cast iron and even steel have been made with considerable success. The reason for this lies in the failure to understand the thermal conditions in the mold and the process underlying the freezing of the metal.

There is a basic difference between casting in a stationary mold and in a spinning mold. In making castings in the former, whether it be a simple ingot or a complicated casting from a pattern, the foundryman has means to provide for the escape of gas from the metal and for taking care of the cavities produced by contraction in cooling. In a casting from a pattern, sink heads are provided, while in an ingot casting the top of the ingot acts as a sink head, in addition to which special methods such as "dozzling" may be used to keep the top of the ingot hot as long as possible, and increase the efficiency of the ingot top in performing the functions of the sink head in molds. In both cases the foundryman is prepared to discard as defective a certain part of the casting (the ingot head, risers, sink heads) and his skill lies partly in reducing the quantity of discard as far as possible and especially in directing the process so as to restrict the presence of defective metal to the parts which he is prepared to discard.

In centrifugal casting, however, there is no riser or anything corresponding to the ingot top, and the cooling proceeds essentially at a uniform rate all along the length of the tubular shape. It is obvious, especially in tubes of small diameter and considerable length, such as 6 in. outside diameter and 16 ft. long, that the loss of heat inward must be extremely small, because the entire inner air cylinder is surrounded by metal at approximately the same temperature. Heat is therefore lost mainly outward to the mold and through it to the air. As a result of this, the part of the casting in immediate contact with the mold chills first. The problems with which the "centrifugal" foundryman has to deal are essentially the same as those which confront the man pouring into stationary molds, and these are, first, to get rid of the occluded gases, and, second, to take care of contraction cavities. As regards occluded gases and slags, it would appear at first sight, especially to those familiar with such centrifugal processes as cream separation, that they would be eliminated automatically; pure metal, being heavier than either slag or metal containing gases, should be thrown to the outside, against the wall of the mold, while all impurities should go to the inner wall. This does actually happen, provided one condition is satisfied, and that is that sufficient time is available; and it should be remembered in this connection that this separation takes place at a fairly slow rate because of the great viscosity of molten steel.

The second problem is that of cavities formed in the casting as a result of contraction in cooling. As stated above, the part of the casting in immediate contact with the mold chills first. In doing so it contracts, and if left to itself might easily form contraction cavities and thin spots. If, however, the rest of the metal is still in a liquid state, it is projected, with a pressure at the rate

of, say, 100 lb. per lb. of metal, against the chilled layer, and fills all possible cavities with an efficiency many times greater than can be obtained with sink heads in stationary casting. (To obtain the same results in a stationary mold, it would have been necessary to put into the sink head 99 lb. of metal for every pound of metal in the actual casting, a propositon that is not likely to appeal to a sane foundryman.) This again presupposes, however, that the cooling proceeds at a fairly slow rate, and enough time is available for each succeeding layer to take care of chill conditions in the preceding layer. In cold-mold centrifugal casting, which means with a mold warmed only enough to take off the chill, say, 300 to 400 deg. fahr., temperature conditions do not favor slow cooling, which is one of the reasons of the many past failures to produce thin-walled steel tubing by centrifugal casting. On the other hand, very excellent steel tubes (both plain carbon and nickel alloy) have been produced with diameters ranging from 10 in. up and wall thicknesses up to $3^1/_2$ in. In the latter case there is so much metal in comparison with the area in contact with the mold that enough time is available to produce a good segregation of impurities inward before the inner wall freezes.

It would appear, therefore, that the secret of producing centrifugally thin metal castings (under $^1/_2$ in.) lies in establishing conditions under which the cooling of the molten metal will proceed at a fairly slow rate. This applies, of course, only to such metals as steels and monel metal, but not to bronze, which is governed by different conditions. In the Cammen process this has been accomplished by preheating the mold to a temperature close to the melting point of the metal itself, which may vary from, say, 1600 to 2000 deg. fahr. for steel and monel-metal castings. Under these conditions a $^3/_{16}$-in. wall takes about 45 to 60 sec. to harden completely, which is sufficient to produce clean metal. Casting in such extremely hot molds is a rather novel procedure and at first one might anticipate trouble due to oxidation and warping of the molds and the difficulty of handling large molds conveniently. As a matter of fact, however, with proper equipment it offers comparatively few difficulties. The question of oxidation of molds is taken care of by using proper alloys, such as alloys of a nickel-chrome base or cast tungsten (the latter, however, not yet being used on a commercial scale). The question of warping is partly taken care of by the same use of proper alloys, but mainly by the use of extremely substantial molds and proper facilities for handling them between the casting machine, the transfer table and the furnace. In all this handling, the molds have to be properly supported throughout the entire length, either by carrying them on a very heavy "horn" extending from one end of the mold to the other, or in a cradle supporting the mold throughout its length.

The method of operation is as follows: The mold with its casting inside, both at a temperature well above white heat, are rapidly pulled out from the casting machine and carried over to what is known as a transfer table, where the casting is pushed out of the mold by a hydraulic plunger. While the casting is going to the proper rolls or benches, the mold itself is coated inside by a protective layer and carried over to a reheating furnace. The furnaces used in this connection do not differ essentially from the billet-heating furnaces in tube mills. The mold coating is intended to protect the metal of the mold from coming into direct contact with the molten metal of the casting and need not be more than, say, $^1/_{64}$ to $^1/_{32}$ in. thick. It consists of some refractory material like alumina, zirconia, kaolin, electrically calcined magnesia, or the like. Either pitch with some addition of solvent naphtha or clay may be used as a binder, the former being preferable as it contains no water. The coating may be applied either by a swab or through a compressed-air gun.

Field of Application of Hot-Mold Centrifugal Casting

The particular feature that determines the field of application of hot-mold centrifugal casting is the ability to produce cast shapes of comparatively thin metal (down to $^1/_8$ in.) in great lengths—with our present knowledge of the art, up to 20 ft. One of the first applications that comes to mind is in the production of seamless tubing.

Hitherto the principal tonnage of seamless tubing has been made by the Mannesmann piercing process and its variations. Essentially this process consists in imparting such a twisting motion to a steel billet as to break down its central fibers. This motion is set up by means of obliquely placed rolls or disks. There are several objections to this process. In the first place, while it does pierce high-grade mild steel or muntz-metal billets, it stresses the central part of the billet far beyond its elastic limit. While apparently this does not affect very seriously the tensile strength of the finished product after it has been cold-drawn or hot-rolled, there is good reason to believe that it impairs the resistance of the metal to corrosion, the latter, as we know now, being particularly active in the case of metals stressed up to or beyond the elastic limit. Furthermore, the Mannesmann process is not at all applicable to metals which are either extremely tough or very brittle. Thus, all attempts to produce commercially by the Mannesmann process, hollow billets of either monel metal or Admiralty brass have so far failed. Not only that, but the Mannesmann process, by its very character, is limited to the production of comparatively small sizes, not in excess of 6 in. in diameter, as the cost of a Mannesmann mill becomes prohibitive after passing that limit.

At the same time there is a demand for larger sizes of tubing of greater strength than a single-welded joint can give, and this is where the most obvious field of hot-mold centrifugal casting appears. With this process, tubing in extra heavy and double extra heavy thicknesses can be easily produced in sizes up to 24 in. in diameter at a cost per ton that can compete with plain welded tubing, and considerably lower than that of double-welded tubing such as is used for hydroelectric installations.

The next field of application in connection with steel tubing is in standard sizes from 6 to 14 in. up, where welded tubing is now used exclusively. Such pipe can be produced in two ways: First, by casting a hollow billet of wall thickness two to three times that of the finished pipe, and either cold-drawing or hot-rolling it to size. In such a case the billets cast would be roughly 8 to 10 ft. long so as to have, say, 22 ft. in the finished pipe, barring cropped ends. The other method is to cast the pipe direct with only a slight excess of wall thickness and then to give it one pass between straightening rolls over a ball, so as to reduce the diameter and wall thickness to exact size with standard tolerances, and give the exterior and interior walls a finished appearance. From data now available it would appear that the final cost of both kinds is approximately the same and is well within the range at which centrifugally cast steel pipe can compete in price with welded pipe. There is at least 50 per cent less handling of material in centrifugal casting than there is in making pipe by welding, and such a difference cannot help being reflected in costs.

In this connection it might be well to mention one of the psychological factors with which centrifugal casting is concerned, and that is the not unfounded distrust of users of metal products toward castings, especially those in thin sections. Such castings cannot be produced commercially in a stationary mold, and steel castings in a stationary mold as made today generally are of such physical properties as to be usable only where they are not subject to complicated stresses and where an extremely high factor of safety can be provided. Wherever the stresses are high and especially uncertain and the factor of safety is not more than ample, no engineer today will use a casting but will insist on either a forging or a piece machined or hot-rolled.

This not unfounded distrust of castings is due to the fact that in either the sand casting or chill casting the temperature conditions in the metal are uncontrollable, with the result that one part of the metal may be entirely different in its physical properties, such as hardness and crystalline structure, from another, and there is no guarantee that two castings made under apparently the same conditions will be entirely alike. There is too much individuality in products cast in stationary molds to make them suitable for engineering requirements where a failure would be disastrous and where only moderate factors of safety may be employed. The situation is, however, entirely different with centrifugal castings, because there ample facilities are available, especially in hot-mold casting, to control the rate of cooling of the metal, and the nature of the process is such as to tend to give a uniform product, provided, of course, the process is carried out properly. From this point of view, one cannot help agreeing with an editorial in *The Iron Age* (Feb. 9, 1922), which states that "the successful operation of centrifugal-casting processes insures a product, no

matter of what composition, which is of a high grade. It is a realization of quality production in quantity, for rapid output is a marked characteristic. There is also the advantage of the elimination of sand and dirt. The condition of casting and cooling tends to produce a dense casting and one whose microstructure is different from the sand-cast products. Centrifugal force is substituted for sink heads as an insurance against unsoundness." This brief analysis states strikingly the difference between sand castings and centrifugal castings, and explains the reason why centrifugal castings may be used on a par with forged or hot- and cold-worked metal where sand castings would be too hazardous.

But the field of application of centrifugal casting, especially of the hot-mold type, does not stop with plain carbon steels. There are a number of alloy steels which it would be very desirable to have in tube form, such as stainless steel, high-speed tool steel, chrome-nickel-vanadium steel and the various "near-steels" which are iron alloys with a predominance of materials other than iron, such as heat-resisting alloys. Practically none of these materials will stand for piercing by the Mannesmann process, but cast with great ease into tubular shapes. In fact, even Hadfield manganese steel has been found to make, by centrifugal casting, excellent tubing, although it is very doubtful it has any commercial application outside of some very limited specialties.

Plate Manufacture

Centrifugal casting is peculiarly applicable to the manufacture of plates. Andrew Shanks, a British inventor of the middle of the 19th century, to whose pioneering work in the manufacture of cast-iron pipe reference has already been made, was also the earliest manufacturer of plate. His process was to cast a thin-walled pipe, cut it, and then by careful annealing and hammering, flatten it out. The process was kept secret and was successful commercially until rolled steel sheet was put on the market.

The use of a hot mold makes it possible, however, to secure comparatively thin-walled castings in large sizes. A process has been worked out, though not yet applied on a commercial scale, in which a cylindrical casting is made in such a manner that a longitudinal split about half an inch wide is produced. The split cylinder as it comes from the mold is sent first through a flattening jig where it is flattened out on its own heat, and then to rolls, of which there are at least two, one for sizing and the other for finishing. Under certain conditions more than one sizing roll may be required. The casting has to be cast oversize, the wall thickness being from 10 to 15 per cent greater than that of the finished plate. Thus, for example, $^1/_4$-in. plate would be cast in sizes 240 in. long, 20 in. in diameter and 0.265 in. wall thickness. It is expected that it can be brought down to a thickness of $^1/_4$ in. in one pass in the sizing rolls and that no reheating will be necessary.

This process is today only in its initial stages of development. It is attractive, however, as it does away with the ingot-casting work, soaking pits, blooming mill and a great share of the rolling equipment, permitting a conversion from molten metal to finished plate at a cost estimated at about $4 per ton.

Not only that, but it also makes quite attractive the manufacture of alloy-steel plates, in particular, of such materials as acid-resisting steels for use in chemical tanks and the like. These steels are very difficult to roll. The final product could stand the cost of the two or three passes necessary in centrifugal casting of plates, but not the many operations of the conventional methods of plate manufacture, the main item of expense being not the actual rolling but the complicated heat treatment absolutely imperative between the rolling operations. In fact, it would not be surprising if with prices of alloy-steel plates brought within reason, they would be used far more extensively than one would expect to find from present indications.

Other Applications of Centrifugal Casting

The casting of gears by centrifugal methods, in particular worm and herringbone gears, has been achieved with great success both in England and in America, especially in the latter country. As far as the author is aware, however, all such gears have been cast in non-ferrous metals and not in steel.

There is one more field of application of centrifugal casting, especially the hot-mold type, comparatively small today but which may become of material interest shortly, and that is the production of cylinders requiring extremely high strength. When the oxygen industry first called for cylinders that would safely withstand 2000 lb. pressure to the square inch, it looked like a big problem, but it was solved by progress in the cupping process. When, however, the Haber synthetic ammonia process demanded great pressures combined with considerable temperatures, special expensive tools had at first to be provided for machining the cylinders required from solid stock. The Claude ammonia process employs temperatures and pressures far exceeding those of Haber, and the experiments of Professor Bridgman of Harvard University and of others all point to the likelihood that before many more years have passed pressures of the order of 100,000, 200,000 and possibly even more pounds to the square inch will be used commercially.

At pressures between those used by Haber and Claude and those used by Professor Bridgman for containers of commercial size, carbon steels are but little suitable and the vessels required will have to be made from alloy steels. This may be done in two ways, either directly by centrifugal casting on a vertical axis which would give a vessel with closed bottom, or by the cupping process from alloy-steel plates, which, in their turn, would be made by centrifugal casting as already described. In this connection it may be of interest to mention that a high measure of success was achieved during the war by the Bethlehem Steel Company at Bethlehem, Pa., in casting air flasks for torpedoes centrifugally in a machine running on a vertical axis.

No attempt has been made in the foregoing discussion of the field of application of centrifugal casting to present anything like an exhaustive list. Instances have been merely cited in order to show the enormous field in which this process is now or may be employed.

The same applies largely to the description of the mechanics of the process, where likewise no attempt has been made to show the historical development of machinery for centrifugal casting or to give details of the actual apparatus. Such machinery, it should be emphasized, is and should be comparatively simple, for the process when properly worked out is the acme of simplicity. It should be clearly understood, however, that in centrifugal casting we are dealing with large rotating masses and with metal subjected in its molten state to the effect of great force. Furthermore, the distribution of the metal in the mold is effected primarily not by rigid material visibly distributed as in stationary casting, but by the action of invisible forces which do not come into operation until the moment when the metal is delivered to the mold.

Because of all this, and notwithstanding the great simplicity of the machinery and methods of centrifugal casting, it should be clearly remembered that even the slightest imperfection in the design or operation will immediately show up in the casting. Centrifugal casting is a process which is peculiarly impossible to be worked either by slipshod methods or on a shoestring, i.e., skimping on the quality of materials and on factors of safety in the design of machinery.

There is an old saying current among molders to the effect that a lie in sand will be shown up in the metal. The same applies with still greater force to centrifugal casting. The slightest mistake in the layout of the machinery or the use of poor materials in the machine, its bearings and foundations, will produce an uneven casting, result in excessively rapid wear of the molds, and at times may even cause disastrous accidents with danger to life. At the same time, with good engineering and the use of first-class materials, centrifugal casting may be carried on entirely by semi-skilled labor and still give products of unsurpassed excellence.

[Five appendices accompanying the complete paper are devoted respectively to (1) a bibliography of the subject; (2) what is believed to be a complete list of all patents on centrifugal casting issued since 1848 by the U. S. Patent Office; (3) mathematical considerations governing casting about a vertical and a horizontal axis and the axial forces acting on the liquid metal in a horizontal mold; (4) temperature control of the metal of the casting and of the mold; and (5) fluid-pressure, fly-wheel and thermal-expansion stresses in molds used in centrifugal casting machines.—Editor.]

Hydroelectric Power-Plant Design

By J. A. SIRNIT,[1] BIRMINGHAM, ALA.

The most logical and simplest way to maintain the full capacity of a hydraulic power plant during flood periods is to remove the high tail water from the discharge opening. This may be most successfully accomplished by a backwater suppressor utilizing the waste water, and the present paper is chiefly devoted to the development and application of this method.

Two testing models are described and the results presented, while the design of the draft-tube orifice is discussed at some length. Finally the plant of the Alabama Power Company at Mitchell Dam on the Coosa River in Alabama, where the Thurlow type of backwater suppressor was first conceived and applied, is described, details of its construction and equipment being included

THERE are many power plants and possible sites for such plants where the supply of water is very irregular, and where, owing to the nature of the surrounding country, it is impossible to provide sufficient storage for the utilization of all the water flowing in the stream.

In many hydraulic power plants, now in operation or proposed, there is, or will be, a great loss of power annually, due to the fact that during flood conditions when water is being wasted over the spillway, the level of the water in the tail race at the outlets of the draft tubes leading from the turbines is raised, thus reducing the head on the turbines, and in turn their capacity and the output of the power plant. There are many notable examples of these conditions, and in some cases reduction in effective head on the turbines becomes so great at times as to completely shut down the power plant. The Hales Bar plant on the Tennessee River is an example of where these conditions occur during the spring floods.

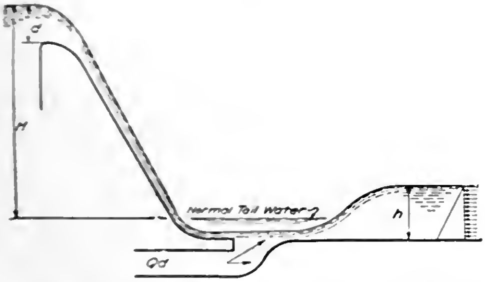


FIG. 1 ACTION OF SPILLWAY WATER ON TAIL WATER
(H = head above tail water; d = depth of water above spillway; h = total water column balanced, Qd = quantity through draft tube.)

In many cases of proposed developments, engineers have hesitated in recommending the carrying out of the development on account of backwater conditions in the tail race, which can be foreseen and predicted very closely. The proposed development at the Great Falls on the Potomac, which has been under discussion for many years, represents an example.

Engineers for many years have wrestled with this problem and have tried to overcome this difficulty by installing a greater number of generating units where it was possible to do so, to compensate for the loss in capacity of each unit; of course such a procedure necessarily makes the installation more expensive, with the resulting increase of production costs. Attempts have also been made to counteract this loss in head by admitting water into the draft tube through jets at a relatively high velocity which, by accelerating the velocity of the combined turbine discharge and jet water through the draft tube, produce a negative head which is added to the head on the turbine. A number of variations in the place and manner of introducing this jet into the draft tube have been tried and results published. But the results have not been entirely satisfactory.

The most logical and simplest way to maintain the normal head on the water wheel, and thereby the full capacity of the plant, during flood periods, is to remove the high tail water from the discharge opening, and credit is due to O. G. Thurlow, chief engineer of the Alabama Power Company, who conceived the idea of utilizing the waste water to accomplish this fact, thereby successfully solving the problem. The development of this conception resulted in what is now known as the Thurlow backwater suppressor.

THE THURLOW BACKWATER SUPPRESSOR

It is a well-known phenomenon that water flowing over a masonry dam having a downstream face of ogee section, leaves the apron in a thin sheet at high velocity. At a point below the dam the water rises turbulently, forming a so-called "standing wave," "hydraulic jump," or "back roll." The thickness of this sheet and the velocity of the water depend upon the height and shape of the downstream face of the dam, upon the depth of water at the crest of the dam, and upon the quantity of water flowing over the dam. The energy developed in this thin sheet of water has generally been regarded heretofore as solely of a destructive nature, but in the backwater suppressor the energy of the spillway water is so directed as to remove the backwater from over the draft-tube orifice, sweeping it downstream, thus freeing the draft tube from this pressure of water over it and maintaining a practically uniform head on the turbine as long as the spillway water is able to sweep the backwater away from the draft-tube orifices. In Fig. 1 is shown diagrammatically the action of the overflow spillway water on the tail water. The energy of the spillway water not only removes the height of tail water from the draft-tube orifice, but even lowers the normal tail-water level to a predetermined depth.

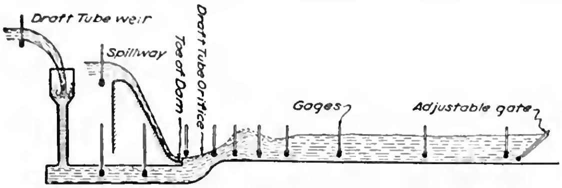


FIG. 2 DESIGN OF TESTING FLUME

MODELS TESTED

In order to substantiate the idea and evolve a definite theory on which to base the calculation, a model was constructed on a 1 : 24 scale at East Lake in Birmingham, Ala., where a small flow at 3 ft. head was available. The results obtained were so interesting that, to check the data obtained and to increase the accuracy of measurements, a second and larger model was constructed on a 1 : 10 scale at Jackson Shoals, Ala., where a greater flow and head were available.

The results obtained with the two models, when reduced to the same scale, were in close agreement and the observed results followed those calculated for similar conditions.

Fig. 2 shows diagrammatically the essential elements of these models. Each consists of a forebay for stilling the water, a spillway having the usual ogee section, a draft tube with its orifice located directly under the spillway, and a tail-water wasteway.

The heights of the water in the forebay, wasteway and draft tube were measured in glass gages conveniently located on central platforms. By means of these, measurements corresponding to the pond-level head above the river bed, the effective turbine head, the depth of water over the spillway, and the backwater head could be conveniently determined.

Weirs were used in admitting water to the draft tube so that the amount could be accurately measured. This amount was ordinarily maintained to correspond to a normal turbine discharge.

---

[1] Designing and Electrical Engineer, Alabama Power Co. Mem. Am. Soc.M.E.

Presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly abridged. All papers are subject to revision.

TABLE 1 SUPPRESSING PERFORMANCE OF JACKSON SHOALS MODEL

Water over river bed, in.	Head without suppressor, in.	Head with suppressor, in.	Water over river bed, in.	Head without suppressor, in.	Head with suppressor, in.
0	96	. . .	21¾	71¼	88
½	95½	96½	26	70	87
2¾	95¼	95¾	27½	68½	80
19	77	96¾	29	67	73
20¼	75¾	96½	29¼	66¾	74
21½	74½	97	30¼	65¾	73
22	74	96½	34	62	68¼
22¼	73¾	96¾	35¼	60¾	66
22¾	73¼	96¾	40½	55½	66¾
23¾	72¼	96½	46	50	56½
24½	71¾	89½	. . . .	. . . .	. . . .

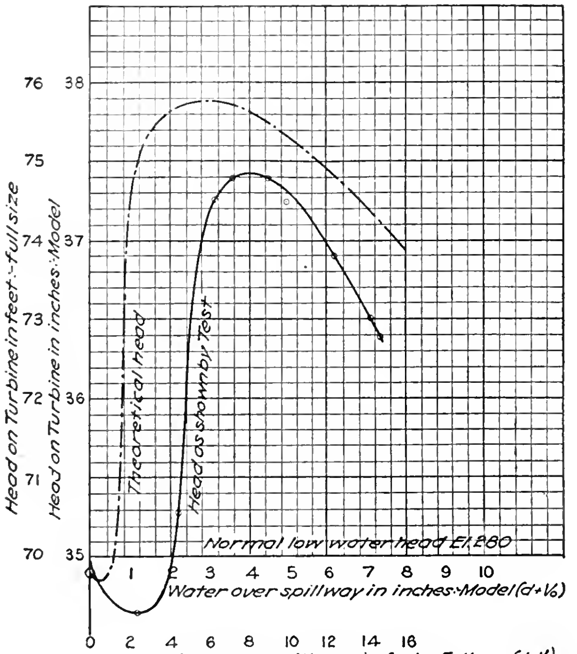


Fig. 3 East Lake Head Curve

Bear-trap stop logs were provided at the end of the wasteway by which the height of the water in the wasteway could be varied to simulate backwater.

Calculated and Observed Results

The height of the standing wave, taking a section of unit width (1 ft.) and neglecting losses due to the friction of the moving water over the spillway, can be approximated by the empirical formula $h = \sqrt{d^{3/2}H^{1/2}}$, in which d is depth of water in feet over the spillway and H the head in feet above the spillway apron. This does not take into account the effect of the turbine water. This factor will increase the height of standing wave, so that the actual results will be somewhat better than as shown by the formula.

The figures of Table 1 were compiled from three separate tests made at different times and show the performance of the Jackson Shoals model with 18 in. of water over the spillway in suppressing various heads of backwater.

The effect on the turbine head of different amounts of water over the spillway of the East Lake model is shown in Fig. 3. It should be noted that very small amounts cause a decrease in head because sufficient velocity has not been given to the draft-tube water to cause a thinning of the sheet over the draft-tube orifice, but when the ratio of spillway to draft-tube water increases to about 1 : 1 the curve takes a decided course upward and reaches its peak and starts falling off again due to a greater quantity of water passing over the orifice, with practically no increase in velocity above that of the point of maximum head. This curve does not represent the best performance possible but it is typical of the ideal theoretical curve which is shown in the same figure.

The curve in Fig. 4 shows the overall performance of the test as compared to that without the suppressor. It will be noticed that the head drops off slightly as the backwater increases, due to a greater quantity of water necessary to hold the standing wave, until a point is reached where the standing wave is 13.26 in. high and the curve turns sharply down. This point represents the critical stage or the maximum height of backwater capable of being suppressed by a given amount of spillway water. This could be increased by having a design of spillway permitting a greater discharge.

Even after this point is reached a substantial increase in head is obtained, and at the last point plotted, with backwater 50 per cent of the total head, an increase of 5 in. is recorded. Fig. 5 illustrates the condition of backwater after the critical stage has been passed.

Design of Draft-Tube Orifice

Several shapes of draft-tube orifices were tested. That shown in Fig. 6 leaves very little to be improved upon for getting a maximum height of standing wave and a maximum head on turbine. This design can be modified to give a greater head on the turbine, but only at a sacrifice in the height of the standing wave.

The location of point x is of great importance as it controls the increase in head on turbine, and its relation to the elevation and angle of discharge of the spillway apron must be very exact or a poor performance will result; also consideration for the turbine "run-off" during the period when the suppressor is not in action must be kept in mind.

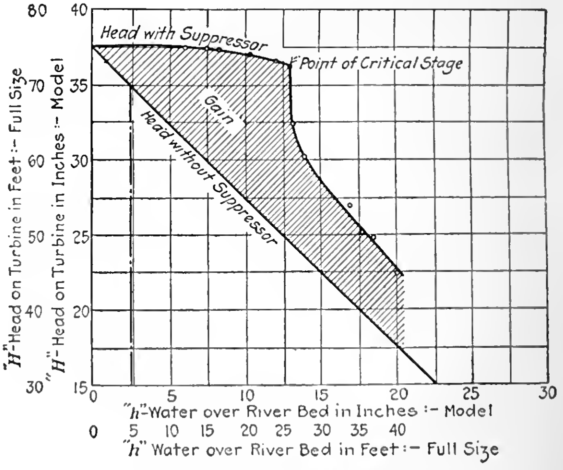


Fig. 4 East Lake Performance Curve

The length of tangent t must be such that it will direct the spillway water well along the line ab, and it should be at least 5 ft. for heads up to 25 ft. and 7 ft. to 10 ft. for heads varying from 30 to 100 ft. The amount of water flowing over the spillway will cause this length to change, but for depths up to 15 ft. this range will hold good.

The distance out of point x is determined by the amount of water passing through the draft tube. The area of the draft-tube orifice subject to the action of the sheet of spillway water must be proportioned so that a back pressure in the draft tube is not necessary to force the two waters to mix. The curve of R_3 is great enough so that the centrifugal force of the fast-moving sheet of water will not cause it to leap clear of the concrete surface. R_2 makes a smooth transition, connecting point x and R_3, and is about $^1/_2$ R_3.

The standing wave is held out just beyond tangent R_3. The total distance from the lip of spillway apron to the point of wave must not be greater than good design of the other features will permit, as the friction of the high-velocity water diminishes the height of the standing wave, thereby causing a greater amount of waste water necessary to operate.

The river channel below tangent R_3 must be finished with neat concrete for a distance of four heights of the standing wave, in the case of heads up to 25 ft., and five to six heights for heads varying from 30 to 100 ft. This is necessary for good performance although a rough bed or water pocket can be used, but a great waste of water is required and heavy undercurrents, due to an imperfect standing wave, might scour the river bed badly or undermine the protecting apron.

This is of great importance if the rock strata are poor, as open seams will allow the high static pressure beyond the wave to be transmitted back under the protecting apron, causing an uplift. This uplift must be given attention, even when the apron is carried out to the desired point and provision made for its secure anchor.

Dividing Walls

Each unit must be provided with dividing walls to prevent the water from coming in on the sides and to allow any one unit to operate independently.

The correct height and length of these walls is determined by the backwater and discharge curves of the river at the location of the power house. Section A-A, Fig. 6, shows the condition for the installation of four units. The three intermediate walls are at an elevation shown by the backwater curve when the required amount of water to operate four turbines and three suppressors is passing that point. When the fourth suppressor is brought into action the condition is as shown by the dotted line in unit No. 2, and these walls simply act as a guide to hold better conditions at the point of wave and prevent surging.

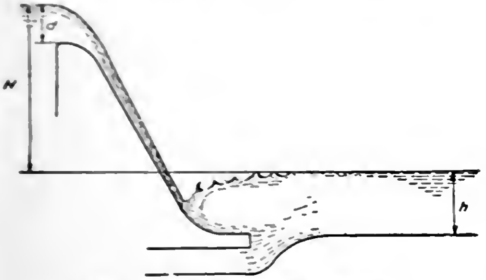


Fig. 5 Flood Conditions of Model

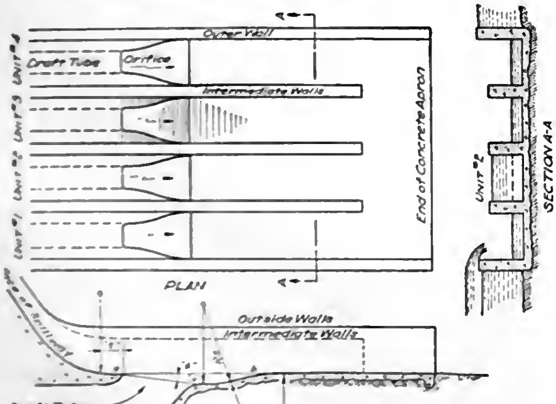
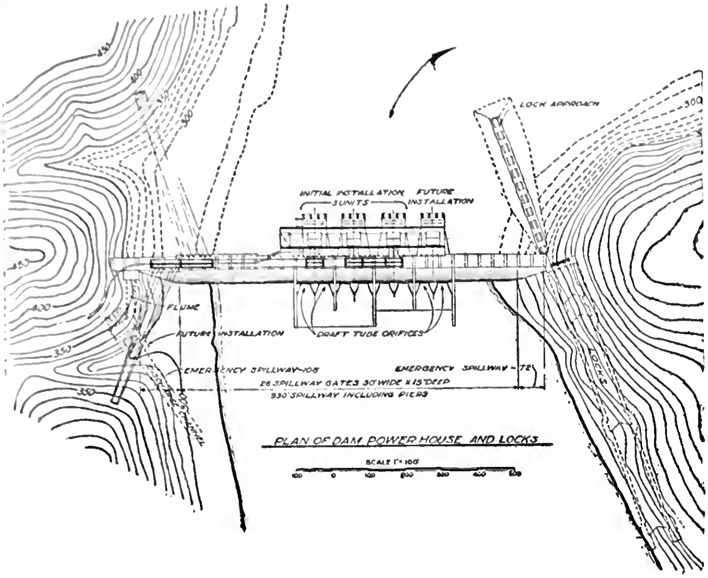


Fig. 6 An Excellent Design of Draft-Tube Orifice

The two outer walls are designed for extreme flood conditions, as any water passing over the walls into the suppressor sheet will cause a loss in head on the turbine and in height of standing wave. However, if there should be spillway gates on both sides of the power-house section equal to the width of two units, it need not be at the maximum high-water elevation, but at the stage shown by the combined discharge passing the power house and side spillway. This is due to the fact that although a perfect standing wave is not formed at the toe of the side spillways, a lower elevation is created than will be further downstream, where the true backwater elevation is measured.



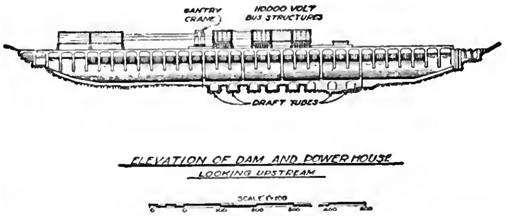


Fig. 7 General Plan and Elevation of Alabama Power Company's Dam and Power House on the Coosa River

Power Plant with Backwater Suppressor

Encouraged by the splendid results of the model tests and the economic advantages of the undertaking disclosed by careful analysis, the Alabama Power Company decided to apply the backwater suppressor at Mitchell Dam on the Coosa River in Alabama, which is now under construction. The estimates showed that not only was the cost of the suppressor-type plant not higher than that of a conventional-type plant of equal output, but even lower in cost for the same number of units, and therefore for a given output the suppressor-type plant was considerably less expensive.

The principal and most outstanding feature in this plant is the location of the power units on separate foundations in the river on the upstream side of the dam (Fig. 7). Although this was not necessarily the only possible way to build the power house, it was the most economical. The river at this point being comparatively narrow, the entire length of the dam was required for spillway, and since the prime requisite of this type of plant is that the draft-tube discharge directly under the spillway section, the units had

to be so located that they would not obstruct any part of the spillway section.

The individual and separate power-house units offer the added advantage that trash racks do not present a solid front, which helps materially in cleaning them and affords an easy and convenient way of diverting the trash past the power house and over the spillway.

The usual power-house building is entirely eliminated. The generator room is covered with a low roof, which is designed in two sections, joined on the transverse line, mounted on rollers; each section moving in opposite direction. In normal operation the generator room is completely protected from the weather, but for handling large parts of the machinery, this roof can be opened and a crane utilized for performing the necessary work.

A single gantry crane (Fig. 7) with full travel over the entire length of power-house section is so designed that everything, with the exception of spillway gates, can be handled by it. It is equipped with one 125-ton and one 20-ton hook, the former for handling heavy machinery and the latter for raising and lowering penstock gates, handling racks, stop logs and all other lighter parts.

An outdoor transformer and high-voltage switching station is located on the bridge over the spillway (Fig. 8). This plant is designed for operation on unit system, i.e., the generator and its bank of step-up transformers are connected as a unit and all principal switching is to be done with the high-voltage circuit breakers. In stations where units are of large capacity, as in the 20,000 kva. plant under discussion, the unit system is very economical and preferable, as it presents the simplest, yet sufficiently flexible, form of operation.

The entire operating floor is on one floor level. The generators, governors, switchboard, low-tension switches, bus galleries and offices are easily reached without climbing stairs or ladders. This materially adds to the convenience of operators and makes the supervision and inspection of the plant more effective. This feature of providing easy accessibility to all important parts of the station is very frequently lost sight of by power-house designers and the lack of these conveniences has been the cause of inefficient operation or even of breakdowns, due to the fact that operators have neglected the equipment to a lesser or greater degree.

The generators are so installed that the hot air from the generator is discharged into a separate compartment under the main floor and is expelled into the atmosphere through side openings of that room in summer time, thereby keeping the generator room reasonably cool. In winter, however, when heat in the rooms is desired, the outside openings can be closed and through registers in the floor the warm air enters the generator room.

The penstock does not represent a true scroll casing but rather a combination of scroll effect and open flume. The water velocities in the penstock being low, approximately 4 ft. per sec., this combination affords a better design.

The location of power-house units on the upstream face of the dam lengthened the discharge tunnel to a distance of about 120 ft. from the center line of the unit. Although the velocity of the discharge is only 4 ft. per sec., the effect of this long column of moving water had to be carefully investigated and studied. This problem was solved satisfactorily by increasing the governor action to $3^1/_2$ sec. and setting the turbine to the lowest practical level. Turbine settings always should be as low as possible, especially where improved draft tubes are employed. Many of the troubles in existing power plants, such as pitting of runners, excessive vibration, etc., can be directly traced to high wheel settings, particularly with high-specific-speed runners.

Fig. 7 shows that 26 spillway gates of the Tainter type are provided, each 15 ft. high and 30 ft. wide. These gates are capable of passing the maximum flood water known to have existed in the past. There are also six bays, two on the east and four on the west end of the dam, which are designated as emergency spillway openings. The crest of these openings is level with the top of the spillway gates and their function is to provide additional spillway capacity in case of unprecedented floods when water would rise above normal pool level.

Although little has been said about the electrical equipment, it is one of the most important parts of the installation and should always receive close study and serious consideration if economical and efficient operation is expected.

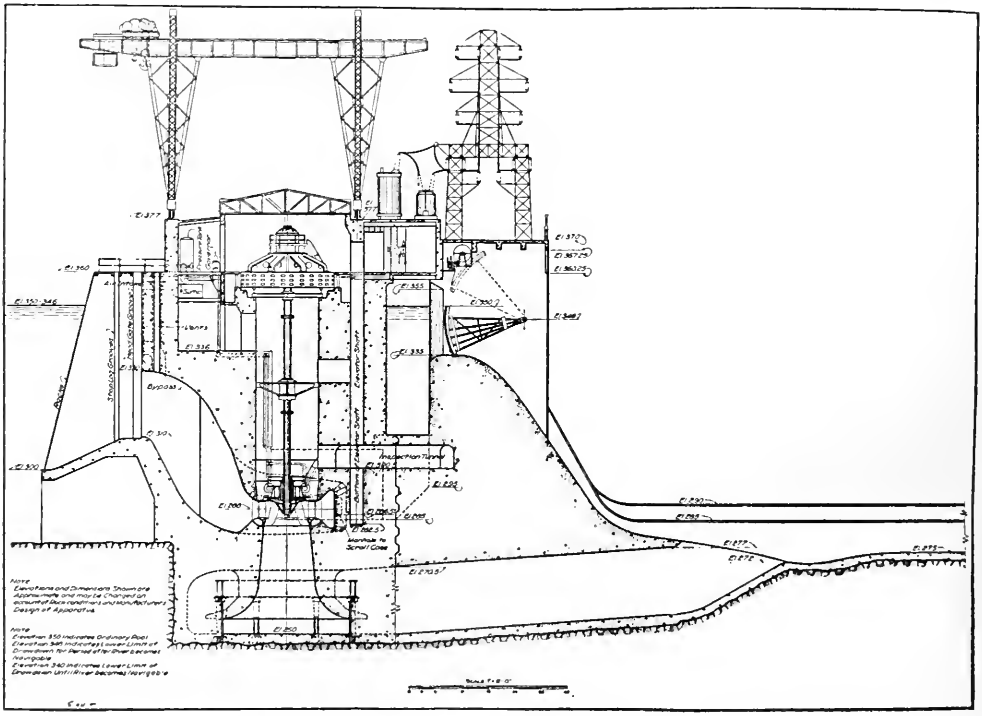


Fig. 8 Cross-Sectional Elevation View of the Power House Shown in Fig. 7

The Boiler House of the American Sugar Refining Company at Baltimore, Maryland

By E. B. POWELL,[1] BOSTON, MASS.

TO AN industry such as the refining of sugar, the proper functioning of the boiler house is altogether vital. Almost every phase of every process in the refinery is directly dependent upon the application of steam as a heating or drying agent. For this reason, also, the cost of steam is an important factor in the manufacturing costs of the refinery.

In the design of the boiler house for The American Sugar Refining Company at Baltimore, the effort has been made to combine a high degree of dependability, efficiency and simplicity in operation and agreeable conditions of work, in a type of construction readily adaptable to the economic requirements of any permanent or long-term condition of fuel market, such as might call for the installation of economizers in any form, or the substitution of any other class of fuel than that initially selected.

The steam requirements estimated for the present developed capacity of the refinery were about 7,300 boiler-hp. average, and 8800 boiler-hp. maximum, demand. It was also considered that further developments might possibly increase the steam demands by about 50 per cent. The general suspension of refinery operations over Sunday would allow opportunity for any minor repairs that might be required in the steam-generating equipment, so obviating the necessity for much duplication in reserve, and permitting the economic adoption of moderately large units even for the initial development. On these bases, 6000 rated boiler hp. in 1200 hp. units was decided upon as the most suitable capacity to be installed for present requirements and 9600 rated hp. as the probable ultimate capacity of the boiler house.

A careful survey of the possibilities of all fuels considered commercially available led to the selection of a grade of small-sized anthracite, popularly known as "creek coal," as most satisfactory and economically meeting the requirements. This coal is not only low in price and, for practical purposes, entirely free from deterioration in storage but possesses as a fuel for the refinery boiler house the additional and important advantages of cleanliness—the refinery is turning out an essential food product of the highest quality—and of permitting the adoption of a single fuel for the entire plant—anthracite is required in the refinery processes for firing the bone-charcoal regenerating kilns. The major equipment of the boiler house, however, was designed for ready adaption to any type of fuel.

General Features of the Plant

Fig. 1 shows the refinery boiler house and outdoor coal plant as viewed from the Patapsco River, and Fig. 2 a representative cross-section. The building is of structural steel frame with brick walls and reinforced-concrete flooring, the basement being at the grade of the lot and the main operating floor about 28 ft. above. The structure is 111 ft. 5 in. wide by 132 ft. 10¾ in. in length with a height of about 125 ft. from the ground level to the top of the coal-bunker housing. The building footings rest on a continuous concrete mat foundation supported on wood piling closely spaced.

The main operating floor is practically clear of all equipment, except the boilers and stokers themselves. Liberal aisle space is provided to give convenient access at all points. Also, to minimize attendance, practically all the auxiliaries of the station are grouped together on the mezzanine and basement floors under the west line of boilers. The space under the east line of boilers is utilized for offices, toilet and locker rooms, laboratory, tool and storeroom, raw-sugar electric-truck charging station, and repair shop.

The boiler-house stacks are of reinforced concrete, 200 ft. high above the roof, 15 ft. in internal diameter, and supported on the building frame at the roof level. The coal bunker is of reinforced concrete, of the longitudinal type, set above the firing aisle and having a capacity of about 1200 tons, or three or four days' estimated normal requirement. To provide for ample daylight illumination, the bunker is raised somewhat higher than is usual and continuous skylights are set at either side, which admit a full flood of light into the boiler aisles.

The main coal storage is provided out of doors in the lot space bordering on the water front and to the east of the boiler house. Coal is normally delivered by rail to the B. & O. R.R. pier head, where it is discharged on to refinery-owned barges of about 700 to 800 tons capacity. The loaded barges are warped alongside the refinery coal wharf with the aid of electrically driven winches and are there unloaded, either directly to the station or to the yard storage, by means of an electrically operated movable tower of the through-boom type carrying a 2-yd. bucket of 150 tons' hourly capacity. The movable tower has a storage and reclaiming capacity of about 9,000 tons immediately beneath the boom; the remainder of the 25,000-ton outdoor storage capacity is served by locomotive crane.

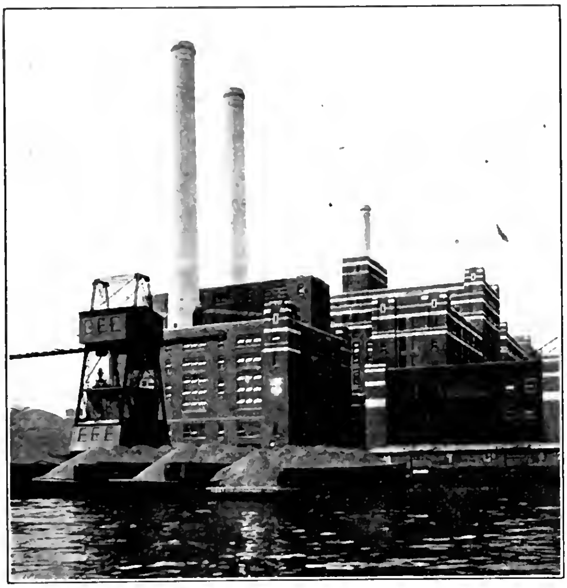


Fig. 1 The Boiler House of the American Sugar Refining Company at Baltimore, Md., as Viewed from the Patapsco River

Coal intended for the station bunker is delivered by the movable tower on to a 30-in. trunk-line belt conveyor which in turn delivers to the double-chain fixed-bucket-type elevating conveyor at the north end of the boiler house. From the latter conveyor it is distributed to the different sections of the bunker by means of a 24-in. belt conveyor and automatic tripper. From the bunker, coal is delivered to the stoker hoppers by an electrically operated automatic weighing larry. A separate pocket is provided in the boiler-house bunker for coal intended for use in the filter-house kilns; this coal is conveyed to the filter house by special overhead belt conveyor and weighed on automatic weightometer en route.

Steam leaves the boiler house and condensate, hot and cold water, and compressed air from the refinery reach the boiler house over a bridge near the northwest corner and at a level slightly above that of the mezzanine. The main steam header within the boiler house is in the form of a loop with one side carried above the east line of boilers, the other side accessibly located at the rear of the west line of boilers about three feet above the operating floor.

---

[1] Consulting Engineer, Stone & Webster. Mem. Am.Soc.M.E.

Paper presented at a joint meeting of the Baltimore, Md., Sections of the A.S.M.E. and A.I.E.E. and the Baltimore Engineers' Club, May 24, 1922. Slightly abridged.

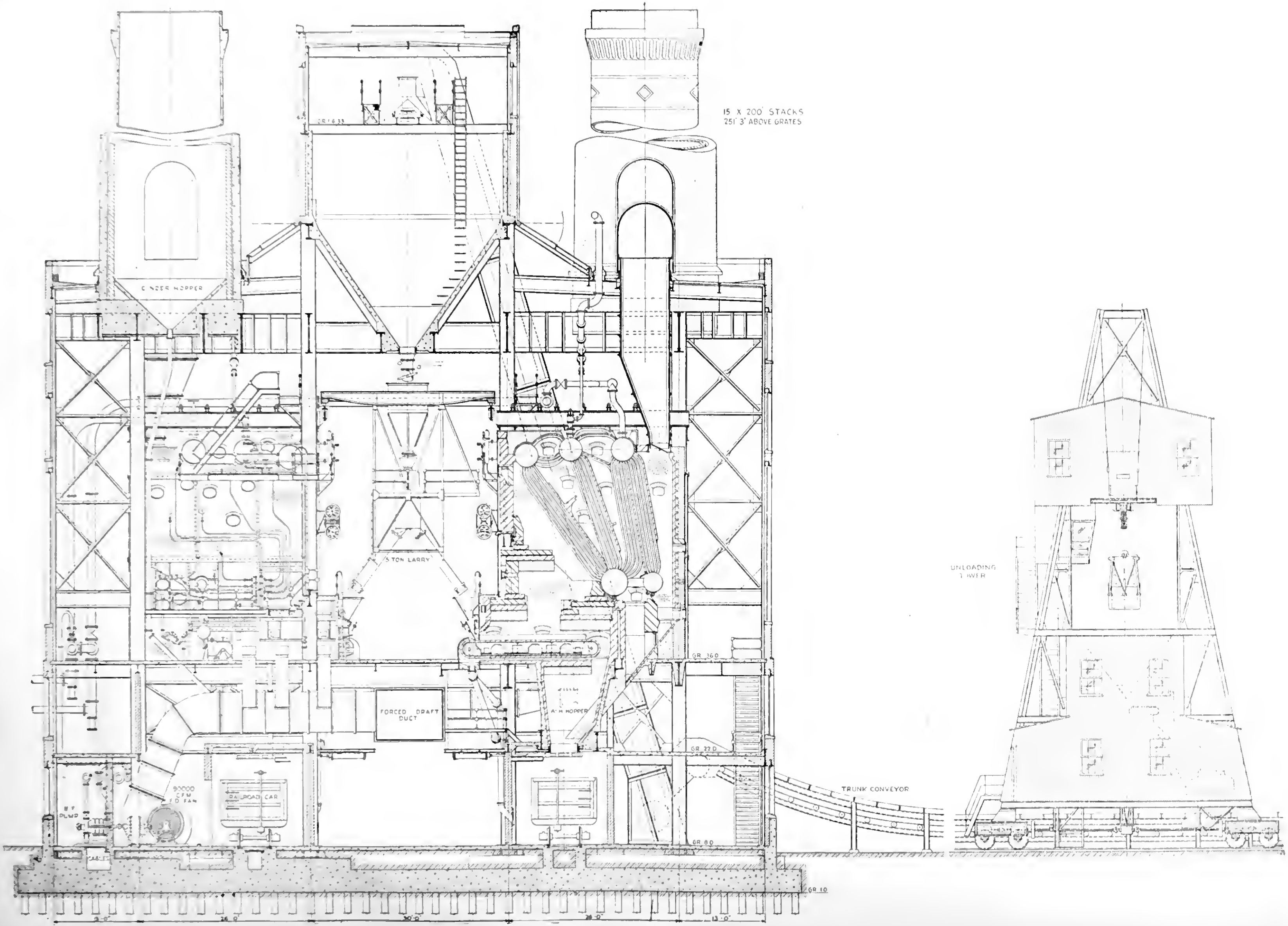


Fig. 2 Typical Cross-Section of Boiler House

At the point of take-off for the two lines which lead respectively to the engine house and to the refinery, provision is made for opening the loop and feeding these two lines separately, with a regulating valve between set to maintain the desired pressure in the engine-room main. In normal operation, one of the division valves in the boiler-house loop will be closed to segregate to the engine-room main the boiler capacity required to carry the power load, the remainder of the boiler capacity on the line feeding through the other side of the loop to the direct-refinery main in which any pressure above 110 lb. will meet all requirements. With this arrangement sudden demands in the refinery can produce only negligible drop in pressure at the engine house, and such loss of pressure as may occur in the refinery main may readily be regained before there is any interference with manufacturing processes.

The Boilers

The boilers are in 1206-hp. units, Stirling type, with 26 per cent integral economizer surface and are encased in settings which, except for the rear wall back of the integral economizers, are of solid firebrick. There are no superheaters. The boilers are designed for 250 lb. pressure and will normally operate at about 210 lb. They are equipped with 18-element mechanical soot blowers and with automatic feedwater regulators. To avoid risk of corrosion the interior surfaces of all boiler drums and of economizer sections complete, both tubes and drums, are treated with a special carbon coating. This coating has been applied as a measure of extra precaution, as under normal conditions all air and other gases will have been removed from the boiler feed and there should be no tendency to corrosion in any form.

Flues and uptakes are of steel plate with 2 in. of inside insulation. Provision is made in the space above and at the rear of the boilers, including the space now occupied by uptakes, for the installation of additional economizer surface or of air heaters, should either prove desirable in future, and for cinder catchers, should the need for such apparatus appear.

The stokers are of the traveling grate type, two per boiler, with an effective surface for each stoker 9 ft. $8^3/_8$ in. in width by 16 ft. 4 in. in length, giving a ratio of grate surface to heating surface of 1 : 38. Each stoker is driven by a $2^1/_4$–3-hp. d.c. motor with hand-operated drum controller.

The ash hoppers are of reinforced concrete, brick-lined, providing capacity sufficient for about 16 hours' requirements and so set as to give ample clearance for the standard railway car of full gondola size beneath. The ash gates which form the bottoms of the hoppers are operated by air cylinders and designed to discharge directly into the railway cars.

All auxiliaries, except one feed pump for emergency and starting purposes, are electrically driven by d.c. motors. Four centrifugal feed pumps are installed in the west basement: two motor-driven of 750 gal. per min. capacity, and one motor-driven and one turbine-driven of 350 gal. per min. capacity. Forced draft is supplied by three turbovane-type fans of 90,000 cu. ft. per min. capacity at $5^1/_2$ in. pressure, driven by 125-hp. motors under automatic control from the steam-line pressure. These fan sets are located on the basement floor under the west line of boilers and draw the bulk of their air supply from the ash alleys. Adjustable louvres opening into the fan bays from the west mezzanine are, however, provided for ventilation. For cleaning purposes and for operation of ash gates, damper regulators, and other devices of a 200 c.f.m. motor-driven air compressor is provided which is located with other auxiliaries in the west basement. Reserve air supply is had by pipe connection with the compressor plant of the refinery.

The Feedwater System

As practically all steam leaving the boiler house, including that used for power purposes, is condensed in closed coils in the refinery and so normally available for boiler feed, the feedwater make-up requirements estimated are but slightly greater in percentage than those of the modern condensing-type electric generating station. To meet the accidental condition of evaporator-coil leakage, or other cause of contamination or loss of condensate, however, it has been necessary to make provision in the feedwater equipment for the emergency use of raw water exclusively.

Under normal conditions, condensate will be returned from the refinery at a temperature of between 180 and 220 deg. fahr.; the raw make-up water will normally reach the boiler house at city main temperature, about 50 to 70 deg. fahr. The condensate returned to the boiler house is first passed through standard toweling-type filters to remove any suspended impurities; from the filters it discharges into a 12,000-gal. receiving tank located on the west mezzanine. The normal make-up, direct from the city mains, is delivered first to a deaerator having a capacity of 21,000 lb. per hour and located above the receiving tank and on the west wall of the boiler house. In this apparatus practically all dissolved oxygen and other gases are removed. The deaerated water, so called, is delivered direct to the receiving tank under float control at about 190 deg. fahr. A 15,000-gal. storage tank equipped with float seal to prevent air contamination is set in the northwest tower of the boiler house to provide a reserve supply of deaerated water for boiler-filling purposes and to meet all except the most unusual or emergency demands. At times of low make-up requirement this storage tank will be filled. Its contents at all times are indicated by pneumercator gage conveniently located on the wall of the west mezzanine. The supply from this reserve storage is fed into the receiving tank automatically, as required, through a float-operated valve. Two emergency supplies are provided, one from the hot-water system of the refinery, the other direct from the city mains, both under float control, the latter at the lower level. The emergency supply direct from the city mains is delivered to the receiving tank through a closed-type high-pressure heater. The opening of the float-controlled valve on this line caused the simultaneous opening of a motor-operated valve admitting steam to the emergency heater, after which, regulation of temperature is under thermostat control. When the float-operated valve closes off the emergency supply to the receiving tank it at the same time causes the motor-operated valve to cut off steam to the emergency heater.

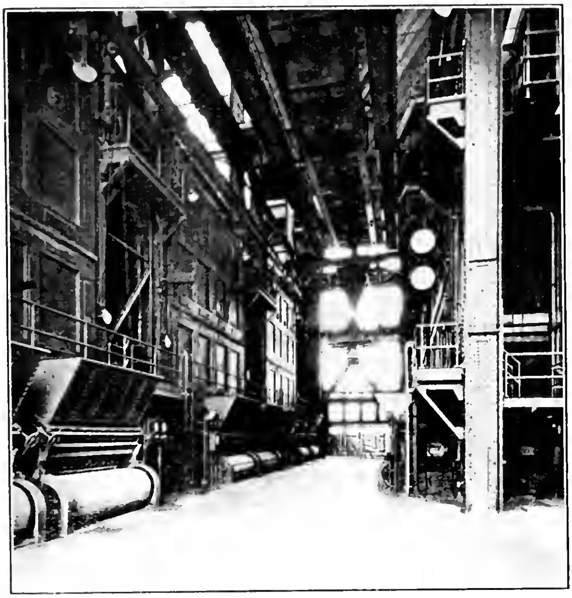


Fig. 3 The Firing Aisle

Condensate from the high-pressure mains in the boiler house is taken care of by a Holly system, which of course returns this condensate direct to the boilers. Condensate from the low-pressure or exhaust mains in the boiler house is collected in traps which discharge directly into the return tank in the engine house and are returned to the receiving tank with other condensate through the oil filters.

Instruments

The more important instruments employed in gaging the boiler and furnace performance—two electric tachometers to indicate the grate speed of each stoker and a boiler meter recording steam out-

put, rate of air flow, and flue temperature—are mounted on a small slate panel at one side and immediately in front of the several boiler units. For guidance in adjustment of drafts, multi-reading draft gages are mounted, one at each side of the boiler in convenient view of the stoker blast-box damper levers and a third gage at the rear of the boilers beside the exit damper control.

Illuminated master gages, mounted at either side of the main operating aisle and about midway of the ultimate length of this aisle, indicate, on the one hand, the pressure carried in the two distributing mains leading from the boiler house to the engine house and direct to the refinery, respectively, and on the other, the rates of steam flow in these two mains. The steam flow through these mains is also recorded by meters which are mounted on a small slate panel beneath the corresponding master gages and of general design and position to harmonize with the boiler-meter panels referred to above. An illuminated number signal, operated from the vacuum-pan floor in the refinery, gives the fireman advance warning of major changes in load. There are also numerous indicating and recording thermometers and gages which are required in following the performance of the feedwater system and other details of the boiler-house equipment.

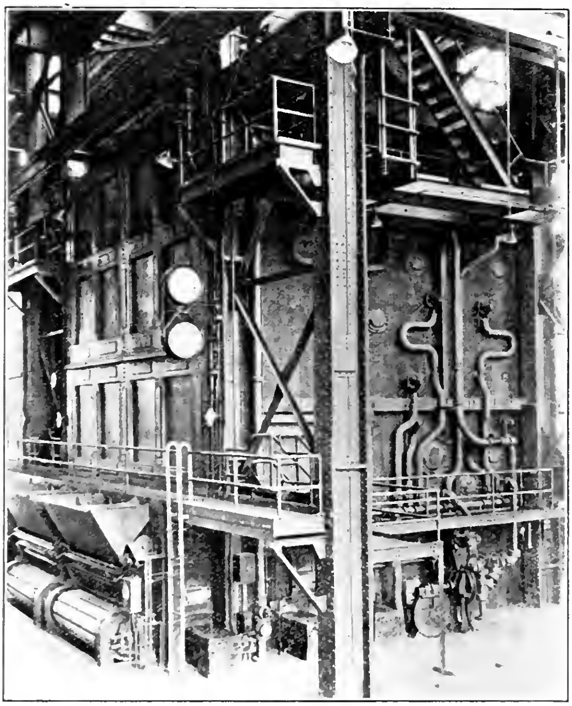


FIG. 4 ONE OF THE BOILER UNITS, SHOWING ARRANGEMENT OF ACCESSORY EQUIPMENT

SELECTION OF BOILERS

The refinery type of load, while including a fairly large proportion of power of reasonably stable demand is subject to relatively wide fluctuations which may come at any time of day as the vacuum pans are cut in or cut out. For this reason it is necessary to carry continuously in service sufficient steam-generating capacity to take care of the maximum demand, this steam-generating capacity on the average being operated at only moderate ratings. For this service the Stirling integral-economizer-type boiler was selected as combining, with low first cost, very high efficiency at all moderate ratings, exceptional ease of inspection and maintenance, and, with the steam take-off from the rear drum as here adopted, remarkable freedom from tendency to prime under sudden heavy demands. Also, for the peculiar requirements of anthracite in the small sizes decided upon for the Baltimore refinery, this general type of boiler possesses, over any other type of approximately equivalent efficiency, the added advantages of wider grate space and of presenting to the furnace gases steeply inclined tubes, which experience with anthracite has demonstrated are less liable to heavy coating and clogging of the heating surface from deposits of slag and ash than the tubes of boilers of the so-called "horizontal water-tube" type.

THE COMBUSTION EQUIPMENT

In determining upon the method of combustion, the traveling-grate stoker was decided upon as the most satisfactory type of combustion equipment commercially available for the particular coal selected. However, the plant design provides for later adaptation to pulverized-coal firing if desired.

One of the most serious difficulties, or more aptly perhaps, one of the most serious sources of loss, encountered in the use of very small-sized and so-called "creek" anthracite for boiler fuel has been the high percentage of the material that has remained unconsumed—either discharged over the end of the grate with the ash or carried by the gases beyond the zone of combustion to be deposited in some cooler part of the boiler, or over the surrounding neighborhood. One of the chief defects, seemingly inherent in the traveling-grate type of stoker, has been that of gas stratification, insufficient mixing of gases so that in the usual case, gases given off from that part of the fuel bed near the front, in other words, near the entrance of the furnace, carry a relatively high percentage of combustible constituents, as CO for example, with insufficient air for their combustion, while those gases from the rear of the grate carry an excess of unused air and oxygen.

Boiler furnaces in this country have, with two or three exceptions, been of box-like construction—for a traveling grate, two boxes connected together,—offering but little interference with simple stream-line flow of the gases. With such an arrangement of furnace, operating beyond the most moderate ratings, the richer gases from the front of the grate rarely find the full air requirement until they have passed over a part of the heating surface so that combustion if not already extinguished must continue through the boiler, resulting in loss to efficiency and, occasionally in exaggerated cases, serious damage to the boiler plates and other parts not designed for direct contact with intense flame.

The arch arrangement used in the furnaces of the refinery boiler house, and shown in Fig. 2, is intended as a step toward overcoming these several sources of loss and inefficiency. The rear arch deflects the gas flow over the corresponding portion of the grate surface, from a generally rearward direction, toward the front of the furnace and by so doing checks the shower of fine unburned particles into the ashpit—a phenomenon characteristic of the combustion of small-sized anthracite in the usual type of furnace—and gives opportunity for the lean gases from the rear of the grate to combine with those from the front. The width of throat between front and rear arches is so proportioned that some degree of mixing of gases is forced to occur except at the very lowest ratings. The presence of the rear arch, by its radiating and reflective capacity, also tends to increase the rate of combustion at the rear of the grate and so further reduce the carbon loss to the ashpit.

As the rear arch is not only exposed to the most intense heat of the furnace, but also projects directly into the furnace at the hottest zone, it was considered necessary to provide forced ventilation. Air for this purpose is obtained direct from the blast duct, and after traversing the rear arch, passes forward through the side and center walls to be finally discharged into the furnace at the rear face of the lower front arch where it serves to aid combustion of the rich gases traveling close under the arch from the front of the furnace. The final mixing of gases occurs under the upper front arch which also forms a deflector to throw the gases into the boiler-heating surface. The intention has been that the mixing zone between the lower front and rear arches and the upper front arch by affording increased intensity of combustion at this point, would not only hasten combustion of evolved gases, but also promote combustion of those solid coal particles normally carried off the grate by the draft.

Preparations are now under way for complete tests of one of the boiler units. In connection with these tests it is intended to make thorough trial of the creek anthracite of several different degrees of fineness. The tests are planned to develop not only the relative commercial values to the refinery of these different coal sizings, but also the general characteristics of a furnace of the design shown.

The Utilization of Waste Heat

A Group of Papers Dealing with the Application and Performance of Waste-Heat Boilers, and the Utilization of Waste Heat from Blast and Open-Hearth Furnaces and Cement Kilns

GREAT progress has been made in recent years in the development of methods of utilizing waste heat, especially in the steel and cement industries, and serving a region in which these products are extensively manufactured, the Lehigh Valley Section of the A.S.M.E. appropriately devoted its meeting of October 11, 1921, held at Bethlehem, Pa., to a consideration of this growingly important subject. Three papers embodying much valuable information were presented, namely, Waste-Heat Boilers, by H. B. Smith of the Babcock & Wilcox Co., New York, N. Y.; Utilization of Waste Heat in the Steel Industry, by A. T. Lewis, of the Bethlehem Steel Co., Bethlehem Pa.; and The Utilization of Waste Heat from Rotary Cement Kilns, by Joseph Brobston, vice-president, Dexter Portland Cement Co., Nazareth, Pa. The texts of these papers, slightly abridged, immediately follow.

THE APPLICATION AND PERFORMANCE OF WASTE-HEAT BOILERS

By H. B. SMITH,[1] NEW YORK, N. Y.

SO MUCH has been written within the past few years on the theory of the modern design of boilers for the utilization of heat in the waste gases from various industrial furnaces that there is little or nothing new that can be added. The present paper, therefore, will deal wholly with the application and performance of waste-heat boilers.

The company with which the author is associated has at the present time installed and in operation in connection with the various types of industrial furnaces, waste-heat boilers of a total capacity of 153,499 rated boiler hp., distributed as follows:

Open-hearth furnaces	102,211	Glass tanks	1,716
Cement kilns	15,831	Copper-refining furnaces	1,347
Beehive coke ovens	11,730	Nickel furnaces	922
Zinc furnaces	8,740	Lime and dolomite furnaces	848
Heating furnaces (various types)	4,243	Malleable-iron furnaces	373
Oil stills	3,975	Silicate furnaces	232
Gas benches	1,328		

Generally speaking, three classes, or designs, of the Babcock & Wilcox boiler are ordinarily offered for waste-heat work, namely, 18-high, 3-pass boilers for such types of industrial furnaces as require a comparatively high draft for their operation, this draft varying from 1½ in. to 2½ in. water column; 24-high, 3-pass for furnaces requiring a draft of 1 in. water column or less; and 27-high, single-pass boilers where the draft requirements of the primary furnace are very low, and where such requirements and the frictional loss through the boiler can be met with a natural-draft stack. Further, such boilers are offered where a direct connection to the primary furnace is possible. The single-pass boiler, strictly speaking, is not of the modern waste-heat design, but it has its special field which will be discussed later.

The flues and valves connecting the furnace and the waste-heat boiler must be of such construction that the air infiltration and radiation may be kept at a minimum. As a rule very little difficulty is found with radiation losses, but the air infiltration in every plant is, without exception, a difficult problem. Of course, it is possible to install a fan and fan turbine of sufficient size and capacity to overcome all of the air infiltration, but if this is done the net steam output of the installation may be reduced to such a point that the return when figured in dollars and cents will not warrant the investment.

Draft and the resistance of the gases passing through a boiler are two of the important factors in waste-heat-installation design. The draft loss is a function of two factors, the loss due to frictional resistance and the loss due to the passage of gases over and under the baffles. In order to obtain the greatest net amount of steam from the boiler, the draft required at the entrance to the boiler and the draft loss through the boiler should be so proportioned that when a steam turbine of minimum water rate for this class of machine is used to drive the fan, the exhaust steam from this turbine will not be greater than can be absorbed by the water in heating all the water consumed by the boiler to 210 deg. fahr. With such an arrangement there is a thermal loss which, when expressed in boiler horsepower, will be approximately 2 per cent of that generated by the boiler.

Whether or not an electric motor should be used in place of a steam turbine for the fan drive is a question that must necessarily be solved in each individual case. The items involved in such a question are the amount of hot water or the exhaust steam available for heating the water, the economy of the electric generator, and the reliability of the electric service. In regard to the latter, it would not be good engineering to equip, say, eight or ten open-hearth furnaces with waste-heat boilers, the fan drive for which is an electric motor, and not be doubly sure that the current would not be interrupted from time to time.

Failures Due to Lack of Attention

"Because of the war" is an expression much used when citing causes for trouble and sometimes failure, and to this same cause can be attributed in a large measure the failure of some of the users of waste-heat boilers to give proper attention to the upkeep of their installations. This failure has come through the customer's abnormal drive for output which has affected not only the waste-heat-boiler installations but the apparatus of the entire industrial plant as well. Another thing which has contributed to the inadequate attention has been the more or less unreliability of the labor obtainable.

As an illustration of the result of lack of attention given waste-heat installations, there were installed in a steel mill in 1917 a number of waste-heat boilers in connection with open-hearth furnaces. In May of the following year after the boilers had been operated some four months, evaporative tests were run to determine for the customer just what he was obtaining in boiler capacity. The tests showed an average of 445 hp. per hour from a 75-ton furnace, or an average of 70 boiler hp. per ton of steel per hour. At the coal and labor costs existing at the time, a horsepower was worth in this plant approximately $110 a year, showing a return of $49,000 a year per furnace, or at least 50 per cent return on the investment. But little was heard from this plant until less than a year ago, when a complaint was received from the customer that the boilers had fallen off in efficiency to such an extent that they were only attaining 250 boiler hp. per hour, which was a reduction of over 40 per cent. Coal and labor costs existing in the plant at the time of the complaint as compared with those of 1917 were not available, but the loss resulting from the reduced capacity is obviously great. The complaint was investigated and conditions were found such that an engineer was placed in the plant to thoroughly overhaul one of these boilers and put it in good operating condition. This work required five weeks with a gang of three to five men. From this one can appreciate the extent to which the installation had been neglected and realize the tremendous loss which resulted from neglect to properly care for the boilers.

Upkeep Costs Low

There is every reason to believe that the upkeep cost of waste-heat installations are very low, for, taking them as a whole, it will be agreed that because of the low-temperature gases which are encountered the tube losses from blisters will be rendered practically negligible, if not impossible. These low-temperature gases also result in a minimum brick deterioration, and in practically all cases the brick replacement cost should also be negligible. The only class of waste-heat work where brickwork upkeep cost need be considered is in the open-hearth field. While there are systems

---

[1] Babcock & Wilcox Co. Mem. Am.Soc.M.E.

of reversing valves which entirely eliminate the possibility of explosions in open-hearth waste-heat work, the use of such systems is not general, and with the valve reversing systems in common use it is practically impossible to prevent an occasional explosion. These explosions vary in intensity and have under certain conditions been sufficiently severe to blow out the side boiler wall, and in one instance to break off the header doors from the hinges.

Types of Boilers Used in Steel Works

The simplest form of Babcock & Wilcox waste-heat boiler offered is of the single-pass short-tube type, usually 9 to 11 ft. in length and 27 tubes high with a stack located on top of the boiler setting. This type of boiler is particularly applicable to furnaces requiring a low draft for operation and high gas temperatures as the gases leave the furnace. By high gas temperature is meant a temperature considerably in excess of that encountered in open-hearth and cement work, yet below that encountered in coal- and oil-fired furnaces. It does not follow, however, that such a boiler could not be used with temperatures from 2500 to 3000 deg. fahr., for with these temperatures and the very low draft required the boiler would show a high efficiency. As a matter of fact, the higher the temperature of the gases entering the boiler, the higher will be the efficiency of this boiler.

The arrangement of heating surface is such that there is a very low draft resistance, and further, this arrangement is such that the boiler in itself serves as a stack. In other words, if there were no stack located on top of the boiler setting there would be a draft of from probably 0.05 in. to 0.1 in. in the furnace from this boiler with gases entering it at 1800 deg. or above.

This type of boiler was developed many years ago for waste-heat purposes and a large number of them were installed. It was looked upon as an efficient boiler for the purpose for which it was designed, but the change in operating conditions, in the furnaces, etc., to which it was attached, caused it to become less satisfactory and for quite a considerable period practically it was not used. During the past few years, however, several installations have been made under proper conditions which have resulted most satisfactorily and in very economical installations.

The following figures which are taken from a test conducted at a plant in Pittsburgh where the old type of puddling furnace is still in use, show what may be expected from a boiler of this design installed where conditions are suitable for the single pass. The boiler tested was a 7-wide, 27-high, 9-in. tubes, having a total heating surface of 1880 sq. ft. There was a stack on top of the setting 75 ft. by 36 in. The boiler was operated at 122 lb. pressure and developed 220 hp., which, it will be noted, is slightly over rating. The temperature of the escaping gases was 501 deg. and the amount of coal fired (moisture content 2.33 per cent) was 857 lb. per hour. The evaporation per pound of dry coal was 9.09 lb. of water from and at 212 deg. This is equivalent to 3.85 lb. of coal per boiler hp. and an efficiency of 64 per cent. The results obtained were therefore but slightly lower than those representing good practice in hand-fired power houses.

The typical Babcock & Wilcox waste-heat boiler for open-hearth furnace work is an 18-high cross-drum, usually with 16-ft. tubes, the gases being delivered to the fan through the horizontal circulating tubes. The fan, gears, and turbine are supported on a platform above the boiler carried on the boiler columns.

The majority of installations with open-hearth furnaces have been in mills already in operation, and oftentimes it has been no little problem to find a space large enough to install a boiler of the proper heating surface. The sectional design of the B. & W. boiler, however, has been of immeasurable advantage in such cases, for with this it is possible to modify the width, length, and sometimes the height to accomodate the local space conditions and thereby provide a sufficient and efficient heating surface.

The returns from such installations have been most gratifying. Not only has there been a return in steam sufficient to pay a handsome return on the investment, but in many of the plants there has been an increase of two heats a week from the open-hearth furnaces and this was accompanied, as one would expect, by an appreciable reduction in the coal per ton of steel. This reduction follows from a positive draft control.

Figures given during the war indicated a saving due to the installation of waste-heat boilers on open-hearth furnaces of from 25 to 30 cents per ton of steel produced. On the basis of 25 cents a ton, 50-ton heats, and 14 heats a week for 45 weeks, the annual saving would amount to $8400, while for a 100-ton furnace it would be $16,800. With a 100-ton furnace there would be offered a boiler of 550 hp., which at the period mentioned could be installed complete for approximately $50 per hp., or $27,500. On such a basis the installation would pay for itself well within two years. While the saving expressed in cents per ton of steel may not be as high today as the wartime saving given, nevertheless the ratio of saving to boiler cost would be approximately the same, since boiler costs closely follow steel costs.

In a certain waste-heat boiler installed over a reheating furnace at the Bethlehem Steel Works the gases and steel pass in opposite directions through the furnace and the former enter the boiler immediately above the gas-discharge end of the furnace. This boiler is 19-wide, 17-high, with 16-ft. tubes and 48-in. cross-drum, having 5830 sq. ft. of heating surface. Tests on this unit showed an average output of 540 hp. per hour with an entering gas temperature of 1445 deg. fahr., the gas exit temperature being 545 deg. The draft loss was approximately 1 in. water column. To overcome this loss and furnish sufficient draft for the proper operation of the furnace required approximately 8 boiler hp., or less than two per cent of the total generated by the boiler. Unfortunately, during these tests sufficient data were not obtained to show the relation of power developed to the steel reheated or the fuel consumed.

In a representative arrangement such as would be made with a malleable-iron furnace the boiler employed is 24-high, 3-pass, with longitudinal drums, the draft apparatus being located on a platform carried on the boiler columns. The unit is equipped with an auxiliary hand-fired furnace, which makes possible steam generation during such times as the malleable-iron furnace may be shut down. It is possible, however, to operate the boiler on both waste gases and gases from the hand-fired furnace, due to the fact that the draft required to operate the malleable furnace is about the same as that which would be required for hand firing.

Installations in Cement Mills

In 1915 a 1530-hp. Babcock & Wilcox boiler was installed for the Louisville Cement Company, this company being really the pioneer in the use of the modern design of waste-heat boiler in connection with cement kilns. Regarding the operation of this boiler, H. D. Baylor, superintendent of the company, in a paper presented before the American Institute of Chemical Engineers in June, 1917, said:

> Our coal consumption in the boiler room for 1914 averaged 91.7 lb. per barrel of cement. The waste-heat boiler was put into service during May, 1915, with the result that our average coal consumption for 1915 was 57.6 lb. per barrel of cement. During 1916 the boiler was operated practically full time and our average fuel in the boiler room for the year was 40.2 lb. per barrel.
>
> By using the hot clinker to heat the air for combustion and the waste kiln gases to generate steam, our percentage of heat utilized has almost doubled, showing 67.2 per cent fuel efficiency in the combined system of kilns and waste-heat boiler, and this we hope to increase to 70 per cent by reclaiming a part of the heat now lost by radiation from the kiln shell; and it is but another step to reclaim a part of the heat now escaping from the stack of the waste-heat boiler; or in other words, our combustion efficiency will eventually compare very favorably with general boiler-room efficiency.

In one more or less standard arrangement of waste-heat boilers, economizers, fans, collecting and connecting flues for cement-kiln work there is a common flue located transversely to the kilns into which they deliver the gases. On the opposite side of this flue the boilers are located, the gases passing through the short connecting flues. Between the kilns and the collecting flues as well as between the collecting flue and the boilers, water-cooled dampers are provided. The bottom of the flue is in reality a series of hoppers for depositing and handling the dust precipitated from the gases. These hoppers are provided with a slide valve and chute for discharging the dust to screw conveyors located beneath the main flue. The boilers, economizers and all short connecting flues are also provided with hoppers similarly equipped with slide valves and chutes. Ordinarily the main flue and all connecting flues are made of steel plate lined with insulating material and firebrick.

An arrangement of this kind lends itself to flexibility in that any boiler or kilns may be taken off without interruption of the

plant output, since the boilers are so designed, when there are three or more, that one boiler may be taken out of service and the remaining boilers handle all of the gases. When an installation of only two boilers is made it is not practicable, from the standpoint of cost, to have each unit of sufficient size to handle the total weight of gas, should it be necessary to take one unit off the line. A two-unit installation is therefore not as flexible as one with a greater number of boilers, and with one unit down, the remaining unit, while capable of handling more than half the total gas, would probably not handle more than 75 per cent of the total, necessitating the by-passing of the remaining gas to the atmosphere.

The economizer employed is of the counterflow type. The tubes are inclined horizontally, extending transversely to the boiler tubes, a recent development of the Babcock & Wilcox Co. and desirable for its compactness. The gases pass downward over the heating surface, thereby reducing the tendency of dust to settle and lodge on top of the tubes. The water flows upward, thereby avoiding pockets should any steam be formed in the economizer.

These boilers and economizers are provided with a type of soot blower which, if properly operated and properly cared for, will keep the gas passages entirely free from dust lodging, so that it hardly becomes necessary to shut down a boiler for external cleaning.

The fan location is at the floor line and a steel stack is carried on the fan housing. The stack should be of sufficient height to relieve the fan of labor in discharging the gases. It should also be of sufficient height to guard against the gases entering adjoining buildings as they leave the stack.

Some interesting figures are given by the Southwestern Portland Cement Company, in whose plant there are three Babcock & Wilcox units installed. Each unit consists of 7560 sq. ft. of boiler heating surface, 720 sq. ft. of superheating surface, 3750 sq. ft. of economizer surface, and a steel-plate fan capable of handling 120,000 lb. of gas under a pressure of $6^3/_4$ in. water column. These three units are connected to three kilns 150 ft. long by 8 ft. in diameter.

During October and November, 1920, this company generated an average of 1,029,900 kw-hr. per month while burning 52,032 bbl. of clinker. To generate this power they burned an average of 2409 tons of coal under coal-fired boilers, or at the rate of 4.68 lb. per kw-hr. During February and March, 1921, after the waste-heat boilers had been in operation 60 days, they developed an average of 1,200,791 kw-hr. per month while burning 64,109 bbl. of clinker. To generate this 1,200,791 kw-hr. they burned an average of 554 tons of coal under the direct-fired boilers, which was equivalent to 0.95 lb. coal per kw-hr. This shows a saving of 3.73 lb. of coal per kw-hr. or 80 per cent, and a saving of 69.8 lb. of coal, for power purposes, per barrel of clinker burned.

UTILIZATION OF WASTE HEAT IN THE STEEL INDUSTRY

By A. T. LEWIS,[1] BETHLEHEM, PA.

THE steel plant has made wonderful progress in new developments in the last decade, but it is only in recent years that utilization of waste heat has been given much thought.

The prime object in the steel industry has been the development of the material desired without much consideration of how it was to be done. Furthermore the location of the steel industry had been in sections where the raw materials were plentiful, with the result that economy of materials was apparently not very essential. But now, on account of greater competition and the high climbing costs of materials, the steel industry is being forced to give closer attention to economies. This is resulting in the greater utilization of waste heat.

The operations of the steel industry are such that very large quantities of heat are necessary to perform the desired work. Only a small part is being converted into useful work, which leaves a large per cent of energy in the form of waste heat.

Blast Furnaces

Most steel plants are equipped with blast furnaces, open-hearth furnaces, mills, forge and machine shops, power plants and buildings, and they are usually so grouped that the utilization of heat in any branch can be converted into work of benefit to the other departments.

In blast-furnace work the gas was considered a waste product a short time back, and still in many furnaces this valuable fuel is bled to the atmosphere. Even in many modern blast-furnace plants a great improvement can be accomplished in its better utilization. This gas is primarily used for stoves, blowing and power engines, boilers and miscellaneous heating. With properly designed equipment and proper control the maximum economy should be obtained, and the quantities are so large that such economy would spell great savings.

A blast-furnace heat balance shows that approximately 40 per cent of the heat available in the furnace is used in its own operation. This includes preheating of the air and the losses carried away from the furnace and leaves 60 per cent available for other useful work, such as power units, boilers and miscellaneous heating. To realize the importance of the proper utilization of this waste gas an approximate heat balance of a 500-ton blast furnace is given in Table 1.

TABLE 1 APPROXIMATE HEAT BALANCE OF A 500-TON BLAST FURNACE

Total available gas leaving the furnace, cu. ft. per ton iron	128,000
Net heat value of cold gas, B.t.u.	95
Coke rate, lb. per ton	1,917
Air displacement per ton at blowing engines, cu. ft.	116,000
Air heated at stoves per ton (from 160 deg. fahr. to 1115 deg. fahr.) cu. ft.	110,000
Stove efficiency, per cent	60.0
Required by stoves, per cent	32.4
Required by blowing engines, per cent (26 per cent thermal efficiency per air hp.)	8.4
Required by power engines, per cent (23 per cent thermal efficiency per kw.)	21.6
Available for boilers, per cent	37.6
	100.0
Cu. ft. gas per lb. net coke	70
Cu. ft. air to stove per lb. coke	66

Since large quantities of material are dealt with, the steel plants are giving closer attention to the proper use of this gas than they ever did. Beyond the present development of efficient burning of the gases in stoves, boilers and gas engines there is a further development that can be placed to good use, namely, the utilization of the waste heat in gas engines. This will be dwelt on later.

Open-Hearth Furnaces

A steel plant is not complete without a series of open-hearth furnaces. The highest temperature that can be obtained from fuel is desired in the refining of steel. For this process a relatively small percentage of the available heat of the fuel is abstracted, which leaves a very high percentage to pass out from the furnace. A small part of this heat leaving the furnace is recovered in the preheating of the incoming air and gas. In a 70-ton open-hearth furnace from 70,000 to 100,000 lb. of gas normally enters the stack per hour at a temperature of from 1000 to 1200 deg. fahr., and this heat should be utilized. The steel mill usually requires a large generation of steam. The utilization of this heat by means of waste-heat boilers is a means of reducing considerably the total steam-generating costs.

The fuel usually employed is producer gas, unless coke-oven or natural gases—of higher calorific value—are available. In order to develop the necessary temperature and also to effect economy of fuel the air for combustion is preheated before entering the furnace. Where the more sluggish producer gas is used, it is also preheated, which enables it to ignite more readily than when cold. When coke-oven or natural gas are used they are introduced into the furnace without preheating because they are high in hydrocarbons which disintegrate at temperatures above 1000 deg. fahr., thereby causing great fuel loss. In the average open-hearth furnace it will be well to note that of the heat absorbed and the heat that is available for waste heat development—

18 per cent is abstracted for useful work
3 per cent is lost in the sensible heat of the slag
40 per cent is lost in the sensible heat of the stack gases, and
39 per cent represents other losses such as radiation, etc.

The largest item is the heat lost to the stack, and in many furnaces this amounts to more than 50 per cent. To reduce it the

---

[1] Bethlehem Steel Co.

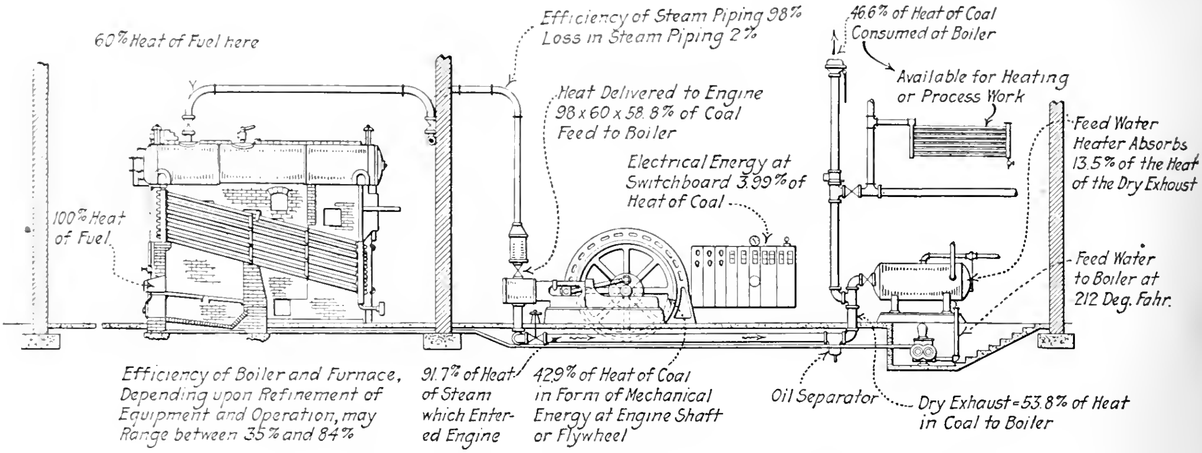


Fig. 1 Typical Power-Plant Installation with Simple Engine Direct-Connected to Generator

steel plants have resorted to waste-heat boilers by means of which about fifty per cent of the loss can be converted into steam. Furnace gases normally enter the boiler at from 1000 to 1200 deg. fahr. and are reduced to a temperature of from 450 to 550 deg. fahr. before leaving. A well-designed boiler equipment with necessary flues is an asset in the operation of a furnace, since the draft may be regulated by the fan speed at the will of the furnace operator. Furthermore, the value of this abstracted heat is equivalent to 60 boiler hp. per ton of steel. This is equivalent to at least 350 boiler hp. per furnace of about 70 tons capacity and is valued at $3.50 per hour, using anthracite steam coal at $3 per ton as a basis for calculation. It amounts to $2500 a year per furnace and is the best way of recovering heat energy that would otherwise be lost at certain times in metallurgical processes.

Mill heating furnaces have a lower exit temperature than open-hearth furnaces, and if the proper state of combustion is maintained and the furnace is designed correctly a higher thermal efficiency should result. The exit temperatures of mill furnaces vary from 850 to 2000 deg. fahr. and the quantity of heat generated is dependent upon the capacity of the furnace. A waste-heat boiler installation on such furnaces makes an ideal layout and fits in nicely with the steel-mill boiler plant. Table 2 shows a typical heat balance of an open-hearth furnace including waste-heat boiler.

Gas versus Steam Power

Modern steel plants that have blast furnaces are usually equipped with gas-engine installations. Gas engines have shown marked improvement in recent years and are employed on account of the low total cost of operation, which is particularly true in the blowing units. This is caused by their relatively high efficiency when compared to steam units.

TABLE 2 TYPICAL HEAT BALANCE OF AN OPEN-HEARTH FURNACE INCLUDING WASTE-HEAT BOILER[1]

	B.t.u. per hour	B.t.u. per ton ingots	Per cent of heat in coal	Per cent of heat in fuel gas	Per cent of heat to furnace
Coal to gas producers....	52,500,000	7,000,000	100.0		
Producer loss............	8,610,000	1,150,000	16.4		
Heat Delivered to Furnace:					
Gas from producers....	43,890,000	5,850,000	83.6	100.0	
Combustion of C, Si, and Mn in charge......	9,370,000	1,250,000	17.8	21.4	
Sensible heat of hot metal	3,450,000	460,000	6.6	7.9	
Total heat to furnace except regenerated gas and air.......	56,710,000	7,560,000	108.0	129.3	100.0
Distribution of Heat:					
Consumed in furnace and losses............	31,450,000	4,192,000	59.9	71.8	55.5
Utilized in boiler........	15,510,000	2,068,000	29.5	35.3	27.3
Wasted to stack at 500 deg. fahr..........	9,750,000	1,300,000	18.6	22.2	17.2
Total..............	56,710,000	7,560,000	108.0	129.3	100.0

[1] Results based on the following empirical data:

Size of heats, tons	75
Time per heat, hours	10
Hot metal in charge, per cent	64
Ratio of product to charge, per cent	88
Fuel consumption (4875 lb. per hr. or) lb. per ton	650
Heat value of coal, B.t.u. per lb.	10700
Weight waste gases at boiler, lb. per hour	81400
CO_2 in waste gases at boiler, per cent	12
Temperature of waste gases at boiler inlet, deg. fahr.	1200
Temperature of waste gases to stack, deg. fahr.	500
Performance of boiler under above conditions, boiler hp.	460

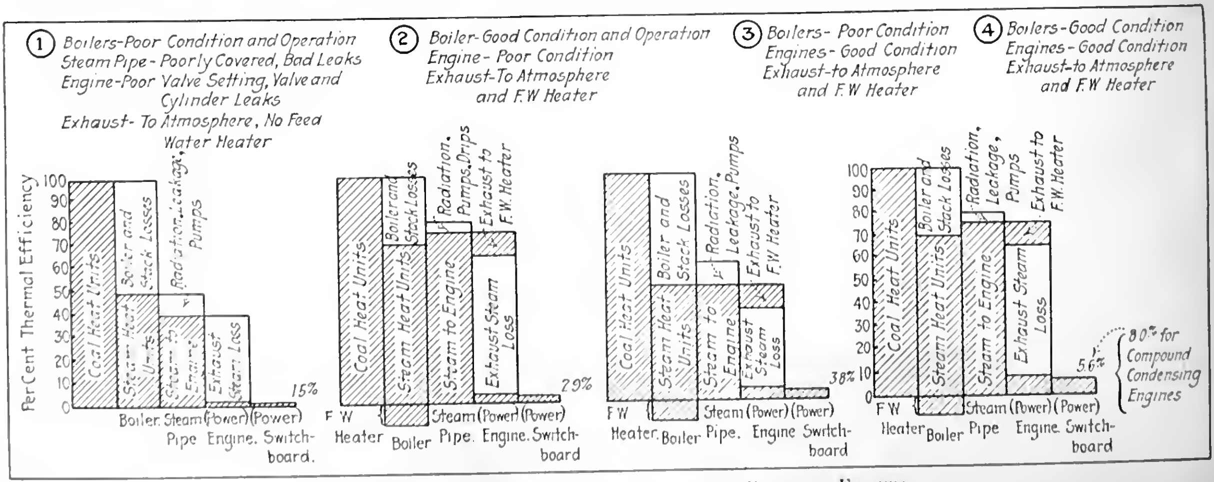


Fig. 2 Approximate Heat Balance, Simple and Compound Engines

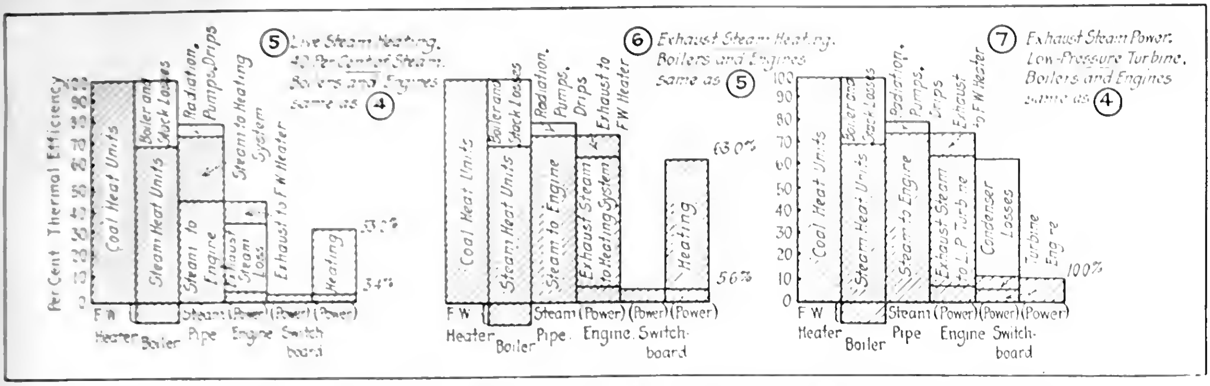


Fig. 3 Approximate Heat Balance, Simple Engines and Turbines, Exhaust Steam Used for Heating

It will be well to consider the percentage heat balance of a gas engine and compare it to that of a steam engine as follows:

	Gas engine	Steam engine
Effective work	28	11
Friction in engine	5	2
Exhaust gases	36	
Exhaust steam		57
Cooling water and radiation	31	
Boiler loss	..	30
	100	100

The total gas-engine efficiency can be raised to above 60 per cent, which establishes it as a most economical thermal unit. The development of waste-heat utilization in gas-engine installations should create a greater demand for this type of prime mover in the future, and it will show up to better advantage as the price of fuels increase. A very high efficiency is readily obtained by installing waste-heat boilers or economizers in the gas-engine exhaust and utilizing the jacket water either for feedwater, heating buildings, or any other scheme that will fit into plant conditions.

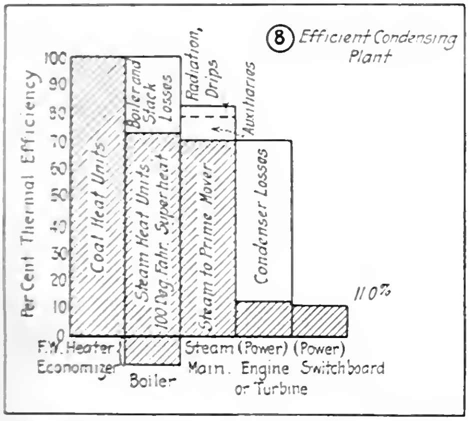


Fig. 4 Approximate Heat Balance of Large Power Station, Condensing Plant

In the steel industry, before the product is finished it goes through many processes where mechanical work has to be performed. This is usually done by steam units such as mill engines, steam hammers, steam pumps, etc. These types of units perform their necessary work very well mechanically, but thermally they are very inefficient. Since they perform their work satisfactorily it is necessary that some means be employed to reduce the cost of operation of such units by converting this very high thermal loss into useful work. To realize the effective work performed by such similar units it is well to examine a few sketches. Fig. 1 shows a diagrammatic heat balance of a typical power-plant installation where the power is derived through a simple engine. This diagram shows the heat extracted from the coal to do its necessary work in the engine and the heat available in the exhaust steam, and indicates the manner in which this exhaust steam can be utilized. Carefully note that in this case 91.7 per cent heat of the steam is available in heat energy after it has done its necessary work in the engine. Further utilization can be effected by the means as shown in the diagram.

Figs. 2, 3 and 4 give approximate heat balances of various steam-consuming units and indicate the available steam beyond the direct consuming unit to be used for other purposes.

It is such units as shown by the heat balances that the steel industry has to contend with. In the warm months of the year exhaust steam is usually not required for heating purposes, but it can be utilized to great advantage if introduced into low-pressure turbines.

UTILIZATION OF WASTE HEAT FROM ROTARY CEMENT KILNS

By JOSEPH BROBSTON,[1] NAZARETH, PA.

In America, portland cement is burned exclusively in what is known as a rotary kiln. This is strictly an American development. It has always been known that it was not an economical method of burning, but as coal was cheap and labor high in America, it was universally adopted immediately after its introduction, whereas in Europe where coal was dear and labor cheap, the old style upright kiln similar to a lime kiln held its own up to within a few years.

While the largest loss of heat in the rotary kiln was in the excessive temperatures of the flue gases, there were two other important heat losses which were at that time attracting attention, one being the heat carried off by the material or resulting clinker, when it was discharged from the kiln; the other being the loss by radiation through the kiln shell.

There was one notably successful attempt made to utilize a part of the heat of the flue gases. In the dry process of cement manufacture it is necessary to dry the raw material before it can be pulverized. Charles Matcham put his stone dryers immediately back of his kilns, and passed a portion of his kiln gases through them. This did not affect the operation of his kilns, dried the stone more effectively, saved about three to four pounds of coal per barrel of cement made and materially reduced the labor charge in connection with the drying. Only a small percentage of the total stack gases were required for this, however, and there were not many of the installations made.

The sporadic efforts made to use the waste heat of rotary kilns prior to the sudden and material increase in the price of coal caused by the war, did not amount to more because of the very low price that the industry as a whole paid for its kiln coal. The coal generally used is the slack or screenings from $^3/_4$ gas coal. This was formerly considered a waste product by the coal mines and had to be moved when the $^3/_4$ coal was shipped, which resulted in a price to the cement industry ranging from 20 to 75 cents a ton at the mines. The cost per barrel for burning cement was therefore comparatively low and the efforts of the

---

[1] Vice-President, Dexter Portland Cement Co. Mem. Am.Soc.M.E.

manufacturers were mainly directed to installing labor-saving machinery and reducing the cost of pulverizing the raw material and clinker.

When the price of coal jumped to $5 per ton at the mines, however, conditions were entirely different, and in 1915 the first modern waste-heat boiler plant in the cement industry was installed at the Catskill plant of the Alpha Portland Cement Company. This installation was a success from the start. The plant operates five kilns, three being 9 ft. in diameter by 120 ft. long and the other two 7 ft. 6 in. in diameter and 120 ft. in length, resulting in an output of about 3000 bbl. of cement per day. The gases from these kilns are drawn into a main or equalizing flue directly in the rear of the kiln housing or dust chamber, dampers being installed to by-pass gases into the kiln stacks, if necessary. Connections leading from the back of this flue conduct the gases to two 750-hp. Edge Moor boilers, of the four-pass type. Two Green fuel economizers, horizontal type, are installed after the boilers. The forced draft is provided by a fan located directly back of the economizers, driven by a Terry turbine. A steam pressure of 175 to 180 lb. is maintained, and sufficient power is generated to operate the entire plant. The finely pulverized stone carried over from the kiln by the hot gases is blown from the boiler tubes three to four times in each 24 hours, a hand lance using 140 lb. of air being employed for this purpose. The economizer tubes are blown off through plugged openings in the top of the casing several times each week. The clean-out doors at the bottom of each pass are opened once a week and the dust removed. Clean-out doors are also provided in the flues. In this way, if the draft at the stack chamber is not allowed to drop below 0.25 in. (water pressure), no real difficulty is experienced in keeping the installation free from dust. The temperature of the gases is reduced from approximately 1400 deg. fahr. at the mouth of the kiln to about 450 deg. when they leave the economizer. The Cochran feedwater heater is heated by the exhaust steam from the pumps and fan turbine. The operation of the boilers has not increased the amount of coal used per barrel in the kilns. It is about 95 lb. per bbl. It requires not less than 40 lb. of coal per bbl. to generate the power required to operate a cement mill. Deducting this from the 95 lb. being used in the kiln we find that today this company is burning their cement with 55 lb. of coal, which is much closer to the theoretical amount required, that is, 30 lb., than the cement manufacturers had ever hoped to come, and means that a rotary kiln with a waste-heat boiler attached is as economical in its coal consumption as the old-style upright kiln. Plants almost exactly duplicating the one described were promptly installed at another plant of the Alpha Portland Cement Company and at the Dexter Portland Cement Company, and plants using B. & W. boilers were installed by the Universal and Louisville cement plants.

By this time all the manufacturers of portland cement were aware of the importance of this development, and the Conservation Committee of the Portland Cement Association, started an extensive investigation of the entire question. The first report presented in December, 1918, showed eight plants in operation. Today there are 24 plants in operation generating with their flue gases from 51 to 140 per cent of the power they require. There are about 120 operating portland-cement plants in the United States, so that 20 per cent of the plants are now making use of their stack gases, saving on the average 40 lb. of coal for every barrel made. This means that these companies are actually using about 400,000 tons of coal less per year than they did formerly.

It may be noted that in some cases more steam than is required to operate the entire cement plant is generated by the waste-heat installation. In other cases only a little over one-half of the amount required is secured.

While this is to a certain extent a question of the efficiency of the boiler installation, it may be due to other causes. The plant that is burning cement with 80 lb. of coal to the barrel will not have the volume of stack gases or temperature that will be found at the plant using over 100 lb. to the barrel, so that naturally not as much steam can be generated. The total amount of coal used per barrel, however, may be lower at the plant using the 80 lb., as it may be possible to generate the additional power required in auxiliary boilers with less than the extra 25 or 30 lb. of coal consumed in the kiln.

But even when two waste-heat plants generate the same amount of steam, there may be a great difference in the percentage of the machinery that can be run with it. Where the amount of steam secured is just sufficient to operate a mill in which the prime movers are well-designed modern turbines, it would probably be only 75 per cent of the steam required to operate another plant which is still being run with old-style inefficient reciprocating engines.

Power Required to Grind a Barrel of Cement

Where the prime movers are identical, there might still be a wide difference in the percentage shown. Recent investigations made by the Conservation Committee of the Portland Cement Association show that the power required to produce a barrel of cement at plants using different types of grinding machinery varies from about 13 kw-hr. per bbl. to about 19 kw-hr.

Some progress has also been made in the last three or four years in solving two other problems. The loss through radiation is being materially reduced by putting between the shell and the firebrick lining in the upper part of the kiln, a brick cut from diatomaceous earth. While it has not been possible to determine the exact amount saved in this way, it has been shown conclusively that where waste-heat boilers are being used this insulation raises the temperature of the flue gases 150 deg., and where boilers are not installed the insulated kilns require from 5 to 10 lb. per bbl. less coal to burn clinker than those not insulated.

This problem is not as yet fully solved, however, as it has been found impossible to use the insulating brick in the hottest section of the kiln, known as the burning zone. Here the fluxing action of the clinker at the high temperature necessarily maintained was such that the firebrick were practically destroyed in from 16 hr. to four days. The hot zone can undoubtedly be insulated by using carborundum, but at the present time the cost of doing this would be prohibitive.

The Technical Problems and Conservation Committees of the Portland Cement Association are working on this problem with the firebrick manufacturers and it is hoped that a suitable block that will stand up and which can be made at a reasonable price, will be developed.

Possibility of Reclaiming Heat Carried off by Clinker

As to the possibility of reclaiming the heat carried off by the clinker, the development of the rotary pressure cooler in the last few years has demonstrated that where the cooler is of sufficient size and proper design to handle the kiln output it is possible to heat the air entering the kiln to a temperature of 800 to 900 deg. fahr. and to have enough heat left over to dry the coal used for kiln operation. How much this saves is problematical. So far the power required to operate the system has been found to be so great that there appears to be very little actual saving.

In the ideal cement plant of the future there should be no wasted heat. Where the engine room is equipped with the modern economical type of prime mover, and the mill has been designed and equipped with grinding machinery that requires the minimum amount of power, the stack gases will generate not only sufficient steam to run the plant and heat the buildings, but there will be enough left over to dry the stone. All the heat will be drawn from the clinker and it will be sufficient to raise the temperature of the air required to support combustion in the kilns to a point that will materially reduce the amount of coal needed for burning, and there will be enough left over to dry the coal before it is pulverized.

With the preheating of the air and the insulating of the balance of the kiln, the amount of coal required to burn should certainly not be over 75 lb. to the barrel. Deducting from this the 40 lb. required for power, the 3 lb. required for drying the stone and 1 lb. each for drying the coal and heating the buildings, the theoretical figure of coal required to burn a barrel of cement is reached, namely, 30 lb. per bbl.

While this ideal may never actually be attained, the work on all three problems has progressed far enough to show that within the next five years through the insulation of kilns, the preheating of the air going to the kilns, and the use of stack gases, there will be saved in producing 100,000,000 bbl. of portland cement, besides the 400,000 tons already mentioned, about 1,600,000 tons, or a total of 2,000,000 tons due to the utilization of waste heat.

Paint Protection for Wood

By CORNELIUS T. MYERS,[1] RAHWAY, N. J.

About two years ago the writer, in carrying on some research work on wood wheels had occasion to make inquiry among paint manufacturers as to the value of various kinds of paints and primers for the protection of wood against moisture. This inquiry brought out so many differences and variations in opinion as to paint materials and mixture proportions that a more extensive inquiry among paint men was started. This inquiry revealed that:

1. (1) There was comparatively little technical information to be gained from the paint industry on the relative protective values of different coatings for wood
2. (2) The paint industry did not generally recognize the moisture-proofing of wood as a problem, but was concentrating so far as the more reputable manufacturers were concerned on producing paints that would last as long as possible on the surface to which they were applied. In other words, such improvements as have been made have contributed to the life of the coating rather than the life and usefulness of the article which received the coat.

As the demand upon our forests depends to a very considerable extent upon the life of forest products, and as the life of these products in many cases depends to a very considerable extent upon the protection against moisture they receive, the intimate knowledge of protective coatings is a factor of great importance in our lumber conservation program; to say nothing of the possible saving in our $300,000,000 annual paint bill. Wood in its natural green condition has a very limited use as a structural material. Its tiny fibres are cellular in form and contain a large amount of moisture, commonly known as sap, the sap being water containing very small percentages of tannins, sugars, gums and coloring matters. To give wood the physical qualities which make it fit for use in buildings, furniture, truck bodies, wheels, etc., it is necessary to remove most of the moisture.

Moisture in Wood

Wood is said to be oven-dry when continued oven drying causes no further loss of weight. In their green state the woods used structurally have a moisture content of 60 to 120 per cent of their oven-dry weight, and weigh roughly from 60 to 120 per cent more than when they are in an oven-dry state. In other words, 35 to 55 per cent of the weight of a green log is water. In the green log this water exists in two conditions:

1. (1) Minute particles of water in each tiny wood cell cavity, known as "free water"
2. (2) The moisture absorbed by the fibrous material which forms the walls of the cells, known as "hygroscopic moisture."

Felled wood exposed to average atmospheric conditions gradually dries, the air taking up its moisture. First the cell cavities slowly give up their moisture. This evaporation goes on until the cell cavities are emptied of the minute particles of "free water" they contain. All that remains is the moisture actually absorbed by the fibres of the cell walls, which are still saturated with the "hygroscopic moisture." Wood in this state is said to be at its "fibre-saturation point." Up to this time the wood does not appreciably change in size or in physical characteristics except as to weight, which of course decreases considerably as it will now contain but 25 to 30 per cent of moisture instead of 60 to 120 per cent.

Further drying of the wood is necessary in order to increase its strength and hardness, increase its durability, enable it to take and hold paint, and in general to improve its condition for the purpose intended. As this drying progresses beyond the fibre-saturation point, the cell walls give up the moisture they have absorbed, and in so doing they shrink and harden. Under natural conditions this drying process will continue until the amount of moisture in the wood bears a quite definite relation to the average humidity condition in the particular locality. (See Fig. 1.) In the eastern and north central states, for instance, the moisture content of wood will become stabilized somewhere in the neighborhood of 14 per cent for what is known as thoroughly air-dried stock. In the arid, southwestern states it will contain a still lower percentage, while in the former war zone of France the wood will normally contain considerably more than 14 per cent of moisture. Of course unpainted wood that is exposed to rain and snow will absorb considerably more than 14 per cent, depending upon the dimensions of the piece and the extent of the exposure.

Data secured from the Forest Products Laboratory of the United States Department of Agriculture show that

1. (1) Many woods should be dried to about 8 per cent moisture content to give the best results as to strength, durability, hardness and finish (See Table I)
2. (2) It is also true that if after being dried, and shrinking in the process, wood reabsorbs moisture, it will swell again according to the amount absorbed
3. (3) The shrinking and swelling along the grain, perpendicular to the grain and tangential to the grain all differ, and very materially, for a given change in moisture content. (See Table 2.)

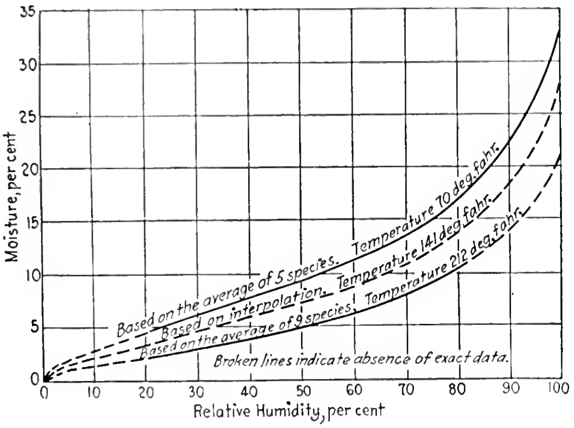


Fig. 1 Relation between the Amount of Moisture Absorbed by Wood and the Average Relative Humidity

From the two following tables it will be seen that it is quite

TABLE 1 APPROXIMATE PERCENTAGE OF INCREASE IN STRENGTH OVER GREEN[1]

	Dried to 14 Per Cent Moisture	Dried to 8 Per Cent Moisture
Bending strength, modulus of rupture	40 to 60	80 to 100
Compressioo parellel to grain	80 to 90	100 to 150
Compression perpendicular to grain	65 to 75	
Stiffness, modulus of elasticity	20 to 30	25 to 35[2]
Hardness	30 to 35	40 to 50[2]
Shearing strength, parallel to grain	40 to 50	60 to 70[2]

[1] Compiled from Data given in Timber, Its Strength, Seasoning and Grading by H. S. Betts.

[2] Estimated.

TABLE 2 SHRINKAGE AND MOISTURE CONTENT OF HARDWOOD[1]

	Specific Gravity of Dry Wood	Shrinkage[2] in Per Cent of Green from Green to Oven-Dry		Green Moist in Per Cent of Dry Wood Wt.
		Radial	Tangential	
Ash, white[3]	0.57	4.8	7.0	39
Birch, yellow[3]	0.55	7.4	8.9	68
Elm, cork	0.57	4.8	8.1	53
Hickory[4]	0.64	7.2	10.9	60
Maple[5]	0.51	4.2	8.5	63
Oak, red[5]	0.56	3.9	8.3	83
Oak, white[5]	0.60	5.3	8.8	66
Average	0.57	5.4	8.6	62

[1] Compiled from data given in Kiln Drying of Lumber by H. D. Tiemann

[2] Average shrinkage along the grain, up and down as the tree grows, is only about ½ per cent.

[3] Average of 2 species

[4] Average of 9 species

[5] Average of 3 species

---

[1] Consulting Engineer. Mem. Am.Soc.M.E.

desirable to have wood thoroughly dried, and that steps should be taken to keep it so. But although it is easy to reduce the moisture to 8 per cent in dry kilns, it is difficult to maintain the wood at this point: because of unsuitable protective coatings, or processes, and because of the lack of knowledge as to relative ability of various coatings for really stabilizing the moisture content within a small range.

Protectiveness of Paint

While we know that several coats of good paint may give adequate protection for floors, truck bodies, furniture, wheels or other wooden articles, we by no means know what paints give the best protection or what paints will give fairly satisfactory protection for the least money. The test fences, where many different paints were exposed to the same atmospheric conditions, have given some data on the durability of paints, but very little data on the durability of the painted article or its dimensional stability. *In durability and dimensional stabilization we are greatly interested;* in the first for very obvious reasons, in the second because wooden structures, furniture, etc., are more durable, serviceable, and can be made more simply if their various component parts do not expand and contract with changing wheather conditions. The cost of drying could be reduced in many cases, if when dried to a certain point the moisture content could be stabilized. Wood, on account of its very valuable characteristics, could be used in places where metal now seems necessary. A dozen or more prominent concerns in the paint industry have been coöperating very commendably in this research work, realizing that the dimensional stabilization of wood by moisture-proofing was a proper function of paint and of world wide importance. There is, however, quite a difference of opinion among these manufacturers as to what materials should be used, and how they should be mixed and applied. During the war the Forest Products Laboratory investigated the moisture-proofing effects of linseed oil and various paints, varnishes and leaf-metal coatings as applied to airplane-propellers and other airplane parts made of wood, but this work has not been broadened because of lack of funds.

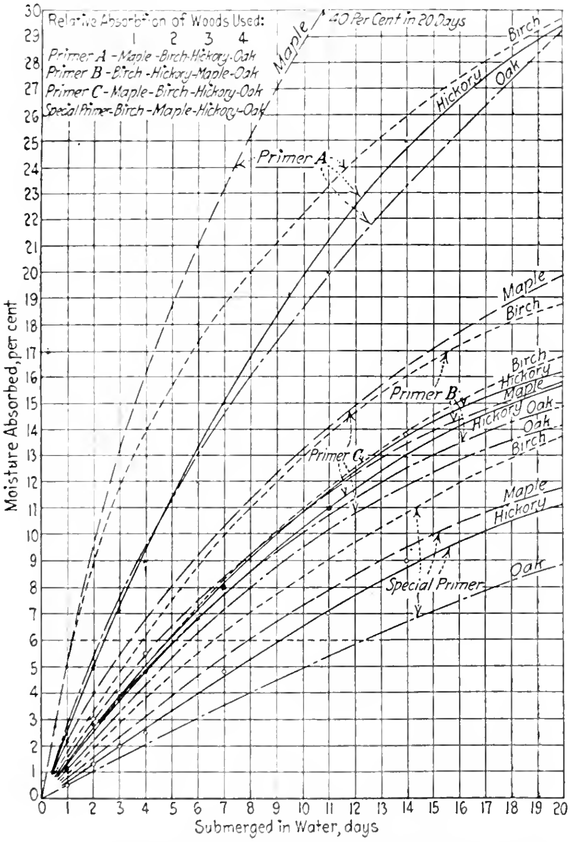


Fig. 2 Curves Showing How the Effectiveness of Different Primers as Moisture-Proofing Agents Varied for Different Woods

In order to get some comparative data on the paints and primers now on the market, the following schedule was drawn up by the writer, and tests were made on small pieces, measuring 1 × 1 × 1 in., of hickory, oak, birch and maple by several well known paint concerns:

(1) Dry slowly and completely until pieces cease to lose weight
(2) Determine "oven dry" weight
(3) Allow reabsorption to 8 per cent
(4) First coating to be applied at 8 per cent moisture content
(5) Second coating to be applied at 8 per cent moisture content
(6) Third coating to be applied at 8 per cent moisture content
Note: 24 hrs. to elapse between 4 and 5, and 5 and 6.
(7) Allow the three coatings to dry for a week under conditions of 70 to 80 deg. fahr. temperature, 40 per cent relative humidity, under which condition the moisture content of the wood should remain at 8 per cent even if the wood had no protective coating
(8) Label and weigh for base weight at 8 per cent moisture content with protective coating
(9) Submerge in water at 70 deg. fahr.
(10) Weigh every 24 hr. for first week, every 48 hr. thereafter and determine percentage of increase in moisture
Note: *Please bear in mind, of course,* that whatever is used in the way of coatings, it must serve as a suitable foundation for subsequent coats of paint and varnish.

In general, the results of the tests showed that paints of the ordinary brands and formulas were not very effective as moisture-proofing agents, even when three coats were applied. One paint concern after testing its standard brands, did a little experimenting, and without much difficulty was able to produce a special primer that was several times as effective. The curves in Fig. 2 show quite emphatically the variation in effectiveness of the paints used. Averaging the results for hickory, oak, maple and birch, it took about six times as long for these test pieces to absorb an extra 6 per cent of moisture when coated with the "special" as when coated with the standard "A." There is every reason to believe that much better results can be secured and with less than three coats. Preliminary tests with a casein solution indicate that it has waterproofing qualities, which, for some classes of protection, may be very valuable. The same is true of some of the pyroxalin compounds. Varnishes are in general more effective than paints, but in the protection of wheels its application was not suitable for primary coats.

Need for Research

What has been said so far shows the need for research work on this subject. Cabinet and furniture makers are vitally interested in a coating which will prevent wood from "working," shrinking and swelling, due to atmospheric changes in winter and summer. Interior woodwork could be greatly simplified if the dimensions of each particular piece of wood remained the same or varied but a very small amount. Flooring, decking, paneling, etc., would be greatly benefited if it did not "work." Many wooden structures would be simpler and more permanent if so protected, and with thoroughly dried timber they would either have a greater factor of safety or could be built with less lumber. Many other advantages will develop as thought is given to this subject—*The Dimensional Stabilization of Wood by Rendering it Moisture-Proof to Some Substantial degree.*

It is well known that shingles and weather boards fastened with old fashioned wrought-iron nails stay tight much longer than those in which the modern steel nail is used. The reason for this is that the steel nail rusts and is flaked off by the movement, or "working," of the piece through which it is driven. A nail tightly driven is practically sealed against external moisture by its head and the paint around it; but if moisture reaches the nail by the capillary action of the wood fibers, it will rust in spite of end sealing. Then too the moisture and capillarity of the wood cause the "working"

Continued on page 545

Welding Session Develops Salient Facts

Gathering Under Auspices of American Welding Society and A.S.M.E. Boiler Code Committee at Atlanta Meeting Emphasized Problems to be Met in Advancing Art of Welding

THE search for dependable information about the strength of welded pressure vessels which the A.S.M.E. Boiler Code Committee has been conducting for the past few years resulted in an exceedingly interesting session at the Atlanta Spring Meeting of The American Society of Mechanical Engineers on May 11, 1922. The session was arranged jointly by the American Welding Society and the A.S.M.E. Boiler Code Committee and was presided over by E. R. Fish, Chairman of the A.S.M.E. Boiler Code Sub-Committee on Air Tanks and Pressure Vessels.

Four papers were presented at the session, namely: Strength of Electrically Welded Pressure Containers, by R. J. Roark, Madison, Wis., assistant professor of mechanics, University of Wisconsin; Some Principles of the Construction of Unfired Pressure Vessels, by S. W. Miller, proprietor of the Rochester Welding Works, Rochester, N. Y.; Steel for Forge Welding, by Frank N. Speller, metallurgical engineer, National Tube Co., Pittsburgh, Pa.; and Tests on Welded Cylinders, by E. A. Fessenden, professor of mechanical engineering, Rensselaer Polytechnic Institute and L. J. Bradford, assistant professor machine design, Pennsylvania State College. Professor Roark's paper, slightly abridged, appeared in the April issue of MECHANICAL ENGINEERING, Mr. Miller's in the June issue, and Mr. Speller's in the July issue. The paper by Professors Fessenden and Bradford will be published in an early issue. These papers brought out a large amount of valuable discussion, both written and oral, liberal extracts from which immediately follow.

DISCUSSION OF PROFESSOR ROARK'S PAPER ON THE STRENGTH OF ELECTRICALLY WELDED PRESSURE CONTAINERS

S. W. Miller[1] wrote that the paper was very instructive in that it showed the inherent weakness of heads convex to the pressure. It should be noted that the nipple in specimen No. 1 was a source of weakness and that great care must be taken in designing pressure vessels to avoid such weakness.

In the case of the longitudinal seams failure occurred in all cases by breaking through the weld. Little was said about the kind of welding wire used, but the chemical analysis showed it to be low in carbon and manganese, and evidently it was much weaker in the weld than the plate, which was of high tensile strength, 64,000 lb. The carbon in the plate was given as 0.12 per cent, but it would hardly seem correct that a tensile strength of 64,000 lb. could be obtained with so low a carbon content. Also the carbon in the weld metal was given as 0.18 per cent, which was not possible with welding wire containing only 0.07 per cent carbon. Electric welds made with such wire contained 0.03 to 0.04 per cent carbon. This pointed to the necessity of careful sampling of weld metal. There was quite an interchange of carbon between the plate and the weld metal and no samples should be taken closer than 1/16 in. to the original line of the V.

With regard to the microphotographs shown, the magnification was not given but it was probably not over 100 ×, which was not sufficient to determine the structure of welds except in a general way. Electric welds made with bare wire were noticeably full of particles of ferrous oxide which required about 400× for their resolution.

The question of tests for welded containers was a very important one, and some means must be devised for so testing welded pressure vessels that such imperfect welds as had been described could not get into service. The danger did not arise from a steady pressure, but from alternating stresses or shocks which were liable to occur in any pressure vessel. Also temperature differences at times introduced unknown and unknowable stresses.

A large number of tests led him to believe that the tensile strength of thin films of such foreign matter as oxide in welds was of the order of 40,000 lb. per sq. in., but under shock combined with tensile stress rupture would occur at a much lower figure.

C. L. Jones[2] submitted a written discussion in which he said he was surprised to note that the low average tensile strength of electrically welded joints was given at 28,500 lb. per sq. in. and the shearing strength at 25,500 lb. per sq. in.

To show that the values were low Mr. Jones cited a number of similar tests, conducted along the same lines as shown by the author. One in particular was conducted on four arc-welded ammonia receivers 16-in. diameter, 1/4-in. plate material, by the York Manufacturing Company about two years ago, and reported in the 1921–1922 Proceedings of the American Welding Society by A. M. Candy. The welded joints were tested for brittleness by dropping a 10-lb. weight on them from a height of 10 ft. These blows, however, produced no visible effects on any of the joints. Following this the containers were tested to destruction.

Upon inspection it was observed that three of the tanks had been welded along the longitudinal seam while the seam rested in contact with a heavy backing strip of metal, possibly spaced 1/16 in. away from the actual joint. Furthermore, judging from the ruptured joints in the fourth tank the weld was made in at least three layers, which enabled the operator to obtain better fusion at the bottom of the joint with the first layer, and the latter layer improved the grain of the weld. These features readily explain the superiority of the fourth tank (70,400 lb. net) over the others (43,000–48,000 lb.) and illustrated the importance of proper welding procedure.

Numerous tests on pure arc-deposited metal cut entirely away from the plate steel upon which it was deposited have shown an ultimate tensile strength of 50,000 to 58,000 lb. per sq. in., and a shearing strength of from 38,000 to 42,000 lb. per sq. in. Further, the Wirt-Jones test of the Emergency Fleet Corporation reported arc welds of 36,300 to 66,480 lb. U. T. S. per square inch, made by a large number of different operators all over the United States.

He had personally witnessed many tests similar to one in discussion, and had never known of an average running lower than 30,000 lb. per sq. in., and did not recall any running lower than 35,000 lb. He believed that Mr. Miller's reports would show the lowest tensile strength of six specimens to be 39,330 lb. per sq. in., and the highest 45,600 lb.

As further assurance of his claims for higher average tensile strength of electric-arc welds he gave tables of tests, conducted by one of the largest railroads in the South, and one of the largest companies in the country manufacturing railroad and mine equipment. These welds were made under his own personal supervision, and the reports were obtained direct from officials of the companies mentioned. In neither of these tests did the ultimate tensile strength go lower than 35,230 lb. per sq. in., and in some of them it went as high as 76,000 lb. and did not break in the weld.

A. S. Kinsey,[3] discussing the low strength values given for the electric welds, said that they were obtained on single V welds on thin bars, and he believed that they were due in considerable degree to the eccentricity resulting from the large excess of thickness of the weld. If allowance was made for that in computing, the maximum stress would be seen to be about 42,000 lb. per sq. in. In any event the actual strength would be greater than this value, which was really not the strength of the material, but the strength of the wires. Strength, however, was not of so much significance as uniformity. The value of the nickel-steel welding rod was generally acknowledged and it was important that something should be done to standardize its nickel content, which should range from 3 to 3 1/4 per cent.

F. N. Speller[4] said that, taking the pressures at which the forge-welded and acetylene-welded cylinders failed and assuming the

---

[1] Proprietor Rochester Welding Works. Mem. Am.Soc.M.E.

[2] Westinghouse Elec. & Mfg. Co., Atlanta, Ga.

[3] Supervising Instructor Shop Practice, Stevens Institute of Technology. Mem. Am.Soc.M.E.

[4] Metallurgical Engineer, National Tube Co., Pittsburgh, Pa. Mem. Am.Soc.M.E.

fiber stress to be 50,000 lb., that being the fiber stress in the weld, the efficiency of the forge weld worked out at 80 per cent and that of the acetylene weld at 48 per cent. It therefore seemed to him that the proper place for acetylene welding on an important cylinder was on the girth seams, and that the longitudinal seams should be forge-welded.

Discussion of Mr. Miller's Paper on the Construction of Unfired Pressure Vessels

After presenting his paper Mr. Miller said that since writing it he had discovered a number of things which were of particular interest with reference to the quality of steel for welding.

In making tests on high-strength wires it was of course necessary to have high-strength plate, and ship plate had the highest tensile strength of any of the commercial plates, the upper specification limit being 68,000 lb. Its carbon content was usually about 0.25 per cent when $^1/_2$ in. thick. Some erratic results had led to a careful examination of some of the plate and of the welds made in it. The results of certain tensile-strength tests had shown a low value and rupture had taken place apparently along the line of the V. A careful microscopic examination showed that in some cases the rupture was parallel with the V at the defects in the base metal. In other cases a large amount of dirt had accumulated at or near the junction of the weld and base metal. These defects were both associated with non-metallic impurities in the plate, the latter being quite clearly so, and the former evidently so, though the connection was not so clear. In the former it seemed clear that at least some of the non-metallic impurities had been absorbed by the austenite when it had reached a temperature somewhat below that of melting. During the cooling and recrystallization these dissolved impurities were rejected to the γ-grain boundaries and became visible there as more or less continuous dark lines, or as spots of grayish matter having the appearance of ferrous oxide. When such a piece was bent and examined under the microscope, the rupture was found to occur at these visible defects.

Another defect which seemed to be of rather frequent occurrence is the accumulation at the bottom of the V of a large amount of ferrous oxide in the shape of minute gray dots and larger particles in size that range from 0.0005 to 0.015 in. in diameter, and sometimes larger. It was quite evident that these impurities were not in the wire as shown by a careful examination of it. Also they seldom appeared except at the bottom of the V.

When using wire that sparked freely, even with a neutral flame, it would be noticed that there were deposited on or near the work large quantities of small spherical particles which were mostly composed of magnetic iron oxide (Fe_3O_4), and which were frequently hollow, although occasionally in the larger ones their centers were filled with iron which had not had time to completely oxidize. These particles were of all sizes from the finest dust to several hundredths of an inch in diameter. They would easily stick to a surface that has been heated, and they actually did this, so that the V near where the torch was working was covered with them. They must be disposed of in some way during the welding, and it appeared quite clear that they might be dissolved in the melted metal, or washed down without having had time to dissolve and settle in the bottom of the V or close to the sides of the V. As most of these particles were very small, they usually escaped observation, and as in some cases they were very numerous, it was very probable that the welder was deceived by this coating melting instead of the metal itself, with the result of an imperfect weld. It seemed quite clear, therefore, that the quality of the base metal must be good if good results were expected, and that welding wire which sparked freely should be watched very carefully during welding. Also the size of wire and size of tip should be so related as to prevent sparking as much as possible.

In any plate impurities were usually found toward the center, which was natural as they occupied a similar position in the ingot. With a single V weld the washing of the melting welded rod naturally carried any impurities down with it toward the bottom of the V so that the weld, if imperfect, would be so toward the bottom of the V. This was almost invariably the case. It was equally true in a double V weld, but this had two advantages. First, the impurities had less surface to scatter over, and second, they were confined to the center of the plate, so that the weld, which was reinforced on both sides, tended to be equally as strong as the plate on account of the weld and plate sections being symmetrical.

J. H. Nead[5] wrote that the author had brought out in his paper the advantages of having the weld stronger than the plate and had stated that this could in general be accomplished in two ways: (1) By using ordinary plate and nickel-steel welding wire; (2) By using Armco ingot-iron plate and Armco ingot-iron welding wire. He believed, however, that all the inherent advantages of the latter method had not been brought out. In designing any structure which was subject to live loads, as most pressure vessels are, it was well to use a material which had a high resistance to fatigue. There had recently been published the report of an investigation on the fatigue of metals carried out by Prof. H. F. Moore of the University of Illinois, under the auspices of the National Research Council. (Bulletin No. 124 of the Engineering Experiment Station of the University of Illinois.) Professor Moore investigated many materials among which was Armco ingot iron and which he designated as 0.02 carbon steel. He found that this 0.02 carbon steel had a higher ratio of endurance limit to proportional limit than any other material. The endurance limit as he defined it was the maximum stress at which the material would withstand 100,000,000 reversals of stress without failure. In other words, that Armco ingot iron was an excellent material to resist fatigue. In the light of this information Mr. Nead believed that a safer pressure vessel could be constructed by the latter of the two above-mentioned methods than by the former.

In the Appendix B of Mr. Miller's paper was reported the performance of several welded pressure vessels under pressure test. The No. 5 tank shown on page 52 of the paper was returned to the American Rolling Mill Company by Mr. Miller after testing and two pieces, size 12 in. by 20 in. were cut out from the side of the tank, one from near each end. These were flattened out and four tensile test pieces cut from each. Two test pieces from each were tested without milling the welds off flush with the plate and two each were milled flush.

Three of the four unmilled specimens showed an average tensile strength of 51,100 lb. per sq. in. and broke in the plate rather than the weld. The fourth specimen broke in the weld (at 45,150 lb.), the fracture starting from a slight defect. In the case of the milled specimens the fracture occurred at the weld, as would be expected, but considerable ductility as indicated by the reduction of area was evident. The breaking load was approximately 48,000 lb. for three of the specimens, and 55,000 for the fourth.

The carbon content of the weld metal from nickel-steel electrodes was given as 0.14 per cent on page 29 of the paper. The figure was taken from the American Rolling Mill Co.'s report and should read 0.04 C. instead of 0.14 C.

S. G. Child[6] in a written discussion called attention to the author's statement that "the base metal most successful for autogenous welding is a low tensile steel of 0.15 per cent maximum carbon content," the objection to a higher carbon content being the danger of burning the steel in the operation of welding.

It was desirable before legislating on the permissible materials for welding to investigate the present commercial practice in the manufacture of welded pressure vessels. He was identified with a manufacturing plant which had for many years successfully welded pressure vessels made from the standard grade of boiler steel, of the grade specified in almost identical form in the A.S.M.E. Boiler Code, in the A.S.T.M. specification A–30, in the American Railway Association specifications and the standard specifications of the Association of American Steel Manufacturers. The tensile strength of this grade was 55,000 to 65,000 lb. per sq. in. and the carbon content usually from 0.15 to 0.25 per cent.

All locomotive boilers were built of this grade of material and were satisfactorily welded both during construction and when undergoing repairs in the railroad shops. No trouble from burning the material was experienced. If a poor weld was made by an inexperienced operator it was usually detected by a visual inspection and the part chipped out and rewelded. If the inspector failed to detect a poor weld on surface inspection it was invariably detected

---

[5] Metallurgist, Research Dept., American Rolling Mill Co., Middletown, Ohio. Mem. Am.Soc.M.E.

[6] Asst. Supt., Baldwin Locomotive Works, Philadelphia, Pa. Mem. Am. Soc.M.E.

and corrected when a test pressure greatly in excess of the working pressure was applied to the vessel.

He had made a careful investigation of the manufacture of welded unfired pressure vessels and found substantially the same result, namely, that the standard grade of tank or boiler steel having tensile limits of 55,000 to 65,000 lb. per sq. in. and usual carbon limits of 0.15 to 0.25 per cent ordered to the requirements of the specification of one of the above-mentioned organizations, was almost universally used.

F. N. Speller[6] asked the author whether he took into account the weakness of the metal near the weld incident to the heating of the plate. This was something that should be considered in discussing the strength and efficiency of a weld. The quality best suited for forge welding was not necessarily the best for acetylene or electric welding.

Stafford Montgomery[7] said that he gathered from the papers that there was a tendency in plain welding for foreign particles included in the base metal to migrate to the region of the weld, there forming a belt of weakness; and asked whether the author had observed in the case of resistance welding or welding under pressure, that the method tended to force out in the form of a slag such foreign particles as were usually found in that class of weld.

In his closure Mr. Miller said that as regarded efficiency of the weld he referred to cases where it was less than 100 per cent, which was always the case where the welding wire was of low-carbon steel—of low tensile strength and the plate of high tensile strength. In the tanks referred to in the paper the tensile strength of the weld was higher than the tensile strength of the plate, and purposely made so.

In order to ascertain what the conditions were, after the tank tests he had cut out a piece about 18 in. square from across the weld and then cut two different pieces from it, straightened them cold on an anvil and tested them. The plate had a tensile strength of 50,000 lb. originally and the tests were made after the tank had been stretched 7 in. It was possible to break it at around 62,000 lb. per sq. in., this high strength being due of course to the cold working on the plate during the test; and the strength of the weld, referring to the original strength of the plate, was therefore at least 125 per cent. With this method of construction the plate would break outside of the weld every time.

As to Mr. Montgomery's question, he would say that in making a flash weld some of the dirt squeezed out and the remainder was held, just as in fusion welding. The metal not squeezed out, which was back of that squeezed out, was still as effective as before. The non-metallic impurities were washed from the V by the metal flowed over the surface of the V during the welding process, and were distributed. There was a certain amount of the metal back of the welded part that was not quite welded, and the impurities distributed themselves by gravity over that section and into the V, adding to the welding material.

Discussion of Mr. Speller's Paper on Steel for Forge Welding

H. V. Wille,[8] in a written communication presented by S. G. Child, said that he had written to a large number of welded-tank manufacturers with the view of determining the present actual practice in this industry.

From the replies received it was evident that a large part of the pressure-tank practice of the present time was based on the use of ordinary grades of boiler and tank steel having a tensile strength of 55,000 to 65,000 lb. and governed by the specifications of the American Society for Testing Materials, the Association of American Steel Manufacturers, or the American Railway Association, which were practically identical and which called for rigid chemical and physical tests.

Some manufacturers were using a softer grade of steel for welded tanks with satisfactory results. This grade was equivalent to the A.S.T.M. specification A-78-21-T.

Mr. Wille believed that both of these grades of steel should be permitted for welding practice. While a number of experimental tests had been made to show the superiority of soft steels over the standard grades for welding, the cases were more or less special and were not representative of general tank practice. It was probable, for example, that welds made by the electric-resistance autogenous process without adding additional metal, should be restricted to a soft grade of steel as had been found desirable in the forge welding of steel pipe, which was lap-welded and had no metal added.

In the oral discussion following the reading of Mr. Wille's communication, questions were propounded to the author by Messrs. John A. Stevens[9] and S. F. Jeter,[10] which he dealt with in his closure.

Replying to Mr. Stevens as to the way a hammer test should be made, he said that in the case of boiler tubes a 2-lb. hammer was formerly used by his company, a pneumatic hammer being later developed on account of the danger to the operator in using a hard hammer. For large forge-welded tubes they had not yet arrived at any set standard. Anything that would not make an impression on the steel but would send a vibration through the cylinder was sufficient for the purpose. It was possible to apply static pressure to a welded vessel almost up to the rupture point without causing a fracture or even a leak. But if the vessel were struck a sudden blow, even with only a 2-lb. hammer, the vibration would carry 8 or 10 ft. from the point of impact, and that would be enough to increase the pressure and disturb the equilibrium, and cause the tube to crack.

As to the objections he had to the Code, he would say to Mr. Jeter that it was incomplete. It should state more than the minimum tensile strength: he noticed that in one place it called for 47,000 lb. and in another, for 45,000 lb., and he thought that 47,000 lb. minimum was enough and would cover the steel ranges that could be used in this connection from 47,000 lb. to 57,000 lb., as specified for "Grade A," on page 7 of the Code. The present Code requirements should be modified if welded steel is to be allowed.

Mr. Wille had asked, why not use flange and firebox steel? It was rather unfortunate that such a widely used grade as the latter should be just a little high in tensile strength, 0.15 to 0.25 carbon being just outside of the range required for good welding. It was, of course, possible to weld it, but the Boiler Code Committee wanted a material that could be welded with the least difficulty, and in spite of the inconvenience of adding another grade of steel, it would be better to have one that had been developed and shown adaptable especially for forge welding. This would be a steel of not over 0.15 carbon. Another grade not over 0.20 carbon might be added to satisfy the demands of those who wasted higher tensile strength, at least for tank cars, and that would include about half the range of the firebox steel. Mr. Wille's problem was somewhat simpler. His company used forged welds on locomotive firebox boilers for the sake of lightness and employed flange steel; all of these welds were reinforced by straps, so that the weld was not depended on to any great extent for strength.

Discussion of the Paper by Professors Fessenden and Bradford on Tests on Welded Cylinders

S. W. Miller[1] wrote that he did not believe it was good practice to heat the shells and the heads of pressure vessels in an ordinary forge fire where the flame was strongly oxidizing, and where it was impossible to keep dirt out of the weld. Even with the best facilities it was difficult enough to keep the mill scale from being included in such a weld, and the chances were that there would be defects in spite of the best practice. The results shown in the paper indicated clearly the difficulty in making a sound weld under the unsatisfactory conditions employed.

The gas-welded tanks apparently had had all the seams welded without beveling, and the heads had apparently been welded to the shells without removing the scale left by the cutting torch.

In the case of the pipe tanks the shell was much thicker than the head, in addition to which the head was beveled, so that the bottom edge of this bevel became hot and ready to weld before the shell did. The result was that there was a great chance of the shell not being brought to the fusion point and the melted weld metal not

---

[7] Construction, Industrial & Production Engineer, Detroit, Mich. Jun. Mem. Am.Soc.M.E.

[8] Asst. to Vice-Pres Baldwin Locomotive Works, Philadelphia, Pa. Mem. Am.Soc.M.E.

[9] Construction Engineer, Lowell, Mass. Mem. Am.Soc.M.E.

[10] Chief Engineer, Hartford Steam Boiler Inspection & Insurance Co., Mem. Am.Soc.M.E.

being fused to the shell. This was true wherever one piece was thicker than another.

His experience led him to believe that it was not possible to get sound welds in this way. A single V weld was liable to be imperfect under the best conditions, although when properly made in soft plate of good quality with the proper welding wire, it was possible to bend such a weld backward without rupture, the bottom of the V being on the convex side. This was the severest test of a single V weld that he knew of, and every condition must be exactly right for it to be successful. The effect of imperfect fusion along part of the V appeared to have been considerable in the case of the longitudinal seams as shown by Fig. 28 which showed a reinforcement of probably 50 per cent of the plate thickness. Assuming it at this figure and using the formula for eccentric load stresses given in Kent's Handbook it would appear that the maximum fiber stress with a perfect weld would be about 56 per cent more than the average stress on the plate section. If the weld were imperfect, the fiber stress would increase beyond this very rapidly, and the vessel might easily become dangerous.

Cylinder No. 2 was tested to a fiber stress much above the yield point, as shown by the permanent set in Par. 28, and the results of the tensile strength in Table 3 should be taken with some caution especially since the yield points were so close to the ultimate strength. Apparently the figures given represented the strength of the material after it had been once stretched, and were not the real characteristics of the material before testing.

Recommendation (*f*) under Par. 69 for overcoming the defects noticed in the gas welds certainly should be always carried out.

It was very doubtful if the increase in grain size alone had much to do with the strength of the material, although in connection with non-metallic impurities it might be a prolific cause of weakness.

The entire paper showed the necessity for the adoption of better practices, which would doubtless be done as soon as it was fully realized by the manufacturers of tanks that some of the practices at present in use were not safe.

G. O. Carter[11] said that the man who subjected a vessel to a pressure of 200 lb. that was intended for only 100 lb., was at fault. The weld was almost always blamed if there was a failure, no matter what the real cause might be, and especially so if the vessel was made of low-carbon steel. He did not believe that makers of steel welds would suffer, however, if tanks failed outside the weld. As to correct design, he believed the convex head should be employed instead of the concave, in order that the strain should be tensile.

There were advantages in using double V welds, for with the single V there was an unbalanced load on the weld, and his company had found that nothing was gained in reinforcing a weld more than 15 per cent. There were some places where a double weld could not be made, but the circumferential welds required only 15 per cent more than in the case of longitudinal seams and they were a large additional factor of safety.

In welded construction it was possible to obtain more than 100 per cent of the deposited metal or of the base metal, but in riveted work 100 per cent could not be reached. Especial attention should therefore be given to the correct depositing of metal, and the use of low-carbon filler rods should be done away with, in spite of the fact that they were easy to work and easy to clean.

George Bird[12] spoke in approval of the double V weld and said that in experiments his company were conducting the V's on the inside of the vessel were made two-thirds the capacity of those outside. In his section it was difficult to set uniform plate from the mills. He had seen tank plate so stiff that it could not be bent and which was as hard as high-carbon steel.

F. N. Speller[4] protested against the conclusion of the authors that forged welds in cylinders were much inferior to acetylene or electric welds. For 25 years, he said, ammonia containers with dished heads had been forge-welded, the heads being of the same thickness as the shell. Failure, when it occurred, was by reversal, which would open any sort of weld. Forge-welded cylinders made under the I. C. C. specification No. 4, when tested rarely failed at the weld, however, and it was almost an unknown experience to have a dished head reverse itself.

S. F. Jeter[10] said that insurance companies were more willing to accept risks on forge-welded than on autogenously welded vessels although they considered the latter to be reasonably safe. He differed with Mr. Carter as to the use of convex heads for the reason that heads dished inwardly were better fitted to resist the stresses up to some point near rupture. The companies were not particularly interested when the weld had begun to fail.

John A. Stevens[9] closed the discussion by saying that the session had been without doubt one of the most important meetings ever held to consider welding problems. The end in view, of course, had been to obtain information as to the best materials to use for the various classes of work in order that standardization might be effected. A matter that he would like discussed was that of preheating the plates.

General Discussion

The meeting being thrown open to a general discussion of welding, Chairman Fish said that the reason for having delayed so long in getting out the unfired-pressure-vessel code had been primarily the uncertainty as to what the provisions covering welding should be. The demand was insistent for a code, and the Sub-Committee of the Boiler Code Committee sincerely wanted the best advice it could get, and was particularly desirous of getting as much real data as possible regarding construction.

C. W. Obert[13] read an extract from a letter written by Augustine Davis, Jr., president of the Davis Welding and Manufacturing Co., Chicago, in which Mr. Davis said that from his rather extended experience in welding he was certain that almost any class of pressure vessels could be welded if the proper construction was used, without any greater danger, in fact, with less danger than in the use of rivets or other mechanical means. For instance, pulp digesters, ammonia condensers for ice plants and stills for oil refineries were lap-welded. Ammonia condensers were at present and had been successfully oxy-acetylene welded. In fact, he understood they had been more successfully manufactured this way than by any other method. While failures had been made on oil stills and pulp digesters, yet there was no reason why these should not be oxy-acetylene-welded to even better advantage and more safely than by lap-welding except lack of experience and time for manufacturers to develop welding for these purposes.

J. O. Leech,[14] discussing the qualities of base metals, said that tank steel from the steelmaker's standpoint was any grade of steel that would bend or could be fabricated readily. It did not have any definite chemical or physical properties. Some railroads used very soft steel for locomotive fireboxes, while others used a medium grade. The Pennsylvania Railroad had reported that they obtained the best results from steel of 55,000 to 65,000 lb. tensile strength. Other roads wanted 45,000 to 55,000 lb. He would impress on those present that grade did not make quality, and quality did not make grade.

Professor Roark[15] said that there would be no tensile stress on the head joint of a cylinder, unless the head was of the same thickness as the shell and truly spherical, with the same radius as the shell. There seemed to be a general impression that a rounder head, convexed outwardly, would lead to additional tensile strength only on the joint, but analysis would show that such was not so.

S. W. Miller,[1] replying to Mr. Steven's request for information on protecting plates, said that this while procedure of itself would not make a good weld, it would nevertheless tend in that direction because it permitted the use of a smaller tip which did not blow the metal away, and in the case of an electric weld it would enable the welder to get better fusion with somewhat less current. It was hard on the operator with the temperature, say, 100 deg. in the shade. There were those who insisted that preheating was necessary to avoid destruction in circumferential seams, but from his experience he felt warranted in opposing this view. After-heating was no more necessary than preheating except in the case of forge welds, where it was good practice to anneal sufficiently to remove the stresses due to hammering.

F. N. Speller[4] said that with respect to forge-welded vessels, where the welds were heavy it was preferable to anneal the whole vessel to relieve the internal strain.

---

[11] Union Carbide Company, New York, N. Y.

[12] Bird, Potts Company, Atlanta, Ga.

[13] Secretary, A.S.M.E. Boiler Code Committee. Mem. Am.Soc.M.E.

[14] Carnegie Steel Co., Pittsburgh, Pa.

[15] Asst. Prof. Mechanics, Univ. of Wisconsin.

Compounding the Combustion Engine

Interesting and Valuable Discussion of Paper Presented by Elmer A. Sperry at the 1921 Annual Meeting of the A.S.M.E.

IN a paper presented at the 1921 Annual Meeting of the A.S.M.E., Elmer A. Sperry set forth the results of his work, extending over 30 years, in developing a successful compound combustion engine. Such engines are light compared with the normal Diesel engine, being in special cases, according to Mr. Sperry, less than one-tenth, and in some cases less than one-twentieth, the weight for the same output. A high mechanical efficiency and a distinct gain in overall efficiency from fuel to shaft were reported in the paper, as well as a very definite gain in simplicity, direct performance and smoothness of crankshaft diagram—all achieved while adhering to the best practice, namely, four-cycle operation.

Mr. Sperry's paper, slightly abridged, appeared in the January, 1922, issue of MECHANICAL ENGINEERING, which went to press before it was possible to prepare an adequate abstract of the valuable discussion it drew forth. Such a résumé, however, is now printed below and should prove of great interest to those who read or heard the paper presented. The figure numbers above Fig. 8 refer to the complete paper, and not to the abstract published in the January issue.

ORAL DISCUSSION

In opening the oral discussion, George A. Orrok[1] called particular attention to the transfer valve between the high- and low-pressure cylinders, which in Mr. Sperry's engine is the solution of a particularly severe problem. He emphasized the importance of mechanical atomization of fuel, which has proved so successful when using fuel oil under boilers. He also drew attention to the fact that the engine in question followed the accepted canons of steam-engine design.

Francis Hodgkinson[2] pointed out as important the increase of size of the compression space, which leads to detonation and is a remarkable aid to good combustion.

A number of questions were asked of the author by others present at the session, as to the efficiency of the engine, to which he gives attention in his closure.

WRITTEN DISCUSSION

J. C. Shaw[3] submitted an extended and searching written discussion, the greater part of which follows.

DISCUSSION

Mr. Sperry's engine is interesting, as well as ingenious, particularly in the methods employed in effecting the idea of compounding the oil engine, and he is to be commended for his research along the lines indicated.

It would appear on casual observation that there might be some saving in weight over the simple engine, due to the low-pressure element of the compound engine having twice as many working strokes as the corresponding part of the four-cycle simple engine. This advantage, however, is evidently more apparent than real, as will be shown later, provided the same general construction is adhered to for either engine. A similar argument has been frequently advanced for the two-cycle engine over the four-cycle for effecting weight saving, but which has not always proved correct in actual service conditions.

The claim for inherent superior economy of the compound engine over the simple engine, wrote Mr. Shaw, is to be seriously questioned and it is particularly to be regretted that the author has failed to supply any actual figures for fuel consumption to substantiate this general claim. The parallels that have been drawn with other types of machinery, as reasons for anticipating the better efficiency, are incorrect as a rule, and more or less misleading.

The compounding of the steam engine is cited, but this (as is well understood) is done entirely for another purpose, that is, to prevent the condensation and reëvaporization of the medium in the cylinders.

The author similarly makes mention of the large expansion in a steam turbine as a reason for greater expansion desirable in the oil engine, but the comparison is again incorrect. The turbine must work down to a very low absolute pressure, and the final specific volumes handled are accordingly very large. The turbine, furthermore, is not handicapped by having restricted exhaust openings. In the oil engine the back pressure cannot be less than atmospheric pressure, large expansion ratios not being required, and there must be some "toe loss" in card area, or slight pressure drop, so as to get the gases through the exhaust valves, which are limited as to size.

The author also cites the multi-staging of the air compressor as a parallel reason for doing the same in an oil engine. This is primarily done to permit of intercooling the air to reduce the amount of external work required to be done on the air. Any loss of heat in oil engines, either during expansion or compression, beyond keeping the temperatures within practical limits, conversely is to be avoided.

The author further advances the claim for superior economy by "hanging on to the pressure in the gases throughout two strokes, clear across the card twice, thus extracting much more of the power they contain." This is difficult to comprehend, as the pressure in either the compound or simple engine should follow the same general adiabatic curve of expansion, due to the burnt gases being composed of the same constituents of combustion. In the formula $PV^n =$ Constant, for adiabatic compression or expansion, the exponent n for air is 1.403, and for exhaust gases is usually taken as 1.37. To sustain or "hang on to" the pressure more during expansion as suggested, would have the effect of lowering the exponent below 1.37 and to approach the isothermal curve in which the exponent becomes unity. This would be undesirable, as it would indicate after burning and loss in efficiency. In the theoretical thermodynamic formula for thermal efficiency, the efficiency varies directly with n, and the pressure should fall rapidly enough to approach ideal adiabatic expansion. It also follows that with the adiabatic expansion less expansion ratio in cylinder is required, and should not be carried beyond what is practically necessary. The high-speed engine, especially working on the constant-pressure cycle, is prone to after burning and raising the end of the expansion curve, and the back pressure is also augmented by the choke in the exhaust valves, in itself due to the high speed. On the other hand, in the slow-speed engine the burning is much more complete in the beginning of the stroke, due to the time element being longer, and there is less restriction in the exhaust passages than with the high-speed engine.

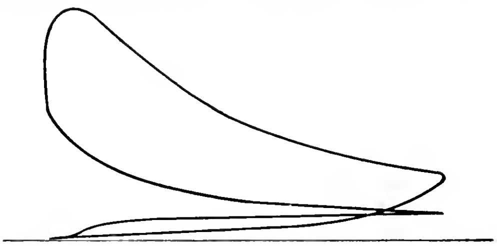


FIG. 1 INDICATOR CARD FROM PORT ENGINE OF MOTORSHIP *William Penn*

The author shows in Fig. 2 a theoretical card of a two-cycle Diesel engine with exaggerated "toe loss," and indicates in extended dotted lines the additional area which is supposed to become available with the compound effect. In contrast to this card there is reproduced in Fig. 1 on this page a tracing of an actual card taken from the port engine of the motorship *William Penn*. The cylinder size is $29^{1}/_{8}$ in. diameter by $45^{1}/_{4}$ in. stroke, and the m.i.p. of the

---

[1] Consulting Engineer, New York, N. Y. Mem. Am.Soc.M.E.

[2] Chief Engineer, Westinghouse Elec. & Mfg. Co., Lester, Pa.

[3] Turbine Engr., Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia. Mem. Am.Soc.M.E.

sard shown is 5.9 kg. per sq. cm., corresponding very closely to the normal rated power of the engine when turning at 115 r.p.m. The end of the expansion curve is about $1^{1}/_{2}$ kg. per sq. cm. or 22 lb. This curve has been extended in dotted lines by calculation to half the above actual release pressure, should it be possible to work to the lower pressure, and the additional area that becomes available is found to be less than 6 per cent. This would necessitate increasing the expansion ratio by about 27 per cent with the additional weight and friction of parts involved, and it is accordingly extremely unlikely that any improvement in efficiency could actually be realized with the greater ratio.

An actual card is given in Fig. 12 for the 7 by 11-in. engine, working on the explosion cycle. By comparing it with the constant-pressure card in Fig. 11, it is assumed that the scale is about 360 lb. to the inch, as usually employed. On this assumption the maximum pressure would be about 600 lb., and the compression pressure about half this, or 300 lb., which later is sufficient for automatic ignition with solid injection. The back-pressure line of the high-pressure exhaust as well as the air-charging line is also shown on this card. but it does not follow, as one is lead to assume, that the corresponding pressures registered outside the cylinder will be the same. It would have proved very interesting had corresponding actual cards been taken from the low-pressure cylinder, top and bottom, and had the pressures so obtained been referred to the low-pressure cylinder, as in steam practice. This would show the actual card-area losses due to pressure drops between the various cylinders, as is to be expected. It is to be noted from the high-pressure card given that the negative work of the supercharging side of the low-pressure is actually about equal to the work done by the working side, taking into consideration their relative areas as shown in engine section, Fig. 14. It would appear that at small fractional powers there is danger of overexpansion, and of the low pressures doing very little work and acting as a drag on the system. The engine differs from a compound steam engine in not being able to vary the "cut off" of the low-pressure for equalizing the powers and expansions between cylinders to suit the actual conditions.

The author, however, has furnished us with some ideal cards shown to small scale, Figs. 3 to 8. Comparing cards 5 and 6, showing high-pressure cylinder theoretically functioning both as constant-volume and constant-pressure cycle with same compression pressure, it is seen that the compression pressure is about 650 lb. and the explosion pressure for the constant-volume cycle is over 1000 lb. This is estimated from point *B*, given as 113 lb. The increased theoretical efficiency of the explosion card is readily understood from the theoretical formulas, and is on account of the greater card area available in common with the high maximum pressure employed. It is seriously doubted, however, if the theoretical card could be anywhere nearly approached in practice, especially in the larger commercial sizes. This is on account of the high shocks and strains that would be produced and the heat troubles encountered within the high-pressure cylinder and transfer valve, but not so evident in the small experimental engine of small dimensions.

Mr. Sperry strongly advocates his high-pressure explosion engine for cargo-ship propulsion for replacing the present well tried slow-speed direct-drive engine. The latter, though acknowledged by him as being responsible for the present high standard of the motorship, he particularly criticises for its excessive weight. In so doing he has overlooked completely the shortcomings of the explosion engine and high-speed engine. The explosion engine is inherently unsuitable for marine drive, due to the shocks at dead center and lack of flexibility at reduced powers. The slow-burning engine, on the other hand, is specially adapted by lack of shock and by great flexibility, due to having the burning take place after the piston passes dead center, without any appreciable rise in pressure.

To prove his point for saving in weight the author mentions a mean effective referred pressure of 300 lb. for the high-pressure cylinders. This has been doubled or referred to one high-pressure cylinder only and increased to 660 lb., and it is pointed out that this is ten times that usually employed in the simple engine. From this he infers the weights, respectively, should be inversely in the same proportion. The comparison of mean pressures would be more nearly correct had that of the compound been referred to the low-pressure cylinder, and which in the case of 1 to 10 engine, would have brought it down to that of the simple engine. The comparison of this high-speed engine on a weight basis, without taking into consideration the additional weights of the complicated clutches and gears also involved, with that of the slow-speed direct-connected crosshead engine is considered very unfair. An attempt has been made by the writer to arrive at a true comparison between the particular compound engine and a simple engine of similar construction. In a contemporary copy of the Sperry Company's publication, the *Sperryscope*, there is shown in outline an engine having the same general overall dimensions as shown in Fig. 14, and designed for the same r.p.m., namely, 400. From this it can be assumed that the engines are one and the same. The engine illustrated in the publication is direct-connected to a 50-kw. generator, and the statement is made that two engines placed end on end are suitable for driving a 100-kw. generator. Acting on the above clue and suggestion made, a tandem compound engine, has been laid down from Fig. 14, and to the same scale has been drawn a Burmeister and Wain auxiliary engine, designed for the same r.p.m., and for direct connection to the same size of generator. This engine, which is a new type, designed with the idea of installing in limited spaces, is four-cycle, totally enclosed, and has three cylinders of $11^{3}/_{16}$ in. diameter by $13^{3}/_{4}$ in. stroke. The diameter of the low-pressure cylinders of the Sperry engine is figured from the 1 : 10 ratio as 22 in., and the high-pressure cylinders are 7 in., as given, by 11 in. stroke.

The simple engine was found to have about 55 per cent less cubic displacement than the compound, which figure does not take into consideration the supercharging displacements of the low-pressure cylinders, but which are essential accessories to the high-pressure cylinders. There are three working cylinders as against six, and one set of sizes of parts instead of the two sets required for the compound arrangement. The compound engine, furthermore, has a larger number of objectionable automatic suction valves, inaccessibly located, and the trunk type of air piston is a type of construction to be avoided, having been abandoned by most two-cycle builders as unsatisfactory in operation.

The weight of the standard Burmeister and Wain engine, including attached piping, grating and flywheel, and as heretofore built, is 350 lb. per s.hp., and not 450 lb., referred to by the author in error, and it should be added here that, by a newer construction, the weight is actually being reduced by 10 to 15 per cent below the 350 lb.

The actual fuel oil consumption on the above standard Burmeister and Wain engine, as used with twin-screw vessels, is from 0.38 to 0.39 lb. per b.hp. With oil of 19,000 B.t.u., and with the new special slow-speed engine, adapted to single-screw vessels, the consumption is about 0.02 lb. lower. It is thought that these figures will stand comparison with any that may have been obtained with the compound engine, though not given in the paper.

In Fig. 17 is shown by the author a 1550-i.hp. Burmeister and Wain marine Diesel engine, coupled to a generator in the background, and which appears small due to the effect of perspective. The author states that the generator so shown (but used for test purposes only), "forms the full load of the engine." He has been misinformed, as the generator in question is used for absorbing only the power of three cylinders at a time of the particular engine, with the other three cylinders acting as additional load.

Author's Closure

In closing the discussion, Mr. Sperry wrote substantially as follows:

Mr. Orrok and Mr. Hodgkinson have touched on a very vital point. The transfer valve has been a stumbling block ever since the first compound was conceived, and every one has realized it, except Junker, who must have "slipped a cog" when he tried to uncover a valve at about 2700 deg. fahr. temperature. But such are the temperatures to be coped with.

The air injection of fuel mentioned by Mr. Orrok is most interesting. If air is compressed to the point required in the Diesel cycle, we get a temperature of about 1200 deg. If this air is compressed again to another 500 lb., which is the regular pressure of the air when it is used, there results another great increase in temperature. When this air is injected into the cylinder, that temperature drops back again, creating a tremendous refrigerator effect just where a refrigerator cannot be allowed. The incandescent

air must not be refrigerated; all the heat must be left in it. It ought to be guarded still further, because it has been calculated that the amount of heat taken up in the vaporization of the fuel is 80 per cent of the heat in the air.

As to the efficiencies, it can be said that they approach more nearly the theoretical air cycle efficiency than any engines that have ever been built. In Italy, a 7 by 11-in. Diesel engine, which is the size of the engine shown in the paper, without the low-pressure cylinder, running at 450 r.p.m. was found to give 13 hp. per cylinder. If this engine were to run at 400 r.p.m., the speed of the Sperry engine, it would give about 22 hp. in the two cylinders. In the Sperry engine, with these two cylinders and the low-pressure cylinder, we have 220 b.hp. It has been run a great many hours at 180 b.hp. This is about seven times as much power as the Diesel engine. But there is not seven times as much machinery operating, simply one more piston. Cards have been taken repeatedly from the Sperry engine to check up the mechanical losses and these are about 10 per cent. In larger engines, between 40 and 50 per cent thermal efficiency at the shaft is anticipated.

Now, as to large engines. What are the limitations on Diesel engines today? They are cylinder size and thickness of cylinder wall. It is impossible to go much above 1¼ in. in thickness of cylinder wall, nor much above 30 in. in diameter. With this in view and with 29-in. cylinders running at 800 or 900 ft. piston speed, and leaving only four of these combustion cylinders in line, the layouts indicate that an 8,000-hp. engine would be obtained. With six combustion cylinders in line, this would be 12,000 hp. So there is no trouble about the size. Dr. Lucke, of Columbia, has been good enough to say that the compound has solved the problem of making large oil engines.

Mr. Shaw falls into the almost universal error in visualizing combustion engine compounding. He takes a normal Diesel card of the *William Penn* engines and extends the expansion down to one-half of the usual pressure at which the exhaust valve opens, hoping thereby to set forth a convincing argument against compounding. What he actually succeeds in doing is to produce a real case of what he characterizes as "toe loss." In applying this expression to Fig. 2, he seems to have overlooked such an insignificant point as the line XY. The difference between the two propositions is as great as that between the poles. It is just this attempt to do low-pressure work in a high-pressure cylinder that is condemned and has been the compelling reason for adoption of the compound principle in steam as well as combustion engines.

Were this all we did in compounding, however, it would be even more useless than Mr. Shaw states it to be. He seems to think that the only gain in weight we have is the double use of the same low-pressure cylinder for two combustion cylinders "provided the same general construction is adhered to," etc. But isn't this begging the question? Is the same general construction adhered to? Hasn't he missed several other points, such as the compound combustion cylinder being enabled to handle a great many times the weight of air compared with the simple Diesel—not only many times the weight of air, but many times the fuel with more complete combustion than in any simple engine? Again, the point of very great gain in chilled perimeter and surface per unit volume of the power gases. A number of other definite differences between the compound and simple engine, it is felt, are quite completely set forth in the paper.

The expression "back pressures" appears at several points as being the great argument against compounding. A compound engine of any kind invariably develops back pressure on the piston of the next higher stage. All of these facts have had to be considered in compounding steam. In the early history of this earlier art all of these objections were doubtless dragged forth with many others, groomed and arrayed in opposition to the unthinkable change from simple to compound. Now, as a matter of fact, not only have none of these features been found prohibitive, but they have been so minimized as not even to be serious, and this has been the proceeding in the present instance.

With reference to the comparison made between Figs. 5 and 6, where the constant-volume and constant-pressure cycles are shown doubt is expressed if the theoretical card is anywhere nearly approached in practice. It is believed that Fig. 12 is an answer to this.

The predictions as to shocks, strains and heat troubles are on a par with many other of the imaginary troubles. The facts are there is nothing that approaches shocks in the high-intensity burning shown. The very time factor that so alarms Mr. Shaw carries with it its own remedy in relation to its actual effect on the heat gradient and heat losses. Mr. Ricardo of England has evidently gotten sight of this phase of these interesting phenomena.

There is no lack in the flexibility of the engine employing the high-intensity burning card.

With reference to the comparison of the compound with the simple engine, inasmuch as there is no such thing as a previous compound combustion engine to compare with, the author is perfectly justified in referring all of the mean effective pressures back to the only thing that previous engines do have, viz., the combustion piston area, and the evident value in securing ten times the net mean effective pressures to the crank for each fuel injection, together with a very much better distribution of the power application to the crank from any single injection, it is felt needs no further emphasis here.

In connection with the generating sets referred to in the *Sperryscope*, the author cannot agree that the engine that is lighter than the standard General Electric or Westinghouse generator to which it is directly coupled is not exceptional, especially considering that this applies to the ordinary run of engines, designed with no thought whatever of lightness. Fortunately it is not necessary to compare the compound with other than trunk engines to bring into strong contrast the gain in weight. There are large numbers of these engines in service running between 150 and 350 lb. to the b.hp., many of them running at much higher piston speed than the comparatively low piston speed of 735 ft. employed in the Sperry 7-in. engine. However, when employing the same class of refinements as used in submarine engines, the weight comes down to a very low figure, as indicated in the paper.

A point not emphasized in the paper is that in the compound much larger power units can be made in trunk engines than possible with simple engines, the controlling factor covering this point, as is well known, being the relation of combustion piston and the wrist-pin bearing diameters. This gain follows from the fact that a given combustion cylinder in the compound accommodates from four to six times the fuel with a corresponding gain in power for the size. Naturally the alternative of this is that with the compound we do not have to resort to crossheads until we reach four to six times the power of the simple engine per combustion cylinder at the same piston speed and revolutions. It is felt that these are definite gains that cannot be neglected. The crosshead type of engine is just as applicable to compounds as to simple engines. The builders of crosshead engines are driven to adopt this from the limitations given above, whereas so long as excess slipper area is available with ample lubrication, and it shows practically no wear, many of our leading engineers are commencing to believe that the trunk engine is superior, and we know that it is lighter.

With reference to the heavy engines, the author makes it clear that a plurality of unit engines is necessary in a ship, but in all instances twin screws have to be resorted to, where a single screw would be much better all round. It is believed that plural units with their simple slow-speed gears will forge ahead and win the place that they deserve, especially in view of the complete safeguards of the air-gap clutch, which our critic seems to overlook, making the most completely maneuverable ship yet produced.

As to the generator in Fig. 17, this being a photograph of a foreign-built engine and not one of Mr. Shaw's construction, there seems to be doubt as to the accuracy of the author's remarks concerning it. Halfway measures are not usually adopted. A similar photograph of the Maume engines, which are still larger than the one of Fig. 17, where a full-load generator was used to his knowledge, shows about the same contrast. But suppose the statement to be correct. Does Mr. Shaw think for a moment that if the generator shown were to be multiplied in size by the cube root of 2 the contrast between Figs. 16 and 17 would be substantially altered?

If present signs are any indication, it will soon be possible for the author's critics to satisfy themselves as to all points of efficiency and economy of these engines under practical conditions of operation. This, it would seem to the author, should settle all controversial points and while the engines will probably not be above criticism,

(Continued on page 554)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Investigation of Oscillatory Phenomena in Turbo-Generators by Means of a Vibrograph

By DR. JOS. GEIGER

HITHERTO investigation of oscillatory phenomena in high-speed machinery and, in particular, turbo-generators, has been limited to the calculation of the critical speeds at which the shaft begins to exhibit oscillatory phenomena. In the majority of cases only the first or lowest critical speed was determined, but even these limited calculations were often more or less uncertain, because, in the case of shafts located in more than two bearings, the method of supporting the shaft and of holding it in position by nuts, etc., introduces important factors of which we do not know much but which materially affect the results of the calculations. Oscillations not due to the rotation directly but induced by the rotors, housings, foundations, etc., were as a rule not predetermined at all. Because of the lack of proper instruments, observations were inexact and in many cases incomplete, it being entirely impossible to determine without proper instruments the magnitude, direction, and frequency of the various vibrations, particularly where they were superposed.

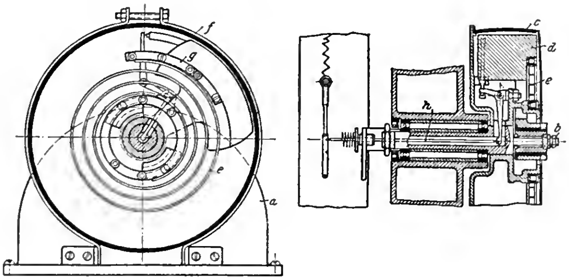


Fig. 1 The Vibrograph

As long as the vibrations were such as not to imperil the structure they could have been neglected; the author, however, ran into a case where something had to be done. In this case he had to deal with a 10,000-kw. turbo-generator running at 3000 r.p.m. The unit ran very nicely for a while and then powerful knocks appeared in the exciter bearing. A series of experiments designed to discover the cause of the trouble proved to be unsuccessful and it was decided to make use of a vibrograph after the ordinary seismograph proved to be unsuitable for this particular purpose. The vibrograph, Fig. 1, was developed during the war to investigate oscillatory phenomena in high-speed Diesel engines and their foundations. It is based on the same principle as the various seismographs, namely, a properly suspended heavy mass oscillating but not in tune with the vibration of the body under investigation. The relative motions of this latter and the inert mass represent the absolute oscillation of the body under investigation. The difference between the vibrograph and the siesmograph or pallograph, (which latter is something like the seismograph), lies mainly in constructional details and to a certain extent in the method of operation. The frame *a* is set or screwed on to the element under investigation, such as a machine part. It is provided with an axle *b* with housing *c* attached to it, and the inert mass *d*, which is rotatably attached to the axle and connected with it by means of wheel *e*. The axle, clamp, and inert mass can be rotated into any position desired and held by tightening the band *f*. If the insert mass lies vertically under the axle, the device can oscillate horizontally; if it is located at the same elevation as the axle, the device begins to oscillate vertically.

The tension of the spiral spring, which is different in the two cases, is each time so adjusted by shifting or clamping the ring *g* that the scribe lever moves about the central position. Of course, the device can record also oscillations occurring at an angle to the horizontal and may be itself placed at any angle to the ground level so that with the same apparatus one can obtain records of disturbances no matter in what direction they may occur. In this respect the vibrograph is different both from the pallograph and the seismograph, in addition to which the vibrograph has the still further advantage of smaller size and smaller weight, the latter being only 6.5 kg. (14.3 lb.), and the size 200 by 200 by 200 mm. (Say, 8 by 8 by 8 in.)

The relative motions of the inert mass of the vibrograph and the cup surrounding it take place tangentially to the shaft *b* and are converted by two angular levers, first into radial and then into axial displacements; they are then transmitted by means of the needle *h* located inside of the hollow shaft and the needle records them on a paper band driven by clockwork.

As the weight of the vibrograph is only very small as compared with seismographs, its sensitivity and magnification are not as great. While seismographs can record very slight movements, such for example, as are produced by distant earthquakes, the range of the vibrographs begins only with much coarser vibrations and extends over the range of those met with in practical engineering up to, say, displacements in excess of 1 cm. (0.4 in.) and oscillations of the order of frequency of 15,000 per min. On the other hand, the vibrograph is more sensitive and handier to use than the Schlick pallograph.

This vibrograph was used for testing the 10,000-kw. turbo-generator set in which vibration was giving trouble. After some testing at various points on the foundations, it appeared that the best way to get a clear idea as to the vibrations taking place would be to obtain a record of oscillations at the three main bearings (front turbine bearing I, double bearing II, and generator and rear turbine bearing III).

While, in the first place, it was important to measure the vertical vibrations, there were also strong axial vibrations in the neighborhood of bearing III. While the presence of such vibrations may be quite surprising at first glance, as the turbine shaft does not produce forces acting on the axial direction, the explanation of the presence of axial vibrations lies in the fact that bearing III was located not directly over but somewhat off the neutral axis of the cross-beam lying underneath. Because of this, the forces which generated the vibrations in a vertical direction tended also simultaneously to create twisting actions about the neutral axis, which appeared then as powerful axial oscillations. A record of these twist motions by means of a torsiograph proved the correctness of this explanation. Furthermore, the vibration at bearing III was much stronger than either at II or at I, and indicated the presence of resonance, as appears from the vibrograms reproduced in the present article.

The magnification was in every case 10.72 times. While there were reasons to believe that resonance vibrations might be present in this case, the origin was not sufficiently clear, as according to previous observations the first critical speed of the turbine shaft lay around 1650 r.p.m., which was confirmed by the vibrogram. But, according to the statement of the turbine builders, the second

critical speed should have been much beyond 3000 r.p.m. which latter was the operating speed.

The author has therefore determined the natural periods of oscillations of the individual parts of the foundation and machinery and, in particular, the turbine shaft. The vibrograph was also used for this purpose as part of the following simple process. The vibrograph is attached to the part of the foundation under investigation and the paper band is started so that the stylus records a straight line; then a sufficiently heavy weight is suddenly dropped down [65 kg. (143 lb.) from a height of 70 cm. (28 in.) was found to be sufficient in the present case]. The vibrograph records then the vertical oscillations (Fig. 4) of the respective part of the foundation. A similar test with proper modifications will give the horizontal natural period of oscillations of the same and other parts.

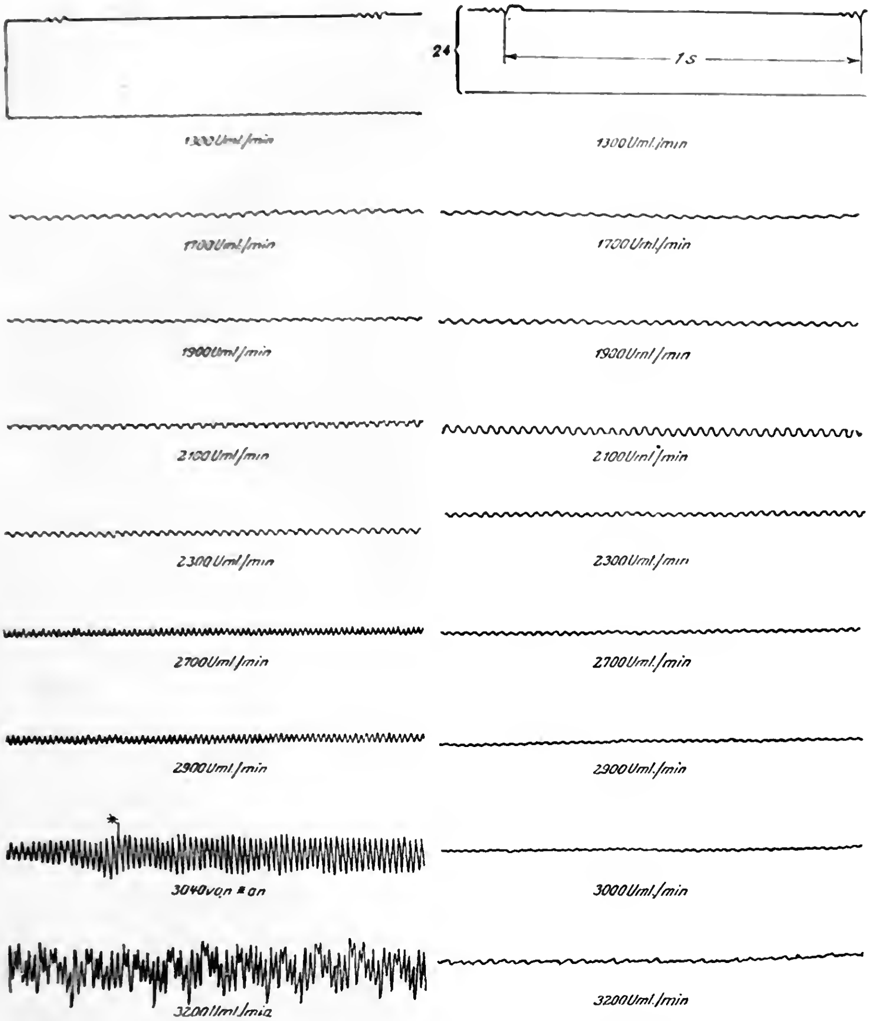


Fig. 2 Vertical Oscillations of the Generator Bearing Before (on the Left) and After (on the Right) Reinforcing the Beam Underneath It and Its Two Supports

(*Uml./min.* = r.p.m.; *von* an* = from* on.)

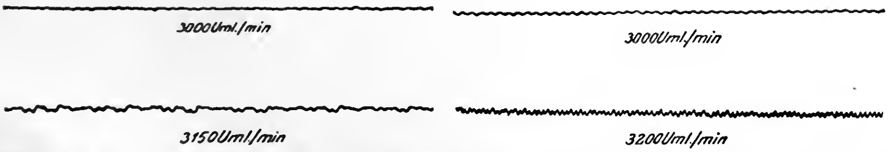


Fig. 3 Vertical Oscillations of the Double Bearing Between Turbine and Generator Before (on the Left) and After (on the Right) Reinforcing the Cross-Beam and Its Two Supports

(*Uml./min.* = r.p.m.)

The vibrograph was also used to determine the natural oscillations of the turbine shaft, but in a different manner. The vibrograph shaft with its inert mass and cup was removed and instead an angle lever with a second needle built in (Fig. 5). The angle-lever holder *a* may by means of nut *b* be shifted into any desirable position on the bearing. The upper part of the turbine housing was removed and the needle connected with the outer rim of a wheel fitted, after the bearing block of the vibrograph was attached, to the upper face of the bottom half of the turbine housing.

The paper band is then started and a shock given (by a piece of

gas pipe) to the turbine shaft or the hub of the wheel. It is not necessary to apply much force in doing this. The vibrograph records then the natural oscillations of the shaft, from which one can determine their period though not at the lowest level.

The remainder of the article gives further details as to the application of the vibrograph and shows how corrections may be made in the turbine supports by means of the information derived from its use. This part of the article cannot be abstracted owing to lack of space. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, no. 18, May 6, 1922, pp. 437–440, 35 figs., *deA*)

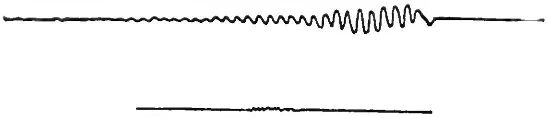


Fig. 4 Vertical Oscillations Due to the Fall of Weight on the Cross-Beam at 9000 r.p.m. Before (above) and After (below) the Foundations Were Reinforced

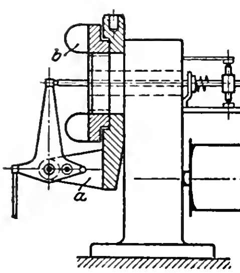


Fig. 5 Vibrograph Altered for Measuring Natural Vibration in the Turbine Shaft

Short Abstracts of the Month

COMPRESSORS (See Refrigeration)

ENGINEERING MATERIALS (See Testing and Measurements)

Formation of Cracks in Boiler Plates

Formation of Cracks in Boiler Plates, Dr. B. Strauss and Dr. Ad. Fry. It would appear that low-carbon steel which has been cold-worked and then heated to a blue heat shows pronounced brittleness when tested at ordinary temperatures, but until lately it has been practically impossible to recognize this brittle condition. The method of etching developed in the experimental laboratory of the Krupp Company, however, makes it possible to recognize the brittleness resulting from blue heat by observing force influence figures.

These force influence bands were discovered not only in old defective boiler plates, but also in new plates after they were heated to 200 deg. cent. (392 deg. fahr.) and straightened in a machine, which means that they have undergone cold working similar to the bending of the plates.

It was noted, however, that these force influence bands did not appear in all soft steels and sometimes appeared only in the zone of high-phosphorus segregation but not in the low-phosphorus surface layers of the plate. Their appearance is therefore dependent on the composition of the metal.

In addition to composition, the temperature at which the plate was finished in rolling is important. Plates which left the rolls fairly dark sometimes showed bands, while plates finished in the rolls at a higher temperature were usually free from the bands.

An important influence on the behavior of the plates is exercised by the manner of their annealing. Plates which were annealed above the transformation point Ac_3 showed force influence lines after bending only in the phosphorus layers, while in plates annealed at a low temperature their presence over the entire cross-section was very pronounced.

Notched-bar impact tests on various specimens have confirmed the original statement that soft steel worked cold or at blue heat is brittle when tested at room temperatures. It has been found, however, that plates, which after bending and annealing are brittle at ordinary temperatures are tough when tested at 200 deg. cent. (392 deg. fahr.), regardless of any previous treatment they may have received.

A supplementary series of warm notched-bar impact tests were carried out. The results of these tests are shown in Fig. 1. The curve shows a rapid increase between 100 and 150 deg. cent. (212 and 302 deg. fahr.), and a sharp turn above 150 deg. cent. Above this temperature the values approach those of the plates annealed at 900 deg. cent. (1652 deg. fahr.).

From this investigation it would appear that boiler material shows in most cases a much higher toughness in the warm condition than in the cold; that the formation of cracks is promoted by allowing the boiler to cool off, and that in many cases cracks are caused by the impact effects when cleaning the boiler or calking it, a result which might be prevented by properly appreciating this condition and taking due care to avoid it. This may explain how microscopic cracks can lead to large cracks during the hydraulic test through the impact effect of the pump stroke, or may lead to an explosion through the breathing of the boiler. (*Stahl und Eisen*, Aug. 18, 1921, pp. 1133 and following, translated in *Forging and Heat Treating*, vol. 8, no. 5, May 1922, pp. 225–229, 23 figs., *et*)

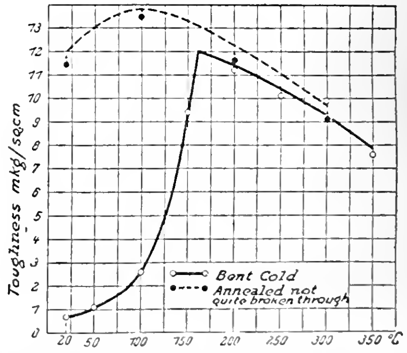


Fig. 1 Warm Notched-Bar Impact Tests on Annealed and Cold-Bent Boiler Plate (45-deg. Notch)

FOUNDRY

Tropenas Converter for Making Steel, S. R. Robinson. The Tropenas process is a variation of the Bessemer intended for making steel in comparatively small lots—one to two tons. The present article applies particularly to practice with vessels of two tons capacity. The process consists in melting a mixture of low-phosphorus pig iron and steel scrap in an ordinary cupola and transferring this metal to a converter in which a blast of air is allowed to impinge on to the surface of the metal. The article gives practical advice as to the carrying on of the process. The following information is given as to the cost of operation.

Assume a charge of 60 per cent pig iron and 40 per cent steel scrap; also a combined cupola and converter melting loss of 18 per cent. Then:

Cost of 1200 lb. pig iron	$21.43
Cost of 800 lb. steel scrap	9.40
Total	30.83
Allowing 18 per cent loss, cost per ton	36.38
Cost of 20 lb. ferromanganese	0.60
Cost of 12 lb. ferrosilicon	0.36
Cost of 300 lb. coke	0.90
Cost of repairs	1.00
Cost per ton of steel in ladle, exclusive of labor	$39.24

(*The Blast Furnace and Steel Plant*, vol. 10, no. 5, May, 1922, pp. 282–284, *gp*)

FUEL (See Power-Plant Engineering)

HYDRAULICS

Pipe Friction and Pump Efficiency, Wm. Brazenall. Tests to establish comparative performance for three types of pumps, namely, turbine, three-throw ram, and differential ram.

The tests are of interest as they are carried out under practical working conditions, and, among other things, indicate the relation between the pipe friction and the pump efficiency. The results are given in the form of tables. One of the interesting features of the article is that it presents the results in units of an electric horsepower and also British monetary units, the intention being to find an economic size of pipe, which, according to the definition given by D. M. Mowat, is such a pipe that the frictional losses may not be greater than the loss of interest on capital used in installing the pipe which will greatly lessen the frictional losses. (*Transactions of the Institution of Mining Engineers*, vol. 63, part 1, March, 1922, pp. 59–69, 1 fig., *e*)

INTERNAL-COMBUSTION ENGINEERING

Airless Injection System for Oil Engines

Airless-Injection System for Oil Engines, Edwin Lundgren. Description of results obtained by K. J. E. Hesselman in Sweden, known as the successful designer of the original Polar-Diesel engine. One of the most important features of the new system lies in the design of the fuel valve. After the fuel enters the valve it is forced through a high-pressure filter of a special design. When the fuel pump delivers a certain accurately determined amount of fuel to the valve, the pressure within the valve rises to such an extent that the pressure of the spring (about 4000 lb. per sq. in.) is overcome and the fuel is squirted into the cylinder through a nozzle and a burner provided with a limited number of fine holes arranged in definite manner suited to the form of combustion space.

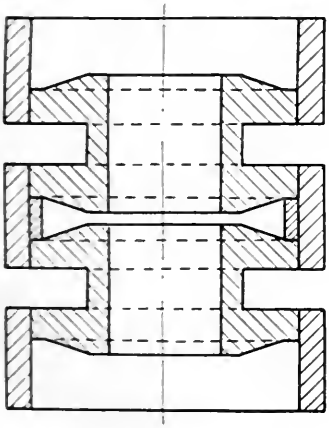


Fig. 2 Spring Elements in the Fuel-Injection Valve of the Hesselman Solid-Injection Oil Engine

In spite of the high pressure exerted on the fuel-valve spring it is of very small dimensions. The fundamental idea of the spring was to use the deflection of circular steel disks supported but not fixed at the edges. A mathematical investigation of the problem confirmed by experiments showed that the deflection attained a maximum when the disk was provided with a hole of a certain size, some of the data of this investigation being shown by curves in the original article. The form of the spring element finally adopted is shown in Fig. 2. Two steel disks are united by an inner circular web to a double disk. The spring is built by a number of these spring elements connected to each other by means of shrink rings and separated from each other by annular distance pieces. The tension of the spring is adjusted by means of a nut on top of a valve which forces the spring spindle downward. This spring spindle passes through a packing of suitable material which prevents leakage. Once adjusted the spring spindle is said to stay stationary and there is no trouble in keeping the packing tight.

The motion of the fuel valve therefore meets no frictional resistance. Consequently the lift of the valve is determined solely by the pressure of the fuel pumped or rather by the amount of oil delivered by the pump to the valve. As this amount must be proportionate to the lead, the lift of the valve must also correspond to the same.

Tests described in the original article were made to show the relation between load and valve lift. The fuel pump used in the Hesselman engine is said to be of novel design. It has only one plunger, even if used in multiple-cylinder engines. Consequently it has to run with at least such a speed that its number of pressure strokes corresponds to the number of power strokes of the engine. The amount of oil delivered each stroke is controlled by a common suction valve which is under the influence of the governor and may also be adjusted by hand. (*Motorship*, vol. 7, no. 6, June, 1922, pp. 444–445, 4 figs., *d*)

MACHINE PARTS AND DESIGN

Pulley Design for Steel Belt Drives

Machinery Driven by Steel Belts, John D. Knox. Steel bands have recently been produced in America having no joints or welds (Power Engineering Co., Youngstown, Ohio). In the process employed each band is rolled from a section of seamless tubing of special chemical and physical qualities or from other kinds of endless rings. The steel belts are made in various widths up to 6 in., dependent upon their ultimate use and the horsepower to be transmitted.

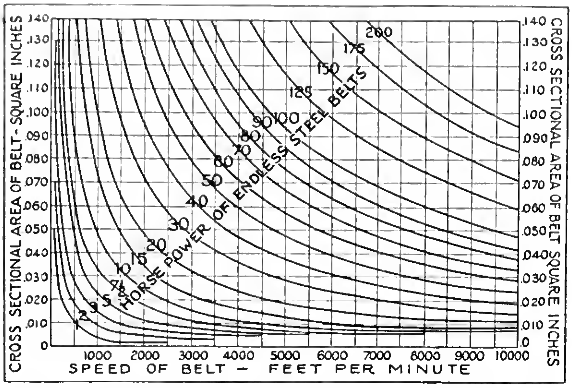


Fig. 3 Curves Representing the Horsepower of Endless Steel Belts for Various Speeds and Cross-Sectional Areas

It is stated that the drives to which the steel belt is especially adopted are air compressors, turbines, fans, motor-generator sets, grinding and polishing wheels and high-speed hot and cold saws. The bands can be run from 12,000 to 18,000 ft. per min., provided the pulleys will withstand the centrifugal force. To secure an even distribution of power over the entire width of the steel belt in order that one edge may not be stressed to exceed its breaking strength and thus result in failure of the entire band, care must be exercised in installing the belt. To obtain a linear speed from 10,000 to 15,000 ft. per min. the diameters of the pulleys are increased, which permits the use of a steel belt about half as wide as those running at ordinary speeds. But since the speed is accomplished by an increase in the diameter of the pulleys, it is possible to increase the thickness of the band, which in turn permits an additional decrease in the width.

The relation of pulley speeds to belt widths and thicknesses are such that about a 50 per cent increase in the diameter of the pulleys decreases the width by a half. Therefore, the problem of belt width, thickness, and speed ultimately resolves into one of pulley design. The curves in Fig. 3, which represent the horsepower of belts for various speeds and cross-sectional areas, illustrate this

point. For example, an 8-in. diameter pulley at 1500 r.p.m. has a speed of about 3000 ft. per min. A belt 2 in. wide and 0.010 in. thick will transmit about 13 hp. If the pulley is increased to 12 in. in diameter the speed becomes approximately 4500 ft. per min. and the thickness can be increased to 0.015 in. The sectional area, therefore, can be increased from 0.020 to 0.030 sq. in. The latter belt as shown in Fig. 3, will transmit 28 hp. In other words, the width can be decreased to one-half of its original width. A diagram which is included in the original article shows the proper speed of belts in relation to the pulley diameter and the revolutions per minute and the linear speed of the circumference of the belt in feet per minute.

From actual operation it has been found desirable but not necessary to use large-diameter pulleys, the larger the better within reasonable limits. They may be relatively narrow and lightly constructed. Pulleys which are less than 4 in. in diameter are not desirable.

To prevent slippage and to cushion the belt the faces of the pulleys are covered with sheet cork. This material will stand compression and still recover its original shape; its adhesion to the steel belt as well as the cohesion to the pulley is satisfactory. Since the cork facing is attached more securely to a rough surface than to a smooth surface, the face of the pulley is either turned with a rough cut or roughened with a file, and made flat or with a slight crown. The life of steel belts has not yet been determined. (*The Iron Trade Review*, vol. 70, no. 16, Apr. 20, 1922, pp. 1114–1116, 6 figs., *dp*)

Bevel-Gear Design, F. E. McMullen and T. M. Durkan. It has been common practice in the past to use in designing bevel-gear teeth, spur-gear formulas such as those of Brown and Sharpe. The Gleason 0.3 and 0.7 long- and short-addendum tooth was brought out to improve this condition and various other alterations of the standard spur-gear design have been used, but for the most part these can be applied to certain combinations only and therefore are not universal. Recent applications of bevel gearing covering a wide range of ratios have made it imperative that a progressive system embracing all ratios and any number of teeth in common use be worked out. An investigation conducted by the Gleason Works with the idea of developing a practical system of designing the quietest form of teeth consistent with strength and wearing considerations has resulted in a simple table. A system has been developed applicable to any pair of generated spiral or straight-tooth bevel gears operating at right angles where the pinion is the driver and has ten or more teeth. It does not apply to bevel gears cut on former-type planers.

The system is described in some detail. It may be mentioned here that the principal qualities considered arranged in the order of their importance are quietness, strength, and durability. As regards quietness, it has been found that bevel gears cut with a lower pressure angle operate more quietly than those cut with a higher one, other conditions being equal. The basis of the system is therefore the use of the lowest pressure angle which will not sacrifice strength by using excessive undercut. Moreover the selection of a low-pressure angle in preference to a higher one does not necessarily result in a considerably weaker tooth, because the stronger section of the higher-pressure-angle tooth is offset by the greater arc of action with the lower angle. The question of durability is somewhat complicated and is discussed in the original article.

The author expresses the opinion that a standard non-interchangeable system, possibly along similar lines to the one developed for bevel gears, is needed for spur gears. He claims that such a system would be of as great importance as a standard interchangeable system, since a large proportion of spur gears like bevels are intended to operate in pairs only. The concessions made to allow interchangeability are so great that the case of the non-interchangeable gear should be granted as much consideration in the way of a standard system as is given to the interchangeable gears. (Paper before Buffalo meeting, American Gear Manufacturers' Association, abstracted through *Automotive Industries*, vol. 46, no. 20, May 18, 1922, pp. 1064–1068, 8 figs., *pA*)

MECHANICS (See Machine Tools)

MACHINE TOOLS

Experiments on the Action of Cutting Tools

An Account of Some Experiments on the Action of Cutting Tools, Prof. E. G. Coker and K. C. Chakko. Description of experiments made on the action of a cutting tool by the aid of polarized light.

The principle used is described as follows: Nearly all transparent bodies when loaded become doubly refractive, and a ray of ordinary light passing through the material in a state of stress is subjected to a selective retardation whereby its transverse vibrations lag one behind the other. No effect is visible to the eye, since ordinary light consists of such a complex system of transverse vibrations that the eye is unable to detect what is going on; but if ordinary light is, as it were, strained through some kind of sieve whereby a homogeneous character of a particular kind is imparted to it, the effect of stress in the material becomes apparent. The most convenient apparatus for obtaining the homogeneous light mentioned is a crystal of transparent calcium carbonate, cut in a special way invented by an Edinburgh optician, William Nicol.

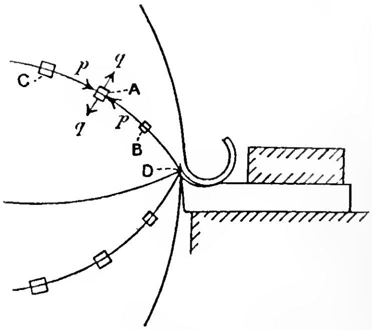


Fig. 4 Disk, the Edge of Which Is Being Turned Up in a Lathe

Ordinary light, after passing through such a crystal, is found to execute its transverse vibrations in one special plane, and this unilateral kind of light is usually called polarized light; and although this is not a very happily chosen designation, yet it seems to be so firmly established that it is hardly possible now to replace this term by a more appropriate one.

If a stressed body is placed between a pair of Nicol prisms and a beam of light is passed through the combination, color effects are observed which are due to the fact that the plane polarized light from the first prism is broken up by the stressed material into two sets of plane vibrations of light, which travel at different velocities through the material. Not only do these two systems of waves travel at different velocities, but they vibrate in planes at right angles to one another. The function of the second prism is to select components in some definite plane from these two systems, so that these latter will interfere with one another. Interference between two sets of light waves in the same plane is visible to the eye, when the light passing through the object under stress is projected on to a screen, and if white light is used, brilliant colors of a rainbow pattern appear, and indicate in a particular manner, to be described later, the stress in the material which the light has passed through. It is owing to this effect that an optical analysis of stress distribution in a transparent body is possible.

As regards the condition of the stressed body itself, the authors consider this to be a plate loaded by forces acting in its plane. This is illustrated by reference to an example drawn from the case of a disk, the edge of which is being turned up in a lathe as shown in Fig. 4.

Select any point A in that disk which has a definite and invariable position with regard to the point D of the lathe tool, and imagine a small square placed centrally over the point A, as shown. If this square is set in one particular position, it is capable of proof, as textbooks show, that the stresses at that point in the disk are perpendicular to the edges of the square and are not so for any other angular position. Further, the intensities of these stresses

p and q are such that one is the maximum stress at the point A and the other is the minimum stress at the same point. If by any means it is possible to measure the intensities of p and q and their directions, then it is quite an easy matter to find the stress at the given point in any other direction. The principal advantage of the experiments described here is that both p and q can be measured, and their directions can also be determined at any points A, B and C, provided the law of the optical effect continues to hold. The trial square can, in fact, be moved from point to point, as indicated on the figure, and for each position, the direction determined in which it must be oriented to give stresses normal to its edges. These stresses are distinguished from any others by referring to them as principal stresses, since all others can be derived from them by simple means. It will be convenient here to describe how the directions of principal stress are obtained experimentally by reference to a disk or plate subjected to the action of a cutting tool. For this and all other optical experiments described here, the polarizing and analyzing Nicol prisms are set with their own principal planes crossed at right angles. Now it is an ascertained fact that the two sets of waves into which the stressed body divides the light ray are also perpendicular to each other and the directions of their vibrations are those of principal stress. Light, therefore, is stopped everywhere in the plate where the directions of the prisms correspond to similar directions of principal stress, and a series of black bands can be obtained by simply turning the prisms round until the whole field of view has been covered, each direction being marked from the index plates attached to the prisms.

It will be noticed, when this is being done, that although the black bands move, the colors remain stationary, so that the indications of stress intensity are not dependent on the angular rotation. A set of lines marking the centers of these black bands is shown in Fig. 5-b and the inclination of the stress in both work and lathe tool are marked thereon.

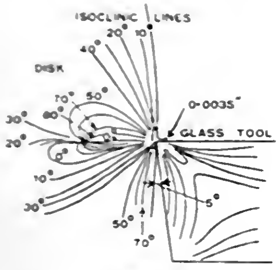


Fig. 5-b

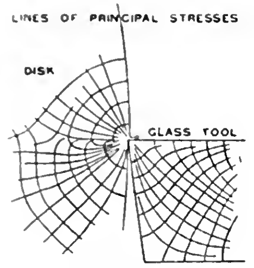


Fig. 5-c

Fig. 5-b Lines Marking the Centers of the Black Bands in Plate

Fig. 5-c Lines Along the Direction of Principal Stresses

This information with regard to directions of stress is complete, since every part of both tool and work is swept over by the black bands during the rotation of the prisms. For convenience, however, it is generally preferable to show this information in a different manner by lines which run along the direction of principal stress. Some of these are shown in Fig. 5-c and are derived from the black bands by a simple geometrical process.

As regards the intensities of the stresses, it is pointed out that the color effect obtained depends on the value of the difference of their intensities at a point and the method to separate such two stresses as p and q, Fig. 4, is described in the original article.

It is said that the color photograph has given a considerable amount of information on the behavior of cutting tools. Thus, in the color photographs very near to the point of the tool an intensely black spot is found which varies slightly in position in regards to the running positions. It forms in part a good qualitative index of the steadiness of the running and of the uniformity of the cutting action. It is also of interest to note that there is a black patch in the shaving immediately above the tool, which remains stationary in time but not in position, as, although the shaving is intensely colored after leaving the tool, the black patch disappears (not, however, with a badly ground tool).

The general appearance in polarized light of a disk under the action of a cutting tool varies with a shape of the tool. Thus, a tool with an edge finished by grinding in the usual way and an angle of from 45 to 60 deg. produces an action quite different from one with a similar edge but finished on a stone as perfectly as possible.

Considerable differences are also noticed with a change of speed when a sufficiently sharp or properly formed cutting tool is used, so that color pulsations are avoided.

The measurement of the stresses in the neighborhood of the tool was not found to present any great difficulty.

Stress distribution in the cutting tool was also investigated, but it does not appear that definite conclusions have been arrived at. (Paper before the *Institution of Mechanical Engineers*, abstracted through *The Engineer*, vol. 133, no. 3462, May 5, 1922, pp. 503–505, illustrated, *d*)

POWER-PLANT ENGINEERING (See Engineering Materials)

Distilling Tar from Coal While Burning Under Boilers

Distilling Tar from Coal While Burning under Boilers, Dr. Alfred Gradenwitz. German engineers are finding it worth while to extract the low-temperature tar from coal used for power and heating purposes. One of the three methods of doing this is by burning the fuel in a grate furnace and distilling shaft arranged to combine the burning and distilling processes. This method has been worked out by one of the engineers of the Pintsch Company of Berlin, and employs a type of furnace shown diagrammatically in Fig. 6.

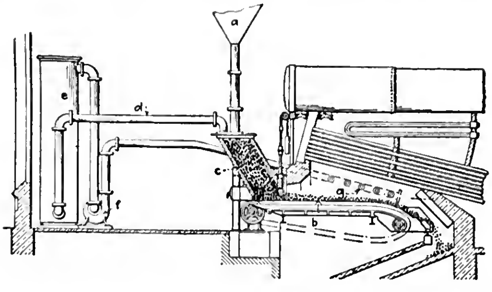


Fig. 6 Combined Furnace and Distillation Plant for Recovering Tar from Coal Burned under a Boiler

Before the coal in the bunker *a* reaches the grate *b*, it passes through a distilling shaft *c*. The coal in the bottom of this shaft is heated by the glowing coals on the front of the grate, and some of the gases given off are drawn through the pipe *d* into the extraction plant *e* by the pump *f*. The permanent combustion gases are then returned through the burners *g* into the furnace, the tar, ammonia, etc., having been retained in the extraction plant.

Not all the gases extracted from the coal are drawn through the distillation shaft and the operation is limited to a relatively small amount of combustion gases of which, moreover, the greater part are reduced to carbon monoxide and hydrogen in the lower part of the shaft by coming in contact with the incandescent carbon at the bottom.

This method was tried out for several months at the municipal electric works near Berlin. The equipment included a Steinmuller inclined water-tube boiler of about 5400 sq. ft. heating area, with preheating and superheating and two traveling grates with a total surface of about 183 sq. ft. Two tests were run on this boiler, each lasting about 30 hr., one being without the tar plant and one with it. The percentage of fuel heat represented in evaporated steam was 76.8 in the former case and 77.5 in the latter. The gain in evaporation was apparently insignificant, but the dry-tar output was 2.25 per cent, representing 4.3 per cent of the heat in the fuel and bringing the total efficiency of the boiler and distilling plant to 81.8 per cent.

A comparatively small amount of distillation gas was drawn off in

this test, but more recently, in the same installation, the tar output was raised to 4.53 per cent; and since that is twice 2.25 per cent, it should represent approximately twice 4.3, or 8.6 per cent of the heat in the fuel, indicating an overall efficiency of perhaps 86 per cent. (*Power*, vol. 55, no. 25, June 20, 1922, p. 970, 2 figs., *d*)

POWER-PLANT ENGINEERING

Condenser Doors

Condenser Doors. Hick, Hargreaves & Co., Ltd., England, have devised a special arrangement for facilitating the opening of condenser doors when they are formed in two parts and carried on a central hinged pin.

The principal characteristics of the scheme are the provision of means whereby the joint between one half of the door and the condenser can be broken independently of the other joint between the other half of the door and the end of the condenser. In Fig. 7 the two parts of the complete door are shown at *A* and *B* and each part is carried on a hinge *C* and *D*. To open either part of the door the joint bolts *E* and the nuts on the studs at *G* are removed and forcing screws *F* are then employed in the ordinary way for breaking the joints. Difficulty however, is liable to be met with in opening the doors *A* and *B* on account of their being close to the central bar on the end of the condenser, any jointing material at the joint *H* being scraped off, while the door is being swung open and again when it is closed.

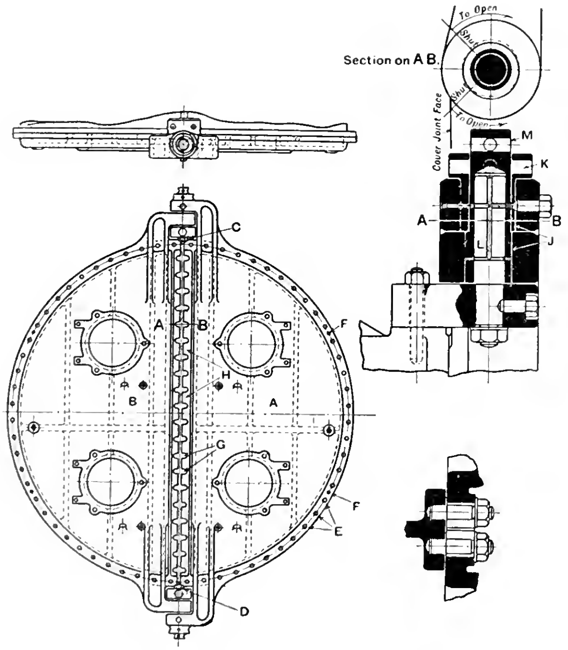


Fig. 7 Arrangement of Doors for a Continuous-Service Condenser

To overcome this difficulty, however, each of the hinged doors is provided with an eccentric bush *J*, which enables each door to be forced away from the facing on the end boxes. This is done in one case by inserting a tommy bar in the holes *K* of the bush *J*, and in this manner the bush is rotated eccentrically with respect to the main pin *L* and the door is moved away in the desired manner, thus giving the requisite clearance between the door and the facing and enabling the door to be swung round clear of the box facing. When closing the door the operations are repeated in the reverse order. In this way the jointing material along the joint *H* is left intact and the pressure is applied by the eccentric bushes prior to the nuts *G* being put on the studs. When it is desired to open the other door, a tommy bar is placed in the holes *M*. The door can then be swung open independently of the adjacent one. Doors of this type are usually employed in connection with surface condensers using dirty circulating water, as one half of the condenser can be cleaned without entirely shutting down the machine.

Continuous surface condensers are also made by Brown-Boveri. The cooling water flows through the condenser in two streams, the water chambers being divided by a vertical wall and the inlet and discharge branches are duplicated, but the steam space is not divided. When both sides are working the condenser differs from the ordinary type only in the manner in which the water flows through it and also in that the air is ejected from both sides. In order to clean half of the condenser it is merely necessary to close the inlet and discharge valves on the portion it is desired to put out of action and drain off the water which remains in that section. The reduction of vacuum which occurs in consequence of half of the condenser being put out of commission is stated to be only about 3 per cent of full load, while at half-load it is somewhat higher than that attained with both the sections in use under load conditions.

The two-part condenser enables cleaning to be done without putting the turbine out of service. (Abstract of a part of a serial article entitled "Developments in Power Station Design," *The Engineer*, vol. 133, no. 3461, Apr. 28, 1922, pp. 457–459; the abstracted part pp. 458–459, illustrated, *d*)

Pulverized-Coal Burning in a Large Station

Largest Station Using Pulverized Coal. Description of the Lakeside Station at Milwaukee, laid out for an output of 200,000 kw., of which 40,000 kw. is installed.

One of the most interesting features is that the plant is designed to use pulverized coal exclusively, this decision having been arrived at on the basis of experiments in the use of this fuel which the company had been conducting at its Oneida Street power plant for over two years.

Pulverized fuel is fed to the furnace by screw feeders from overhead storage bins. Six out of the eight furnaces are fed from the top with the coal discharging vertically downward, while for experimental purposes the other two were fitted with horizontal burners. Recently, however, horizontal burners were discarded and in all furnaces the vertical method of feeding fuel was employed. The furnace volume is approximately 7000 cu. ft. In certain tests in which capacities ranged from 137 to 236 per cent of rating, the fuel burned per cubic foot of combustion space varied from 0.85 to 1.62 lb.

In the coal-preparation plant the belt conveyor leading to the pulverizing-plant building discharges on a reversible cross-belt conveyor of the same width which distributes the crushed coal to three parallel conveyors equipped with automatic trippers; these latter conveyors pass over the green-coal storage bins in the pulverizing building and maintain an even supply in them. Under the bins run three 12-in. screw conveyors arranged to discharge through automatic scales into three indirect-fired rotary driers 5 ft. 6 in. in diameter and 40 ft. long.

These driers reduce the moisture in the coal by means of hot gases from individual furnaces fired with pulverized coal. Each drier is capable of reducing the moisture content in 10 tons of coal an hour from 10 to 12 per cent.

After being exhausted from the drier, the gas is blown through collectors 14 ft. in diameter which recover any coal dust it carries away in passing through the agitated coal. The hot dry coal is next transported to the mill feed bins by means of parallel arrangements of 16-in. screw conveyors and continuous bucket elevators, each set having a capacity of 60 tons an hour. The idea is to provide spare capacity in case of breakdown. The mills are of the pulverized type, utilizing the air-separation system, and driven by 100-hr. motors their total hourly capacity is 48 tons. They pulverize to a fineness that 75 per cent will pass through a 200-mesh screen and 90 per cent through a 100-mesh screen. With the air-separation method no screens are needed. An exciter driven by the mill shaft draws a current of air over the bull ring in the mill and the velocity of this air is such that it picks up only those particles that have been ground to the necessary fineness.

As the quantity of ash from pulverized-fuel furnaces is small and the ashes fine, it is easily conveyed by steam-jet ash conveyors.

From tests made by the U. S. Bureau of Mines at the plant it would appear that efficiencies of blower and superheater were obtained ranging from 79.8 to 85.2 per cent and efficiencies of boiler, superheater and economizer ranging as high as 89.6 per cent with a minimum of 85.0 per cent. These high efficiencies are credited to the fact that with powdered coal the proper ratio of air to coal can be maintained easily, so that there is small loss due to excess air and practically no loss from incomplete combustion and combustible in refuse. (*Power*, vol. 55, no. 16, Apr. 18, 1922, pp. 604–610, illustrated, *d*)

PUMPS

A New Form of High-Vacuum Automatic Mercury Pump, H. P. Waran. The pump is based on a modified Sprengel action. It works automatically, the mercury being removed from the lower to the upper reservoir mixed with a current of dry air which is sucked through a side tube by a filter pump. The defects of design of former types of pump are discussed, their inefficiency at low pressures explained, and suitable simple remedies suggested. The introduction of an intermediate reservoir in the middle of the fall tube, kept automatically exhausted by the Sprengel action in the lower fall, allows the upper half to exert a positive exhaustion for every pellet of mercury falling down, even at the lowest obtainable pressure. The absence of compression in the first fall enables the maximum bore to be used for the fall tube; and hence speeds and efficiencies of exhaustion comparable to those of a Gaede pump are obtainable, though less than a pound of mercury is required to operate the pump. (*The Physical Society of London*, vol. 34, pt. III, Apr. 15, 1922, pp. 120–125, 2 figs., *d*)

RAILROAD ENGINEERING

Nickel-Chrome Steel Railway Couplings. Description of couplings made by a British concern and tested at the Sheffield testing works. The test was a destruction test, the specified minimum load being 100 tons. In addition to being able to withstand this degree of tension, the nickel-chrome coupling, apart from actual fracture, will carry about twice the tonnage of straight carbon-steel couplings without permanent distortion, the elastic limit being 85 per cent of the ultimate strength. The weight is 10 lb. less than that of the carbon-steel castings.

The production of these couplings became possible because of the wide experienced gathered during the war as to the best heat treatment to insure uniformity and soundness. (*The Engineer*, vol. 133, no. 3464, May 19, 1922, p. 562, 1 fig., *ed*)

Ramsay Condensing-Turbine Locomotive. A brief reference to this locomotive was made in Mechanical Engineering (June, 1922, p. 390). It uses the main turbine of the impulse pressure compounded multi-stage type connected through a flexible coupling to a three-phase generator capable of sustaining a 25 per cent overload for half an hour. This generator is separately excited by an auxiliary turbine-driven direct-current generator. The generator supplies power to four three-phase slip-ring motors arranged in two groups on the front and rear parts of the locomotive, respectively. The power is transmitted from a crankshaft to which each pair of motors is geared to six driving wheels on both the forward and rear units of the locomotive, this being done by coupling rods in the ordinary manner.

The rear unit which replaces the usual tender contains the coal bunker and cooling-water tank, as well as the condenser and its accessories. The condenser is of the evaporating type, supplied with air by a fan at the rear of the engine. This fan is illustrated in the original article. The principal dimensions and characteristics are also given in the original article. (*Railway Review*, vol. 70, no. 19, May 13, 1922, pp. 667–668, 2 figs., *d*)

Effect of Tonnage Rating and Speed on Fuel Consumption, J. E. Davenport. The author claims that relatively heavy slow-speed trains are the most economical. Taking a modern Mikado-type locomotive, he plots a coal vs. horsepower curve illustrating the increase in efficiency in locomotive performance as the horsepower output increases to a point near 1400 hp., and the decrease as it increases beyond that figure. On the same sheet he plots resistance vs. speed curves, illustrating the decrease in hauling efficiency as expressed in car resistance in pounds per ton as the speed increases and the car weights decrease.

From data obtained in tests by the Pennsylvania Railroad and at the University of Illinois he finds that at the point of maximum horsepower output the coal consumption increases most rapidly with each unit of power produced.

Data of other tests on the Pennsylvania Railroad are used to establish the importance of the empty-car movement in fuel-economy programs and the importance of proper loading of trains. His general conclusion is that the handling of heavier cars and heavier trains and elimination of excessive speeds will greatly assist in reducing the fuel bills. (Paper before the 11th annual convention of the International Railway Fuel Association, abstracted through *Railway Review*, vol. 70, no. 22, June 3, 1922, pp. 777–782, 10 figs., *p*)

Ljungstrom Turbine Locomotive. Description of a condensing-turbine locomotive recently placed in service on the Swedish State Railways. According to reports the locomotive has performed in a satisfactory manner and has shown great economy in fuel. Complete details of the construction are not yet available, but from photographs it would appear to be a radical departure from conventional locomotive design.

It is intended to displace the Pacific-type locomotives now in use in passenger service on the Swedish State Railways. Unlike ordinary locomotives, there is no driving machinery under the boiler. Instead it is supported by two trucks, the forward with two and the rear with three axles. The driving machinery is located under the tender unit, which also contains the condenser and the necessary fans for aiding in condensation.

The driving machinery consists of a high-speed turbine geared to the six-wheel-connected running gear which has drivers 58 in. in diameter and is located under the tender. The following arrangement is used for heating the air supplied to the furnace: The space between the mud ring and the ashpan is tightly closed and the air for combustion passes through a special air preheater under the smokebox where the temperature is raised by escaping gases from the smokebox. Draft is created by a fan propelled by a small turbine. A damper connected with the firebox door shuts off the draft when the door opens, thus preventing unnecessary cold air entering the firebox flues. (*Railway Age*, vol. 72, no. 22, June 3, 1922, pp. 1295–1296, 1 fig., *d*)

REFRIGERATION

Tests on Compound Ammonia Compression Refrigerating Systems

Compound Ammonia Compression, George A. Horne. An extensive article reporting tests on compound compression systems in two refrigerating plants. Because of lack of space only the major conclusions of this very interesting paper can be reported here.

The machines on which the tests were made are operated with two-stage intercooling in which a gas from the low-pressure cylinder passes through a tubular cooler cooled with well water, and from there into an intermediate receiver into which the high-pressure liquid from the condensers is discharged. The gas is thereby cooled to a temperature corresponding to the intermediate pressure and passes to the high-pressure cylinder; or the high-pressure liquid passes through the intermediate trap where it is cooled to a temperature corresponding to this pressure, and from there passes to the brine coolers. There are no water jackets used on any of the compressors; the liquefied ammonia passes from the ammonia receivers through double-pipe liquid coolers in which it is cooled by well water.

A complete heat balance of the refrigerating cycle is given in the original article.

The results of the extensive tests indicate the advantage of compound ammonia compression with a ratio of compression of six to one or above.

The intercooling by water is clearly demonstrated to be fundamental to the operation of compound compression systems. Where it is impossible to obtain water of a temperature of 60 deg. fahr. a

saving at this stage of the cycle would not be as great, but whatever water is available for condensing purposes there would be a substantial saving in the intercooler.

Among the things found in this test it was fairly established that the venturi meter for measuring liquid ammonia is a valuable instrument in computing capacity of refrigerating machines and may be used to advantage in the practical operation and control of refrigerating system.

Additional tests were carried on in which no liquid intercooling or injection was used, all liquid from the liquid coolers passing directly to the drying, cooling and intercooling between the two stages being accomplished with well water at 60 deg. fahr.

It was found that the operation without liquid intercooling or injection is substantially identical with the operation with liquid intercooling as far as compressor horsepower is concerned. As the chief argument for compound compression over simple compressing hinges on the matter of economy, it is important to determine the simplest and best method of constructing and operating compound compression systems. The author is convinced that any theoretical gain due to liquid intercooling, pressure reduction or injection is offset by losses resulting from handling from 10 to 15 per cent of the total ammonia circulated in the high-pressure side. The elimination of liquid intercoolers materially simplifies the layout of a compound compression system and decreases the first cost. He believes that even 80-deg. fahr. water through the intercooler with a 10-deg. range would hardly justify the installation of the intermediate liquid receivers. He comes to the conclusion that intermediate cooling and injection instead of being essential to compound compression is either entirely unnecesary or merely a refinement of slight merit, while water intercooling is indispensable.

Further tests were carried out by the author and are described in his paper printed in the May issue of the *A.S.R.E. Journal*.

In view of the practice sometimes employed of cooling the low-pressure discharge gas partially or entirely with liquid ammonia, the author has made several observations and comparisons in actual practice in which gas from the intermediate cooler cooled by water was delivered to the high-pressure cylinder with practically no additional cooling by ammonia, and also where additional cooling with ammonia was used he was unable to find any reduction in horsepower per ton in the tests made with this secondary cooling by ammonia. This is of importance, as the use of ammonia in gas cooling results in a reduction of tonnage. Actual calculations have shown that the saving in power due to cooling gas with ammonia is less than 2 per cent, while the reduction in available tonnage is over 5 per cent.

The tests have revealed the fact that in every instance more work was done in the low-pressure cylinder than in the high-pressure cylinder. In some tests over 40 per cent more work was done in the low-pressure cylinders. The author therefore believes (though he does not claim that it had been conclusively demonstrated) that equal work in the two cylinders of a two-stage ammonia compressor produces the lowest horsepower per ton of refrigeration.

He has deduced an empirical formula for determining the correct ratio of cylinder-displacement volumes for two-stage compressors. Without intermediate liquid cooling this is—

$$V = 0.9\sqrt{R}$$

where V = ratio of low- to high-pressure displacement volumes and R = ratio of absolute low suction to high discharge pressures. With intermediate liquid cooling,

$$V = \left[0.9\sqrt{R} - (0.005\,t - t_1)\right]$$

where t = temperature of liquid to intermediate receiver and t_1 = temperature of liquid from intermediate receiver.

For example, let $R = 9$, $t = 70$ deg., and $t_1 = 40$ deg. Solving, $V = 2.55$, which is the correct ratio of low- to high-pressure displacement volumes.

In applying this formula to a common summer ice-making condition, say, of 20 lb. per sq. in. gage suction and 185 lb. per sq. in. gage discharge pressure or ratio of absolute pressures of six to one, with 30 deg. cooling of the liquid, $V = 2.3$. The point might be made that a given cylinder ratio is correct only for one set of conditions, but the answer to that question is found in having a suitable arrangement of clearance pockets on the cylinders. This arrangement of clearance pockets should be such that the highest pressure ratio expected would be satisfied when all pockets are closed on the low-pressure cylinder during the season of heaviest load, which is usually when the condenser pressure is highest. It has been found that the pockets can readily be used to regulate cylinder ratios and at the same time allow reduction in capacity at the time such reduction is desired. The author suggests, for example, that if the maximum ratio of pressures expected requires a cylinder ratio of 2.6 to 1, that an arrangement of pockets should be provided to allow a reduction in cylinder ratios of about 1.8 to 1. (*A.S.R.E. Journal*, vol. 8, nos. 4 and 6, Jan. and May, 1922, pp. 245–296 and discussion pp. 296–307, and pp. 455–487, illus. *epA*)

Influence of Water-Jacket Cooling on Performance of Ammonia Compressors

Influence of Cooling Water Jacket on the Performance of Compression Refrigerating Machines, Dr. Eng. Walther Fischer. The purpose of this extensive investigation was to determine the influence of the cooling water jacket on the performance of the compressor used in refrigerating machinery. The compressor was operated either in the superheated or the wet state at four different vaporization and three different liquefaction temperatures and an approximately uniform speed of rotation. Fifty-four tests in six series were carried out and analyzed in a manner to bring out the influence of the compressor cooling jacket on the output of cold and power consumption, all of these tests being so arranged that the desired temperature relations and permanent state of operation could be maintained quite uniformly. It was found that in work with superheated steam, operation with cooling water was in every way more satisfactory and that both the output and indicated efficiency increased with the fall in the temperature of vaporization. The total losses of the cylinder of the machine were divided into the part which visibly appears in the diagram and the volumetric efficiency, and the invisible part which originates in the wall action at suction. It was found that jacket cooling makes the volumetric efficiency worse, but improves to a greater extent the wall coefficient so that the employment of a water jacket may be considered as being thoroughly justified.

For purposes of comparison two additional series of tests were carried out: one with a variable speed of operation of the compressor, and another with a variable vapor content in the suction chamber of the compressor. It was found that with an increase of speed of rotation the output and indicated efficiency within the region investigated rose constantly, while the volumetric efficiency remained practically stationary, so that the improvement of output was obtained exclusively through the increase in the value of the wall coefficient. The tests carried out with variable specific vapor content in the suction chamber showed the remarkable superiority of superheated vapor as compared with saturated vapor for refrigerating machinery, and, in particular, that at about 90 per cent the output increases more rapidly; then again begins to decrease slowly, and even at $x = 1$ does not yet reach its maximum. (*Forschungsarbeiten auf dem Gebiete des Ingenieurswesens*, published by the Verein deutscher Ingenieure, 1921, no. 244, 78 pp. and 25 figs., *e*)

Advantages of Certain Hydrocarbon Refrigerants

Some Properties of Hydrocarbon Refrigerants, H. D. Edwards. The increasing interest in refrigerating mediums, due principally to the development of chemical processes requiring temperatures not obtainable with present standard machines; to the desire to perfect the small automatic machine; and to the desire, during the war, of the Government to have developed a substitute for ammonia for refrigerating purposes, has caused a study of refrigerants little used or known and has hastened their commercial production.

The selection of a refrigerant depends upon many conditions, such as its vapor characteristics, latent heat, critical temperature, chemical action on materials and lubricants, deterioration, hazard in handling, danger to life, etc.

That the hydrocarbon gases are good refrigerants has been known for some time, and their first application is recorded in England in 1911. They have been used in this country for the past few years.

The hydrocarbon gases are non-poisonous and do not corrode any materials. They must be handled in the same manner as all other inflammable refrigerants.

The use of butane permits of higher suction pressures than are possible with ethyl chloride, and with propane can be mixed so as to give a positive suction pressure.

Due to the similar vapor characteristics, ammonia and propane may be used together in the same equipment, and a change from one to the other may be made by charging the desired gas as make-up.

The density of propane is 2.6 times that of ammonia. While it takes 2.6 times as much propane to charge the system, it takes 2.6 times as long for it to leak out. In addition, propane will not deteriorate or break down under any conditions possible in the system. The density of propane is 50 per cent greater than that of air.

Standard fittings and valves used in air service may be used with propane as the refrigerant will not injure them.

Accurative comparative tests seem to be the only means of determining whether ammonia or propane has the larger net refrigerating effect under all operating conditions, for their value pound for pound seems to be practically identical.

Temperatures approximately 20 per cent lower than those obtainable with ammonia are being maintained with propane.

Due to the characteristics and low cost of CO_2, the application of ethane is necessarily limited to low-temperature work. Temperatures of —70 deg. cent. (—94 deg. fahr.) are being maintained with a standard CO_2 outfit using ethane as against a minimum of —50 deg. cent. with CO_2.

On account of the low discharge pressures resulting from the use of ethane, there is no more leakage than with CO_2, although the density of the former is the least.

The author is conducting comparative tests on the refrigerants mentioned, and is instituting an investigation to determine the unknown physical properties necessary to obtain complete data, particularly on the hydrocarbon gases. (*A.S.R.E. Journal*, vol. 8, no. 6, May, 1922, pp. 488–495, 5 figs., *de*)

SPECIAL MACHINERY

Visco Air Filter. Description of a new filter of British manufacture, intended chiefly for cleaning air supplied to turbo-alternators, blowers, compressors and ventilating plants. The filtering medium consists of innumerable short rings of very thin coppered-steel tubing of small diameter coated with a very thin film of "viscinol," a high-class mineral oil of special characteristics. It has a very high flash point and the temperature of the fire test is such as to render it practically non-evaporating and non-inflammable. This is very important as it is essential that there should be no possibility of oil vapors being formed at any temperature likely to occur in practice. At the same time the solidifying temperature is exceptionally low, so that the filter is not affected by frost. The oil is very viscous, which prevents it from running. The cells which contain the filtering ring are made in standard sections about 20 in. sq. and 3 in. deep and are stamped out of steel in one operation. The filtering rings lie quite irregularly in the cell and offer a very large surface to the air passing through, 1 cu. ft. of rings representing about 300 sq. ft. Due to their irregular position the air is deflected from its straight course a great number of times without at the same time meeting with any undue resistance, which varies from 4 mm. to 8 mm. (0.16 to 0.32 in.) of water according to the time the filter has been in use. After several months of operation the filter is cleaned by either hot soda water or steam, subsequent to which the cells are recoated with viscinol by simple immersion. (*The Electrical Review*, vol. 90, no. 2321, May 19, 1922, p. 717, 3 figs., *d*)

SPECIAL MACHINERY

Wire Saws for Slate and Marble Cutting. Description of products of British manufacture. The cutting wire (helicoidal) in the plans described is continuous and is passed from place to place by means of guide pulleys. The wire travels at about 12 miles per hour. It is made in lengths of from 220 to 880 yd., sometimes more, and in three diameters, 4 mm., 5 mm. and 6 mm., the lighter-gage wire being employed for yard sawing and the heavier for quarry work. In a large working the cutting wire is sometimes driven by a pulley fixed on a countershaft which may drive one or more lines of cutting wire each with its own friction clutch so that each can be worked independently of the other. The wire saw is a useful and economical machine, being cheap to operate, requiring little horsepower, and only occasional attention to see that sand and water are kept fed into the cut. They have been developed primarily for marble working, but can be easily adapted to slate cutting. Attempts to use them for sandstone cutting did not apparently turn out well, because of the excessive wear on the wire. The original article describes the details of their installation. (*The Quarry and Surveyors' and Contractors' Journal*, vol. 27, no. 303, May, 1922, pp. 181–183, 4 figs., *d*)

STEAM ENGINEERING (See Thermodynamics)

Nozzle Losses in Compound Steam Turbines

Nozzle Losses in Compound Turbines. Certain continental engineers have claimed that the higher the steam speed, the more efficient the turbine. This theory is based on the fact that, taking any given nozzle, the higher the velocity of efflux, the less proportionately is the energy wasted in friction. This view is supported also by practical experience.

In a paper published in 1919 in the *Zeitschrift des Vereines deutscher Ingenieure*, Dr. R. Fluegel suggested that the explanation might be found in the fact that a dimensional factor is involved in the resistance to flow of fluids through similar channels.

If in a steam turbine the steam speed be diminished larger nozzles will be required to pass a given quantity of steam, and Fluegel suggested that in this increase of dimension was to be found the explanation of the fact that in practice turbines with low steam speeds appear to be quite as efficient as turbines with high steam speeds.

By the principle of dynamic similarity established by Stokes in 1850, the resistance R per square centimeter of rubbing surface is given by the relation

$$R = \rho v^2 \phi \left[\frac{\upsilon}{vd}\right]$$

where ϕ denotes some function of the expression in brackets, ρ the density of the fluid in grams per cubic centimeter, v the velocity of flow in centimeters per second, υ the kinematic viscosity of the fluid, and d the diameter of some other typical parameter of the waterway.

From experiments analyzed by Prof. C. H. Lees (*Proc. Roy. Soc.*, 1914) it would appear that at low velocities the plotted points fall on an entirely different curve to that which represents them at higher velocities of flow. In the former case the flow is linear in character, while at higher velocities it is turbulent and there is a region of transition between the two curves in which observations plot erratically and repeat experiments do not necessarily yield concordant results. This confirms the truth of the law of dynamic similarity, which may be therefore applied to Dr. Fluegel's program.

For smooth nozzles the author derives the formula for the energy dissipated per unit mass passed per second, as follows:

$$\frac{C}{2} \times v^2 \times \left[\frac{\mu d}{m}\right]^n$$

where C is a constant, m the mass passed per second, μ the viscosity of the fluid, n a small fractional power of the order of 0.1 to 0.2, and d the diameter of the nozzle. In the case of the nozzle, v denotes the actual velocity attained. He shows further that the percentage loss in a nozzle is proportional to $(\mu d/m)^n$.

In a turbine in which the steam speed is high the value of d will be less than in a turbine passing the same mass of steam per second but having a greater number of stages. Hence if n be, as it is natural to suppose, a positive number, the nozzle losses will be less in the high-speed turbine, and the fact that this is not supported by experience must be sought elsewhere than in the dimensional factor suggested by Dr. Fluegel.

Actual experience may be explained in part by the fact that the more stages in the turbine, the higher the reheat factor; but cal-

culation shows that the gain due to this circumstance is very small. The slow-speed turbine has, however, another advantage in that the losses by disk friction and the like in a slow-speed turbine of given output are smaller proportionately than in a machine with high blade speeds. In the foregoing the value of n has been left indeterminate. In the case of parallel pipes it is known to be a small fraction, but its value for nozzles does not seem to have been investigated. Such a research would be of interest and could be carried out with comparatively simple apparatus, using water as the fluid. The viscosity of water is about four times as great at 0 deg. cent. (32 deg. fahr.) as it is at 50 deg. cent. (122 deg. fahr.), so that a fair range of values would be readily available, and from the principle of dynamic similarity the coefficients found for water would also apply to steam.

From this the author proceeds to show that, in accordance with the theory of dynamic similarity, when any viscous fluid flows through a channel the frictional resistance per square centimeter of wetted surface must be expressible in the form

$$\rho v^2 \phi \left(\frac{v}{vd}\right)$$

(*Engineering*, vol. 113, no. 2942, May 19, 1922, pp. 607–608, 1 fig., *t*)

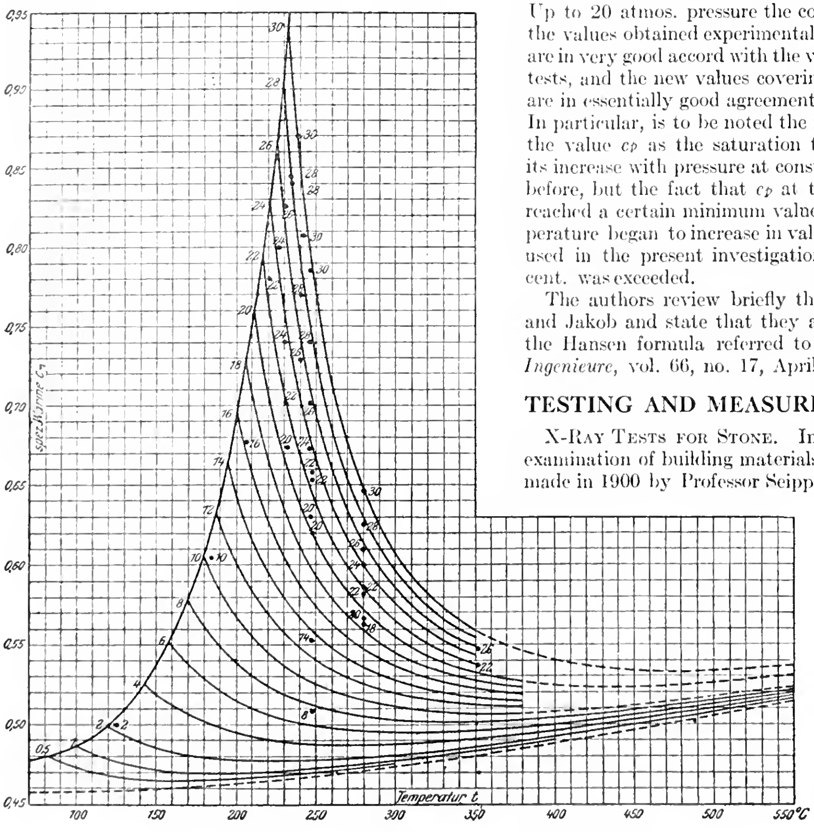


Fig. 8 Specific Heat (c_p) Isobars in the c_p-t Diagram
(Ordinates; *spez. Waerme* = specific heats.)

THERMODYNAMICS

Specific Heat of Superheated Steam for Pressures from 20 to 30 Atmos. and for Saturation Temperatures up to 350 Deg. Cent., Oscar Knoblauch and Erwin Raisch. Description of tests carried out in the Laboratory for Technical Physics at the Munich Technical High School, where so many important previous investigations on the thermodynamic properties of steam have been carried out, among others by the first of the authors of this paper. The present investigation extends the range of previous research to the higher pressures and temperatures indicated in the title.

The results obtained in this investigation are in good conformance with those previously obtained for the lower ranges and further confirm previous observations to the effect that the specific heat increases with the pressure, but decreases with the increase of temperature beginning with the temperature of saturation. In the original article the results are given in a number of tables in addition to which one figure gives the c_p isobars in the c_p-t diagram. (Fig. 8).

In these figures the abscissas are temperatures and the ordinates are c_p values obtained experimentally and by interpolation reduced to whole numbers. Through the points thus obtained curves have been drawn connecting points of equal pressure. For the sake of completeness isobars for pressures below 20 atmos. were plotted as obtained from previous investigations. The part of the curve drawn in full line covers the region determined experimentally; the broken-line curves have been obtained by means of extrapolation.

The curves are based on an equation by A. Hausen (apparently unpublished) which expresses c_p as a function of temperature and pressure. Its constants have been determined from observed values by the method of least squares. From Fig. 8 it would appear that the deviation of the points experimentally obtained from the analytically determined curves is in general less than one per cent. Up to 20 atmos. pressure the comparison between the isobars of Fig. 8 and the values obtained experimentally and given in a table in the original article, are in very good accord with the values previously obtained in the the Munich tests, and the new values covering the region from 20 to 30 atmos. pressure are in essentially good agreement as to general behavior with the old values. In particular, is to be noted the marked increase at the higher pressures in the value c_p as the saturation temperature is being approached, as well as its increase with pressure at constant temperature. This has been observed before, but the fact that c_p at the lower pressures and rising temperature reached a certain minimum value, and then with a further increase of temperature began to increase in value, was observed at the higher temperatures used in the present investigation only when the present limit of 350 deg. cent. was exceeded.

The authors review briefly the latest work of Hencky, Plank, Eichelberg and Jakob and state that they are at present engaged in further work on the Hansen formula referred to above. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, no. 17, April 29, 1922, pp. 418–423, 9 figs., *etA*)

TESTING AND MEASUREMENTS

X-Ray Tests for Stone. In Germany attention is being given to the examination of building materials by means of X-rays. Investigations were made in 1900 by Professor Seipp; and more recently Prof. L. Freind and the late Prof. A. Hanisch have made some extensive researches on the action of X-rays on slates, both natural and artificial. Twelve kinds of clay slate were examined, and various structures were observed in the X-ray diagrams, giving clear indications as to the uniformity and arrangement of the slaty substance. The most conspicuous advantages of the X-ray method as compared with other testing processes are its cheapness and rapidity, as well as the ease with which it can be used without any elaborate or difficult preparation, independently of any chemical analysis or the use of transparent microscopic sections, on large samples as well as on small amounts of material. Other kinds of building material, listed in the complete article, showed interesting variations in permeability to X-rays. (Editorial article in *Quarry and Surveyors' and Contractors' Journal*, vol. 27, no. 303, May, 1922, p. 167, *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Corrosion A1-22. Deterioration of Structures in Sea Water. Since 1916 a series of investigations into the deterioration of structures of timber, metal and concrete in sea water has been undertaken by a committee of the Institution of Civil Engineers, London, with the aid of a grant from the Department of Scientific and Industrial Research. The first report of the committee was published in 1920, and it is now considered advisable to issue the present interim report which deals with work subsequently undertaken.

The report is arranged under the following headings:

Report on deterioration of structures exposed to sea action. (Admiralty.)

Report on the action of worms in the water of the Mediterranean round Malta.

Memorandum dealing with condition of materials of construction of docks, etc., exposed to the action of sea water. (Portsmouth.)

Report on deterioration of structures exposed to sea action. (Devonport.)

Report on the preparation of the various steel and iron specimens for the Committee on Sea Action of the Institution of Civil Engineers. (Sir R. Hadfield).

Report on the work done for the Committee on Sea Action, 1920–21. (J. N. Friend.)

Report on the investigation of the protection of timber against teredo attacks. (G. Barger.)

Report of work done at the Marine Biological Station, Plymouth, July 1 to September 18, 1920. (C. R. Harington.)

Abstracts from Bulletin of the Public Works of the Navy. (United States.)

Abstracts of reports received from correspondence.

Address H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2. Price 2s. 8d.

Electrical Communication A1-22. Radiation from Special Form of Antenna. The Bureau of Standards has just published a paper giving the theory of the radiation from an antenna consisting of 2 horizontal coils. The area within which the signal is heard, and the point at which it is most intense, are discussed. The results of these investigations are given in Bureau of Standards Scientific Paper No. 431, The Field Radiated from Two Horizontal Coils, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents a copy.

Fire Prevention A2-22. Fire Tests of Loaded Timber Columns. See *Framed Structures A1-22.*

Framed Structures A1-22. Fire Tests of Loaded Timber Columns. In an address delivered at the "Building Officials Conference" Mr. T. F. Laist of Chicago gave the results of a series of tests recently carried on by the National Board of Fire Underwriters. The fire-endurance classification of a nominal 12-in. by 12-in. select structural longleaf Southern pine or Douglas fir column of ordinary length, may be more than doubled if the ends are adequately protected against fire. It appeared from these tests that instead of a thirty-five minute endurance rating, a one and one-quarter hour rating may safely be given provided the steel caps as ordinarily used are insulated or a concrete cap is used, thus preventing the crushing and brooming of the wood fibers under the cap and causing failure long before the sectional area of the column is otherwise reduced to the point of failure. It was also shown that such adequate fire protection for the ends of timber columns in mill construction buildings may be obtained by reinforced-concrete post caps such as were used in these laboratory tests. While such caps have been successfully devised for experimental purposes, so far they have not been commercially produced, nor have such tests been made upon caps supporting girder loads.

While in this series of tests no experimental work was done with steel or cast-iron caps, it is apparent that consideration of the results obtained would suggest that adequate insulation for the ends of timber columns may be obtained from the installation of fireproof materials on the exposed faces of standard steel or cast-iron post caps. The tests also verified the greater superiority in fire resistance of timber construction to unprotected steel or cast-iron framing. Address Theo. F. Laist, 1613 Harris Trust Building, Chicago, Ill.

Fuels, Gas, Tar and Coke A10-22. Smokeless Fuel for Salt Lake City. In a brief but satisfactory way Messrs. G. St. J. Perrott and H. W. Clark have prepared a report on their investigations on this subject. This report is known as Bureau of Mines Serial No. 2341. It is a consideration of the practicability of by-product coking of Utah coals for supplying smokeless fuel to domestic consumers of Salt Lake City. The paper reviews briefly the work of the senior author and others in connection with the experimental side of low-temperature coking of Utah coals. The economic feasibility of supplying the entire domestic demand of Salt Lake City with carbonized smokeless fuel is considered from several viewpoints. The discussion includes a consideration of high-temperature and low-temperature carbonization in connection with the character of the coke and by-products produced, and their suitability for disposal on the Salt Lake City market.

Two of the four conclusions reached by the authors are interesting. (1) While the coke and by-products of a low-temperature carbonization plant would probably find a readier market than those of a standard high-temperature plant, neither plant would be a commercial success without protective legislation. A semi-experimental 100-ton plant should be able to operate with a smaller differential between the price of coal and coke due to more favorable disposal of the smaller volume of by-products. (2) No single solution for the domestic smoke nuisance appears available. Means which should be considered for alleviating the nuisance are (1) sale of the available supply of gas-house coke; (2) briquetting of coke breeze from the beehive ovens at Sunnyside for domestic fuel; (3) burning of powdered coal where feasible; (4) installation of semi-experimental 100-ton plant for low-temperature carbonization; and (5) continuation of educational campaign to teach domestic consumers proper methods of firing the native coal. Address Reports of Investigations, U. S. Bureau of Mines, Department of Interior, Washington, D. C.

Fuels, Gas, Tar and Coke A11-22. Preparation and Uses of Tar and its Derivatives. The importance of tar as a commercial product has been emphasized during the past five or six years more than ever before. In that time, the market for tar and its products fluctuated in an unprecedented way, because of the war and other conditions, with the result that the production of tar and tar products increased greatly. A large proportion of the increase is due to the installation of by-product coke ovens, which are fast replacing the beehive ovens, from which tar and other by-products are not recovered.

This paper discusses the uses to which some of the various tars are put and shows briefly the usual methods of working up tar into some of its simple or easily prepared derivatives, for which a market can generally be found. Although coal tars are given chief consideration, the properties and characteristics of water-gas tar are mentioned, for the reason that this tar is often produced in plants where coal tar is made, the mixed tar being collected and marketed, and for the further reason that the presence of water-gas tar in some coal-tar products is specifically interdicted by commercial specifications. This publication is not a handbook on tar distillation, for that subject can hardly be covered adequately in such limited space, but is published by the Bureau of Mines as a general treatise on the utilization of tar. Address Superintendent of Documents, Government Printing Office, Washington, D. C., asking for Bureau of Mines Technical Paper 268. Price 15 cents.

Metallurgy and Metallography A2-22. Metallographic Etching Reagents. II—For Copper Alloys, Nickel, and the Alpha Alloys of Nickel. This article constitutes the second part of the general investigation of metallographic etching reagents in progress at this Bureau. It is closely related to the one already published on copper in the methods employed and results obtained. The following materials were used: Copper alloys, including brasses, bronze and aluminum bronze; nickel and the alpha alloys of nickel, monel metal, cupronickel and nickel brass.

Experimental results are given to show the importance of films in producing contrast in etching. Oxide and sulphide films were used, and it was shown by separating the etching and the filming operations that films varying in thickness on the individual crystals are produced by certain reagents and give rise to "contrast." The better-understood methods for producing contrast by a differential roughening of the crystals upon etching is also illustrated.

The alpha copper alloys closely resemble copper in their general behavior upon etching and in the character of the results produced. The addition of tin to brass appears to render it slightly less responsive to etching reagents than the same alloy without tin; aluminum bronze in the rolled condition was the most unsatisfactory of the copper alloys examined to etch. A series of copper-zinc alloys representative of all the types of structure in this series was examined. The alloys rich in zinc resemble this metal in their etching characteristics more than they do the copper-rich alloys, in that highly oxidizing etching reagents do not appear to be necessary for the successful etching of the alloy.

Nickel, particularly when of high purity, is etched with considerable difficulty. Oxidizing acids, such as nitric, and acids to which strong oxidizers had been added were found effective for a quick etching.

For producing a contrast etch-pattern with freedom from pitting, a long immersion in concentrated hydrochloric acid was found to give excellent results.

Of the alpha-nickel alloys examined, monel metal and cupro-nickel were found to resemble nickel in their etching properties, though they etched more readily. The nickel brasses (nickel silver) resemble the alpha-copper alloys in many respects and were readily etched by the reagents used for the brasses and bronzes.

This report was prepared by H. S. Rawdon and Marjorie G. Lorentz of the Bureau of Standards and is known as Scientific Paper No. 435. For copies address Superintendent of Documents, Government Printing Office, Washington, D. C. Price 15 cents.

Petroleum and Allied Substances A5-22. Evaporation of Petroleum. Bulletin 200 by J. H. Wiggins of the Bureau of Mines. In 1919 the United States was threatened with a shortage of gasoline. In spite of this well-known fact, a detailed field investigation has shown that in one stage only of handling crude oil the volume of gasoline that evaporates is equal to one-thirtieth of the country's yearly gasoline production. This loss occurs during the few days that the oil is stored on the leases before being taken by the pipe line, and in 1919, in the Mid-Continent field alone, it amounted to 122,100,000 gallons. Large as it is, it is only a part of the loss on the lease. Investigation has further shown that the gasoline in crude oil evaporates from one-half to six-tenths as rapidly as the same gasoline after being distilled and stored, all evaporative conditions being the same.

In accordance with its purpose of seeking to conserve mineral resources, the Bureau of Mines investigated the loss of gasoline by evaporation in the storage and handling of petroleum. Inasmuch as most producers had not decided that their losses justified corrective measures and no evidence was available on the comparative losses in various stages of handling the oil, the investigation was limited to determining by experiment and observation the nature and magnitude of evaporation losses, where the greatest losses are, and the factor controlling evaporation. The results of the investigation, as presented in this report, indicate that losses from evaporation are so large that they should receive serious consideration at once by the industry, which should make every endeavor to reduce them to a minimum. The Bureau of Mines is now making a supplementary study of methods of reducing these loses.

This bulletin has three parts: First, a general discussion of the problem and the methods of attack; second, volumetric losses during various stages of handling and in various kinds of storage; third, scientific data on the evaporation of petroleum. Address Superintendent of Documents, Government Printing Office, Washington, D. C.; price per copy, 20 cents.

Petroleum and Allied Substances A6-22. The Analytical Distillation of Petroleum and its Products. Fractional distillation is the most important process in the commercial refining of petroleum. The same procedure, conducted on a small scale, is the basis of a number of analytical methods of wide application in the petroleum laboratory. The Bureau of Mines has studied apparatus and procedure for the distillation analysis of petroleum, and this report is presented as a record of developments up to the present time. The work is incomplete, but the extensive information that has been obtained to date is made available as a guide in handling the laboratory-distillation problems. Address Superintendent of Documents, Government Printing Office, Washington, D. C., and ask for Bureau of Mines Bulletin 207. Price 15 cents.

Petroleum and Allied Substances A7-22. Methods for Testing Petroleum Products. The methods included in this handbook are used officially in the routine testing and inspection of petroleum products bought under Federal specifications. They supersede similar methods published in Bulletins 1 to 5, inclusive, of the Committee on Standardization of Petroleum Specifications. This set of testing methods, known as Bureau of Mines Technical Paper 298, was prepared by the Technical Committee on Standardization of Petroleum Specifications and was adopted by the Interdepartmental Petroleum Specifications Committee, Address the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 10 cents.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Corrosion B4-22. Resistance of Chromium Steels to Acid Corrosion. Tests of the resistance of chromium steels to acid corrosion have recently been completed, and a comparison of the results obtained shows that the relative resistance of a steel to the acid test is not necessarily a criterion of its behavior in other types of corrosion. Pure iron and the steels of low chromium content were found to be much more resistant to attack by hydrochloric acid than those containing considerable chromium. When corroded by water and air, the general order of resistance was reversed. It may be concluded, then, that the addition of chromium increases the rate of attack by hydrochloric and probably by other acids, although this may depend somewhat on the heat treatment which the steel has received. Specimens which had been hardened by suitable heat treatment were found to be considerably more resistant to acid attack than samples of the same composition in the annealed state. The addition of nickel is much more effective in reducing the intensity of the attack by acid than is chromium, since steels containing a considerable amount of this metal were found to be the most resistant to acid of all those tested. Specimens having a polished surface were found, almost invariably, to show a smaller loss in acid than those which were roughly ground.

This difference may be only apparent however, because although the measured surface of two specimens may be exactly the same, the one with a "ground" finish has a slightly greater area exposed on account of the minute grooves and ridges which make up the surface than has the polished specimen. Address Dr. S. W. Stratton, Director, Bureau of Standards, Department of Commerce, Washington, D. C.

Highways B3-22. Recent Developments in the Work of Highway Research. The recent progress in the study of this subject by the Advisory Board on Highway Research is outlined in a four-page pamphlet. Copies of this pamphlet may be secured by addressing the Secretary of the Division of Engineering, National Research Council, 29 West 39th Street, New York.

The subdivisions of the subject discussed are: Design of Stiff Slabs, Materials, Traffic Studies, and Economics. It is also recorded that four new committees of the Advisory Board have been authorized to take up investigations of the following subjects: Highway Finance, Highway Traffic Analysis, Maintenance, and Highway Bridges.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

Hydraulics D1-22. Hydraulic Laboratories in the United States. A Directory of Hydraulic Laboratories in the United States has been compiled under the direction of the Hydraulic Research Committee of the Engineering Foundation, the members of which are J. Waldo Smith, Chief Engineer, Board of Water Supply of the City of New York, and Silas H. Woodard, Consulting Engineer, New York. The book has eighty-four 7 by 10-in. pages and contains information concerning 49 laboratories in engineering colleges, industrial establishments and governmental bureaus. Only statements furnished by the person responsible for the laboratory have been used in each case. Indirectly, this information affords comparison of equipment in the various laboratories and suggests possibilities of greater usefulness in some instances. The information will be helpful to those contemplating the establishment of new laboratories, to persons desiring to have hydraulic tests or experiments performed, and to students choosing schools in which to pursue the study of hydraulic engineering.

Persons desiring copies of the Directory of Hydraulic Laboratories, or more information regarding Engineering Foundation, should address Alfred D. Flinn, Secretary, 29 West 39th Street, New York.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the headquarters of the Society.

Sampling, Coal, Ore, Liquids, etc. F1-22. The Bureau of Mines in its usual thorough way has just completed a bibliography of the literature on sampling. This report was prepared by Messrs. W. J. Sharwood and M. Von Bernewitz and is known by Serial No. 2336; 85 mimeograph pages, 8 by $10^1/_2$ in.

So far as is known, there is no complete bibliography on sampling; this one, therefore, should be of value. In it are nearly eleven hundred references, some dating back 30 years, on sampling at mines, mills, smelters, power plants, pumping stations and refineries. For convenience there are included a few references to methods for sampling such materials as leather belting in mills, salt-impregnated soils, and mine waters. All the important technical journals, including some in foreign countries and engineering society publications, also mining and metallurgical textbooks, have been studied for anything concerning sampling, and while it is not claimed that every important reference has been listed, the bibliography is fairly complete.

The arrangement is alphabetical by authors' names, and the references are numbered serially in the order that they appear in the bibliography. Anonymous references are listed under the name of the journal in which they appear, and are numbered like the references bearing an author's name. Patents are grouped in their numerical order, without index numbers. The report is provided with a subject index. Address H. Foster Bain, Director, Department of the Interior, Bureau of Mines, Washington, D. C.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

The Surge-Tank Problem

To the Editor:

The writer has carefully read an article by Professor Durand appearing in the October, 1921, number of Mechanical Engineering, in which he recommends the construction of models in order to solve surge-tank problems experimentally.

Such problems are so easily, quickly and accurately solved by the process of arithmetic integration that the necessity or desirability of a comparatively expensive model is quite incomprehensible to the writer.

Table 1 shows an example of arithmetic integration as applied to Professor Durand's first illustrative problem. For convenience the value of n is taken as 2 and an instantaneous shutdown is assumed. It is only a little more work to plot a reference curve for friction variation with $n = 1.85$, but there is no practical reason for doing so. The successive computations are made for time intervals of 10 sec. Only three columns of figures are necessary for this work and no figures whatever are used other than those set down.

Table 1

Changing Values of V	Corresponding Values of Y	Δh_f
10.000	7.721	0.00
0.124	7.625	
9.876	15.346	1.30
0.226	7.450	
9.650	22.796	3.60
0.309	7.210	
9.341	30.006	6.40
0.380	6.920	
8.961	36.926	9.85
0.436	6.580	
8.525	43.506	13.70
0.480	6.210	
8.045	49.716	17.70
0.516	5.810	
7.529	55.526	21.70
0.544	5.390	
6.985	60.916	25.60
0.568	4.955	
6.417	65.871	29.42
0.587	4.500	
5.830	70.371	33.03
0.601	4.036	
5.229	74.407	36.36
0.613	3.564	
4.616	77.971	39.35
0.622	3.082	
3.994	81.053	42.03
0.628	2.598	
3.366	83.651	44.33
0.633	2.110	
2.733	85.761	46.27
0.636	1.620	
2.097	87.381	47.80
0.637	1.127	
1.460	88.508	48.94
0.637	0.635	
0.823	89.143	49.66
0.636	0.144	
0.187	89.287	

The time consumed in making this entire computation should not exceed 35 min.

The process should be apparent upon casual inspection, but it may be described as follows: Column 1 denotes velocity in the conduit, column 2 departure of water level upward from its original position, and column 3 the change in the friction loss.

During the first ten seconds the rise in water level of 7.721 is determined by dividing the conduit velocity by the constant 1.295, which is one-tenth of the ratio of the surge-tank area to the conduit area. For non-cylindrical tanks this ratio is simply made variable with respect to Y and read from a previously prepared curve.

In ten seconds' time the velocity in the conduit will change 0.0161 × the retarding head or, say, 0.124 during the first time interval. Subtracting this from the original velocity we have a new velocity of 9.876; dividing this by 1.295 we have 7.625, which added to Y gives the new value of Y as 15.346.

The change in friction from the original velocity to the present one is 1.3 ft., which subtracted from 15.346 gives the new accelerating head; this multiplied again by 0.0161 gives a retardation of 0.226 in the next time interval. This process is continued until the conduit velocity becomes zero, at which time the water has risen 89.287 ft.

The arbitrary unbalancing at the beginning is an inseparable feature of arithmetic integration, and although it is likely to hurt the feelings of pure mathematicians, the error which is initiated is not cumulative but rather is it self-corrective during the subsequent successive computations.

The change in friction can be read directly on a slide rule by squaring the velocity, multiplying by 0.5 and reading backward from 50 ft. on the upper slide. The subtraction of the friction change from the rise in each case need not be carried beyond the second place, and can easily be done mentally and set directly on the slide rule to be multiplied by the constant 0.0161. This example, to be sure, is a simple one, but there is no case too complicated not to be susceptible of the same general treatment.

When demanded loads are considered it is necessary to carry a fourth column denoting draft velocity, and this draft velocity may be made to vary in any conceivable manner, for example, in such a way as to keep the power output constant. Such a study would be in no way more difficult than the one illustrated, but would simply require more time.

7

It will be noted that in using the foregoing method no trial-and-error work is required. The computations are always straightforward, however complicated the problem. If greater accuracy should be required, the time interval could be cut in two, using 5 sec. instead of 10 and doubling the work, but it is hardly likely that the figure 89.287 differs from the true result by as much as three-quarters of one per cent.

The writer has had exceptional opportunities during the past twenty years to observe actual results as compared with such computations as are here presented, and he feels competent to make the unqualified statement that the construction of models for the purpose of solving surge-tank problems is a waste of time and money and cannot possibly lead to results as accurate as those which are easily computed. In fact, once the variation in friction is assumed known, the behavior of the model itself can be readily ascertained by numerical calculation, even for periodic load changes, and with greater accuracy than that with which it can possibly be observed experimentally.

The writer wishes to take particular exception to Professor Durand's fifth enumerated advantage of the model method, and to state the fact that periodic fluctuations of any sort are so assuredly within practical reach of numerical methods that he has found no difficulty in training inexperienced men to do such work. When the differential principle is used, periodic load changes never cause any serious trouble and therefore need no study.

A practically accurate formula for cases similar to the one here illustrated is as follows:

$$N^2 = \frac{6}{3K^2 - \left(2K + \frac{1}{K^2}\right)}$$

where $N^2 = 2gc^2v_2^2F/AL$ and K is the ratio of the total upward surge to the original friction loss, or $K = Y_1/CV_2^2$.

Where the differential principle is used in designing the surge tanks, it is usually unnecessary to resort to the expedient of arithmetic integration.

The direct use of such formulas as are published in the writer's article (Trans. Am.Soc.C.E., 1915) is quite sufficient to work out

accurately an ordinary design. The use of expensive models for the purpose of such solutions would be even more uncalled for, if possible, than in the case of the simple tank studies; furthermore it is difficult for the writer to find any excuse for omitting the differential principle when its use, without exception, produces a cheaper surge tank which will fulfill the same conditions.

For example, in the present instance a differential surge tank only 25 ft. in diameter would cause the water level to rise about the same amount as this 36-ft. simple tank, and it would behave better for the usual requirements of demanded load.

There are so many short cuts available to those who are familiar with the use of the slide rule to assist in arithmetic integration that it is impossible to point them out except in each special case, but they readily occur to most people as practice instructs them. The writer has never found a case too difficult to solve by simple commonsense processes which are available to the mind of any one familiar with Newton's laws of motion. Casting ahead or trial-and-error methods are almost never required. If great refinement is desired the time of a quarter-cycle should be divided into thirty or more parts, but twenty is usually sufficient for practical purposes, as here illustrated.

The interested student may try shorter time intervals. By plotting the final results of several such computations it is easy to find by extrapolation the practical limit where further subdivision of the time gains nothing in accuracy, and this point might well be found in the present case when thirty subdivisions were reached.

By plotting a reference curve between N and K (not N^2) from the formula given, all cases of non-spilling shutdown can be immediately solved with almost no effort, and the results are entirely trustworthy. The derivation of this equation, however, is too long to be set forth in this discussion.

Correction of an Error

The writer wishes to take this opportunity to correct an error of which he was guilty in a paper on the surge tank published in the 1908 A.S.M.E. Transactions.

This error was discovered some six or seven years ago, but inasmuch as no one ever called attention to it, he let it go uncorrected with the thought that where there was not shown a sufficient interest even to discover the mistake, it was probably doing no harm.

Recently, however, it has come to his attention that this old paper, although badly out of date, is still made use of by some engineers, and he therefore believes it worth while to point out what is probably its worst fault.

Reference is therefore made to page 850 of the volume in question, where there appears a formula for the critical size of a simple tank as follows:

$$R = \frac{Khg}{L}$$

As a matter of fact, K is not constant except for cases where C accidentally has the same value, or in other words, K varies with C and is equal to $2C$.

In this form it is known as the Thoma formula and the writer has also derived it independently. It will be observed that the critical value of R is independent of L because C varies directly with L.

New York, N. Y. R. D. Johnson.

Railway and Tramway Wheel Design

To the Editor:

Engineering has, of necessity, been largely a matter of development based on trial-and-error methods, and it has therefore happened that certain details of design or construction have become fashionable (the word is used advisedly) and an engineer must be something of a hero to suggest a departure from what are called standardized methods. Thus in railway practice the idea of keeping the rail joints opposite one another outlived its just life by many years, for as with the use of railway metals of large section and with improved fishplates resilience at the joint was almost eliminated; moreover the use of bogies on fast-traveling trains eliminated the jump that used to be so much feared as the wheels passed over the joints.

In a similar manner coning of the wheel treads was resorted to in some sort of belief that a compensating effect was produced when a pair of wheels, rigidly connected to an axle, passed round a curve; there seems to be a further underlying idea that in some way the coning assists in keeping the vehicle centralized on the track.

Even a cursory investigation of the circumstances of modern rolling stock on a heavy steel railway would reveal the necessity of a reconsideration of the relationship of the wheel and track, yet no one seems to have been bold enough to tackle the problem and obtain the best design of wheel.

The writer does not suggest that there may not be other factors to consider, but would merely point out the enormous loss and disadvantages that arise from the conical form of wheel tread at present in use; these may be summarized as follows:

1 *Loss of Power Due to the Compelling of a Conical Surface to Roll in a Straight Line.* If in an ordinary railway wheel the mean bearing surface of the rail on the flange gives a difference of circumference of 0.86394 in. and this difference has to be accounted for by an acceleration above the normal speed of revolution of the outer bearing line, or an equal retardation of the inner bearing line, of the tread; normally and presumably the difference should be divided, but in any case the skidding of the wheel metal is such as to require the application of 8910.8 ft-lbs. of work per ton per mile, over and above the ordinary effort of traction; and is moreover the circumstance that increases so enormously the starting effort required in rolling stock.

2 *The Wear and Tear Due to the Same Conditions.* The profile of the ordinary rail is such as to give initially a line bearing but it is not very long (two or three months in the case of tramways), before the rails are ground down to the tread profile and thence onward the grinding effort is equivalent to that calculated in (1), moreover in the street tramways the ordinary grind of metal on metal is enhanced by the interposition of street grit, foreign matter between the wheel and rail.

3 *The Elimination of Noise.* The writer was interested in a length of relaid tramway track and was surprised at the absence of noise so long as the wheel ran on the rails with narrow bearings, which was due to the tread of the wheel being straight and the rail top curved; but on reflection it is evident that the grind of steel on steel must necessarily create much of the usual noise associated with tramways and railways.

4 *Corrugation of Rails.* It must be quite obvious that in (comparatively light) resilient tramway rolling stock the chatter due to the slipping of one part of the wheel tread must cause a jump resulting in corrugations, but there must also be a certain synchronism developed due to some local peculiar feature of the track.

It was recently argued that once the rail became worn to the conical profile of the wheel tread, the principles enunciated above would not hold and that the New South Wales Railway Department canted the rails 1 in 20 to compensate for the coning, but geometrically it can be demonstrated that as long as the wheel tread is formed conical nothing will eliminate the disastrous factors enumerated; the best proof however, is to draw a wheel diagram with two treads, the inner one of the larger diameter and the outer one of the smaller diameter, and apply this to a rail stepped with a difference of the two radii, to allow each tread to bear; obviously one or other of the treads must grind.

The fillet of the ordinary wheel design is also a serious loss of power, as what applies to the cone applies equally and to a further extent (proportional to the radii of the similar lines of the fillet curve) to any part of the fillet bearing downward on the rail.

Sydney, N. S. W. F. Ernest Stowe.[1]

To the Editor:

The question raised by Mr. F. E. Stowe on the proper contour of the wheel tread whether initially coned or flat and train resistance loss resulting therein, is a matter worthy of further discussion.

Let us first consider the theoretical loss of energy resulting when perfectly coned wheels are displaced laterally a distance y from their central position and compelled to rotate in a longitudinal direction. If $1/n$ is the taper of the coned wheel and r the mean radius of the

---

[1] Civil and Consulting Engineer; M.I.E. (Aus.); Mem. Am.Soc.M.E.

wheels, then for the radii of the outer and inner wheel tread we have—

$$r_1 = r + \frac{y}{n} \text{ and } r_2 = r - \frac{y}{n}$$

If w = angular velocity of the wheels and v = velocity of translation of the axle, then $v = wr$ and the relative velocity or slippage velocity between tread and rail is—

and $wr_1 - v$ = backward slippage of tread for outer wheel (ft. per sec.)
$v - wr_2$ = forward slippage of tread for inner wheel (ft. per sec.)

Therefore if u is the coefficient of friction and N the normal wheel load, the friction forces at the base of treads are approximately equal to uN (lb.) and act forward on the outer wheel and backward on the inner wheel tread. The loss due to slippage is—

FIG. 1.

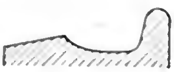


FIG. 2.

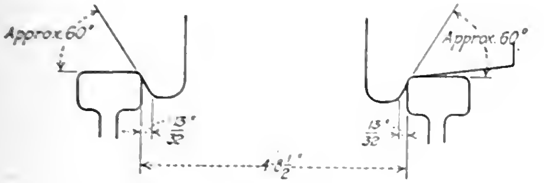


FIG. 3.

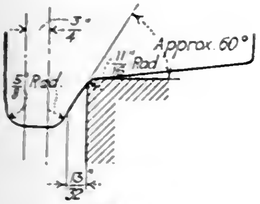


FIG. 4

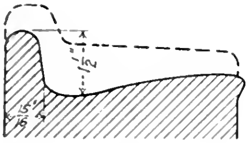


FIG. 5.

$$A_s = uN\left\{(wr_1 - v) + (v - wr_2)\right\} = \frac{2uNwy}{n} \text{ (ft-lb. per sec.)}$$

$$\therefore A_s = \frac{2uNvy}{rn} \text{ (ft-lb. per sec.)}$$

While the maximum possible train resistance per ton, with coefficient of friction $^1/_5$ is—

$$P_s = \frac{400y}{rn} \text{ (lb. per ton), approximately.}$$

The preceding results are based on estimating the relative work of slippage. For a better conception of the reactions involved in this slippage, the following analysis is of interest. Though the frictional forces for the outer and inner wheels at tread base are approximately equal and opposite, they cannot be the same due to the different radii of the treads, and it is due to their resultant differential effect which causes the drawbar resistance required for a given axle. If the wheel is moving with uniform motion, we have no angular acceleration and therefore, if F = total friction at base of outer tread and F' = total friction force at base of inner tread, we have,

$$Fr_1 = F'r_2 \text{ and } F' = \frac{r_1}{r_2}F \text{ (lb.)}$$

The axle resistance exerted at the journal bearings due this cause is—

$$P_s = F' - F = F\left(\frac{r_1 - r_2}{r_2}\right) \text{ (lb.)}$$

and the power loss is—

$$A_s = F\left(\frac{r_1 - r_2}{r_2}\right) v \text{ (ft-lb. per sec.)}$$

As a check, based on the relative work of friction, using the exact friction forces, we likewise have, as before,

$$A_s = F(wr_1 - v) + F'(v - wr_2) = F\left(\frac{r_1 - r_2}{r_2}\right) v \text{ (ft-lb. per sec.)}$$

Obviously these expressions reduce approximately to the values given above.

Fig. 1 shows the tread contour of the M. C. B. standard. The taper at the tread is 1 : 20 and if we assume a total flange play of $^3/_4$ in., $y = 0.375$ in. Hence the maximum train resistance per ton due to cone slippage of a new wheel is—

$$F_s = \frac{400 \times 0.375}{r \times 20} = \frac{7.5}{r} \text{ (lb. per ton)}$$

With an ordinary 36-in. car wheel this amounts to—

F_s = 0.4166 lb. per ton, or to 0.4166 × 5280 = 2200 ft-lb. per ton-mile.

Figure 2 shows the ultimate wear of a tread. From this it is evident that the contour of the tread soon changes from a conical surface to a flat bearing surface. The coning of wheels probably resulted in the early development with the idea of causing the axle to run radially around a given curve. Since the radius of curvature R for a given coning is $(G/2) \times (rn/y)$, where G is the track gage, it is evident that there can be only one curvature for a given theoretical coning. Thus the practical value of coning amounts to allowing a wearing depth for the new wheel, and this alone would seem to justify the continuing of this practice. The losses due to coning with a new wheel are at best relatively small; the maximum possible train resistance for full lateral displacement of the axle not exceeding $^1/_2$ lb. per ton. The average loss, since the mean of the lateral displacements is likely much less, would not probably exceed one-third of this value or $^1/_6$ lb. per ton. Roughly the total train resistance at slow speeds is 5 lb. per ton, therefore the slippage due to the coning of a new wheel is only from 3 to 4 per cent of the total friction and much less at higher speeds. Even assuming a very high coefficient of friction, the slippage due to coning could not account for more than 10 per cent of the total starting resistance.

It is of interest to point out other losses due to the contour of the wheel tread. At high speeds the flange is brought intermittently in contact with the rails first on one side and then on the other and the lateral reaction exerted at the flange is a function of several variables, including the elastic lateral resilience of the rail. Let the mean lateral be Y. With a small obliquity of the wheel, the flange contact takes place at the tread of the wheel. Let r' be the radius of the arc of contact of wheel flange and rail and ϕ the angle to any differential area of contact along the radius r' with respect to the horizontal. Then,

$$P = \int_0^{\pi/2} \frac{upr'd\phi \cos\phi \; r' \; (1 - \sin\phi)}{r}$$

where $p = Y/r$ and u = coefficient of friction. Since the projected bearing pressure in the direction of Y must always equal the actual bearing pressure, therefore

$$P = \frac{uYr'}{r}\int_0^{\pi/2} \cos\phi \; (1 - \sin\phi) \; d\phi = \frac{uYr'}{2r}$$

The reduction of the radius of the fillet tends to increase the depth of flange contact r', and in the wear the mean flange friction increases. Other considerations are a sufficient flange fillet to reduce high local stresses due to large lateral flange reactions. The mean value of the lateral reaction Y on tangent track is very indefinite, but it increases very rapidly with the speed.

Another cause of slippage loss is due to a slight obliquity of the axle when held in the boxes of the frame. Then the peripheral velocity of the wheel makes a small angle θ with the rail tangent. The friction force resulting from this cause in the longitudinal direction is evidently,

$$uW \tan\theta = uW\theta \text{ approx. (lb.)}$$

whereas the work done is—

$$uWv \tan\theta = uW\theta v \text{ (ft-lb. per sec.)}$$

where W is the axle rail load. With poor alignment of axles, this loss may reach appreciable values.

Contour of Wheel Flange and Tread in Practice. Figs. 3 and 4 show the essential contour of a new wheel and Fig. 5 the final wearing limit. We see, therefore, that the tread taper is quite justified in giving additional wearing depth and preventing the wheel after wear from having an excessive reversed taper. The mean life of the tread is actually on a flat surface. With a new wheel for the friction loss to be appreciable with a given coning, we must have a definite lateral displacement. This, however, is prevented, since the throat fillet is brought in contact with the rail and a large lateral reaction is exerted which results in centralizing the axle. With a new wheel and worn rail or with a slight spread of the rails a small lateral displacement is possible, but in the previous discussion the losses shown even in this case are relatively small. Hence the taper is justified in giving a good contour for the tread for average wear.

The dimensions of the flange and the flange fillet are based on wear and strength and proper contour to prevent derailment. For wear and strength a large fillet is desirable, whereas on the other hand too large a fillet will make the slope at the point of tangency to the flange top circle too small. The slope in practice is about 60 deg. and this corresponds to a fillet of radius $^{11}/_{16}$ in. and top flange circle of radius $^{5}/_{8}$ in. in an ordinary car wheel. Such a contour wears to a straight flange with a minimum thickness at root of flange equal to $^{15}/_{16}$ in. and total depth of $1^{1}/_{2}$ in. The value of the lateral flange reaction Y in terms of the normal wheel load N is given by the expression—

$$Y = N\left[\frac{\tan\phi - u}{1 - u\tan\phi}\right] \text{ (lb.)}$$

where ϕ is the slope angle. To show the importance of the slope angle and the coefficient u, the ratios of N/Y are given below:

u	$N/Y = 45°$	$N/Y = 60°$
0.0	1.000	0.577
0.1	1.221	0.718
0.2	1.500	0.874
0.3	1.860	1.058

Thus with an excessive fillet resulting in a low slope, say, 45 deg. the axle load must be roughly 2 × 1.86 = 3.72 times the lateral reaction required to prevent derailment, whereas with a standard wheel with a smaller fillet the axle load required is 2 × 1.058 = 2.116 (min.) times the required lateral reaction. With a smaller fillet the life of the wheel is shortened. It is well to maintain axle loads from 2.5 to 3.0 times the maximum guiding reaction.

In conclusion, it would seem that our standard practice for wheel contour is very much justified from theoretical aspects as well.

Philadelphia, Pa. R. Eksergian.

Second Revision of A.S.M.E. Boiler Code, 1922

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the Society in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be invited and where they may present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

The revisions which have met the approval of the Boiler Code Committee are here published. It is the request of the Committee that these revisions be fully and freely discussed so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

The revisions here published are limited to the paragraphs appearing in the 1918 Edition of the A.S.M.E. Boiler Code, and the paragraph numbers refer to the paragraphs of similar number in that edition. For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

Par. 194 Revised:

194 *Domes.* THE REQUIREMENTS OF PARS. 187 AND 188 SHALL APPLY TO RIVETED LONGITUDINAL JOINTS OF DOMES EXCEPT THAT FOR DOMES 24 IN. AND LESS IN DIAMETER FOR PRESSURES EXCEEDING 100 LB., THE LONGITUDINAL JOINTS MAY BE LAPRIVETED IF THE FACTOR OF SAFETY IS NOT LESS THAN 8. [The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction, irrespective of pressure. When the maximum allowable working pressure exceeds 100 lb. per sq. in., the flange of a dome 24 in. or over in diameter shall be double-riveted to the boiler shell.]

THE FLANGE OF A DOME 24 IN. OR OVER IN DIAMETER SHALL BE DOUBLE-RIVETED TO THE BOILER SHELL. WHERE THE FLANGE OF THE DOME IS USED FOR REINFORCING OR ATTACHING IT TO THE SHELL, THE DIAMETER OF THE DOME SHALL NOT EXCEED ONE-HALF THE DIAMETER OF THE SHELL OR BARREL OF THE BOILER. [The longitudinal joint of a dome less than 24 in. in diameter may be of the lap type, and its flange may be single-riveted to the boiler shell provided the maximum allowable working pressure on such a dome is computed with a factor of safety of not less than 8.]

The dome may be located on the barrel or over the fire-box on traction, portable or stationary boilers of the locomotive type. [Up to and including 48 in. barrel diameter. For larger barrel diameters, the dome shall be placed on the barrel.]

Flanges of domes shall be formed with a corner radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plates for plates over 1 in. in thickness.

Par. 244 Revised:

244 The thickness of a corrugated or ribbed furnace shall be ascertained by actual measurement BY THE FURNACE MANUFACTURER BY GAGING THE THICKNESS OF THE CORRUGATED PORTIONS. IF A HOLE IS DRILLED THROUGH THE SHEET TO DETERMINE THE THICKNESS IT SHALL BE $^{3}/_{8}$ IN. WHEN THE FURNACE IS INSTALLED THE HOLE SHALL BE LOCATED BENEATH THE BOTTOM OF THE GRATE AND CLOSED BY A PLUG. The furnace shall be drilled for a $^{1}/_{4}$-in. pipe tap and fitted with a screw plug that can be removed for the purpose of measurement. For the Brown and Purves furnaces, the holes shall be in the center of the second flat; for the Morison, Fox and other similar types, in the center of the top corrugation, at least as far in as the fourth corrugation from the end of the furnace.

Par. 251 Revised:

251 After drilling or reaming rivet holes the plates and butt straps OF LONGITUDINAL JOINTS shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

Par. 265 Change Center Heading Above This Paragraph to:

WASHOUT [holes] OPENINGS

Par. 287 Revised:

287 When the valve body is marked [with the letters A.S.M.E. Std.] as required by Par. 273, this shall be a guarantee by the manu-

---

Note: Matter deleted, in smaller type; matter added, in small capitals.

facturer that the valve conforms to the details of construction herein specified.

Par. 294 Revised:

294 Each boiler shall have three or more gage cocks, located within the range of the visible length of the water glass, except when such boiler has two water glasses with independent connections to the boiler and located on the same horizontal line and not less than 2 ft. apart. LOCOMOTIVE-TYPE BOILERS NOT OVER 36 IN. IN DIAMETER NEED HAVE BUT TWO GAGE COCKS.

Par. 303 Revised:

303 When two or more boilers HAVING MANHOLE OPENINGS are connected to a common steam main, two stop valves, with an ample free-blow drain between them, shall be placed in the steam connection between each boiler and the steam main. The discharge of this drain valve must be visible to the operator while manipulating the valve. The stop valves shall consist preferably of one automatic non-return valve (set next the boiler) and a second valve of the outside-screw and yoke type; or, two valves of the outside screw and yoke type may be used.

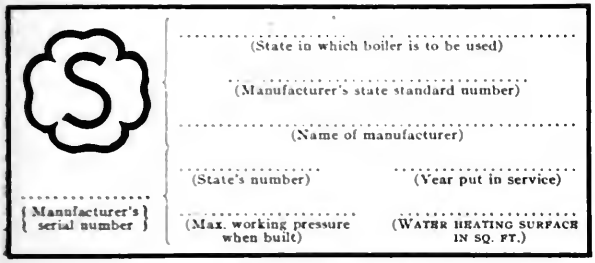


Fig. 24 Form of Stamping

Par. 315 Revised:

315 In a horizontal [return] tubular EXTERNALLY FIRED FIRE-TUBE boiler the feedwater shall discharge ABOVE THE CENTER ROW OF TUBES at about three-fifths the length from the front head (except a horizontal [return] tubular boiler equipped with an auxiliary feed-water heating and circulating device), above the central rows of tubes OR FLUES, when the diameter of the boiler exceeds 36 in. The feed pipe shall be carried through the FRONT head or shell [near the front end] in the manner specified for a surface blow-off in Par. 307, and be securely fastened inside the shell above the tubes.

In THESE AND other types of boilers where both internal and external pipes making a continuous passage are employed, the boiler bushing or its equivalent shall be used.

In Fig. 22 is illustrated a typical form of flange for use on boiler shells for passing through piping such as feed, surface, blow-off connections, etc., and which permits of the pipes being screwed in solid from both sides in addition to the reinforcing of the opening in the shell.

Par. 318 Revised:

A BOILER HAVING MORE THAN 500 SQ. FT. OF WATER-HEATING SURFACE SHALL HAVE AT LEAST TWO MEANS OF FEEDING, ONE OF WHICH SHALL BE A PUMP, INSPIRATOR OR INJECTOR. WHERE A SOURCE OF FEED IS AVAILABLE AT A SUFFICIENT PRESSURE TO FEED THE BOILER AGAINST A PRESSURE 6 PER CENT HIGHER THAN THAT AT WHICH THE SAFETY VALVE IS SET TO BLOW, THIS MAY BE CONSIDERED ONE OF THE MEANS. [When a pump, inspirator or injector is required to supply feedwater to a boiler plant of over 50 h.p., more than one such appliance shall be provided.]

Par. 332 Change Tabulation at End of Paragraph and Form of Stamping as Follows:

1 Manufacturer's serial number
2 State in which boiler is to be used
3 Manufacturer's state standard number
4 Name of manufacturer
5 State's number
6 Year put in service
7 Maximum working pressure when built
8 WATER HEATING SURFACE IN SQ. FT.

Items 1, 2, 3, 4, 7 AND 8 are to be stamped at the shop where built. Items 5 and 6 are to be stamped by the proper authority at point of installation.

PAINT PROTECTION FOR WOOD

(*Continued from page 520*)

that rubs off the layer of rust and exposes the nail to continuous corrosion. The working also abrades the wood and leaves the familiar large, rust-stained hole around an attenuated nail. The same conditions apply to the bolts and other steel fastenings in farm machinery, wagons, motor-truck bodies, and a long list of other articles. It is of vast importance in wood construction, therefore, that we have paints to protect the wood from absorbing moisture. Ordinary paint does not effectively do this except when a large number of coats is applied, and so far as the writer has been able to find out, there has been little or no attempt to produce a paint that will do it.

In the realm of house painting there seems to be a great possibility for economies, either by the use of cheaper paints which will give the necessary protection, or by the use of paints which will last longer. The writer is not familiar enough with this subject to warrant any comments other than to refer to Dr. A. H. Sabin's letter to the *Engineering News-Record* of August 18, 1921, in which he states that even the Pennsylvania Railroad is not always able to protect itself in the matter of paints, and he asks what chance the ordinary citizen has to check up on the paint he should use to protect the house that very possibly represents his life's savings. Paint literature of a technical nature is of no assistance to the average man, and is quite inadequate to explain the why and wherefore of much present practice. Great differences of opinion and some vague reasoning appear. Many contentions seem to be based on a desire to use certain materials or formulas, rather than on comparative service data of a reliable sort. Such men as Dr. Sabin of the National Lead Co., and Dr. Holly of Acme White Lead and Color Works, made frank acknowledgment of the shortcomings of paint technology and totally disavow any detail information concerning the effect of paints on moisture-proofing the cell structure of woods of various kinds. The Engineering Foundation has approved the desirability of this research and has appointed a committee to report ways and means of furthering it. This is a most substantial endorsement. The Society of Automotive Engineers and the American Institute of Architects have also approved and will lend their support.

It would seem that an intimate knowledge of wood cell structure is essential to any investigation of this subject. The Forest Products Laboratory is by all odds our most authoritative source of information on woods and their structure. The Director and his staff have been interviewed and fully agree that this research would be productive of important results, some of which could be expected in the course of 8 to 12 months; also that it can be handled there if funds in a very modest amount, between $10,000 and $20,000 per year, were made available for, say, from five to ten years. The Bureau of Standards has a paint division and has funds to work on the paint end of the research. Doubtless a coöperative arrangement could be made between these two of the most capable and helpful arms of our governmental service. Doubtless, too, the technical heads in the paint and varnish trade would place at the disposal of the Bureau of Standards and the Forest Products Laboratory their great fund of knowledge of paints and oils. Many of these men are already working on this problem, as has been set forth above; but they are handicapped by a lack of intimate knowledge of the various kinds of woods, and they are very much limited both in the time they can give and in the range of materials which they can test.

There is a crying need for such information, and inside of a year after the work is started a considerable amount of usable data should be forthcoming. The difference between the insignificant cost of the research and its value to the country at large is so vast that the writer believes it is only necessary to call attention to the matter in order to institute a widespread demand for action.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie
Ralph E. Flanders John T. Wilkin
O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions

Standardization

The subject of standardizaton is now receiving much attention in all lines of industry and in all countries. Needless to say, such a universal question has many sides, and many varying and differing opinions are held as to the nature and extent of proper standardization. A very unusual and striking address on this subject was given recently by Mr. Albert W. Whitney, Chairman of the American Engineering Standards Committee before the National Construction Conference at Chicago. After pointing out the misconception that standardization will tend towards a world reduced to sameness, he continues:

> The difficulty will disappear if we realize three things about standardization: first that it does not belong with the vanguard, it comes along in the rear just ahead of the commissary department; second it is not exclusive, it does not attempt to pick out the one best, it picks out instead, many that are good; and third its judgments are not final but tentative and ever open to revision.
>
> In the march of progress the way is led by the visionaries, those who get the first gleam of the idea, the prophets, the artists, and the inventors; their heads are in the clouds but their feet are not always on the ground and so they have to be followed by minor prophets and minor artists and minor inventors who can capture the idea and tame it; then comes an army of critics and exploiters and executives, and at last the idea is put to work. But it doesn't work smoothly; the prophets and minor prophets and even the executives, who ought to know better, have left the ground in confusion. The good ideas are lost among a litter of impossible ideas, half-baked ideas, and ideas in every stage of futility. Somebody must come along and clear up, save what is good and throw the rest into the discard. This is the humble job of the standardizer.

This outline of the work of the standardizer will not be accepted universally. For one thing, it is not the duty of standardization to throw anything into the discard. Any given standard, to achieve its object, must meet the conditions of service in the majority of cases as well as, or better, than any other construction or practice would meet them. Yet after this is accomplished, exceptional conditions arise which no standard will meet properly. Every published standard might properly be prefaced with the remark, "Exceptional cases require special consideration." Thus many of the practices and constructions which are not suitable for general use, fill their own peculiar niche. On the other hand, the promulgation of logical standards will develop practice along unified lines, thus eliminating by an evolutionary process many slightly dissimilar ones.

Also, standardization deals with more concrete things than ideas. A large number of similar practices or constructions must be in general use before a need or demand for standardization exists.

Mr. Whitney goes on to describe the effects of standardization upon the processes of production and distribution.

> When deep thinkers and all their class find themselves free of the confusion created by the very fertility and multiplicity of their own ideas, they find that they can turn over the whole subject to a still more minor caste, those who look after routine. For instead of designing a truss or a belt or a generator or a fire-escape, the engineer has now only to specify a certain standard type or certain standard features that have already been worked out and the detail can then be left to subordinates.
>
> Now the prime importance of this upon progress is partly the acceleration and economy and convenience and efficiency that has therefore been produced, but to an equal degree it is due to the fact that the attention and energy of those who are on the frontier of knowledge has been set free for still further forays into the unknown.

Many machine designers object to the use of standard parts and constructions because they claim it robs them of initiative and originality. As a matter of fact, standardization in this field can never cover more than the relatively unimportant details. The use of standards, therefore, instead of hindering them, will free them from this minor detail and give them much more time and effort for creative work.

> With the thought well established then that standardization, if properly applied, not only does not interfere with the initiative and spiritual freedom upon which art and progress must depend, but is the very soil upon which they grow, may I now direct your attention to the wonderful things that this soil can produce.
>
> The result of throwing processes into the field of routine that have heretofore required explicit mental effort not only sets free this mental effort for other purposes, but makes possible mass-production; and indeed mass-production is impossible without standardization. In the opinion of Mr. Hoover and other students of industry, greater mass-production is necessary under our present post-war conditions if we are to maintain our standard of living and if we are to compete successfully with European industry. The relation between standardization and economy and efficiency in production is too plain to require further consideration.
>
> We may definitely make up our minds that we are beyond the era of the craftsman as respects the basic elements of our individual life. The era of machinery, if its peculiar genius is to be developed, leads us to standardization and mass-production. We still need the craftsman, but his place has been moved on into the field of finer values. It is the underlying basic elements of industry that I am discussing; in this field standardization, simplification, and mass-production must be developed to the greatest possible extent.

Exception may be taken to the statement that we are beyond the era of the craftsman. This may be due to the particular meaning that Mr. Whitney attached to this term. To my mind, the term "craftsman" has a peculiar significance. It implies not merely manual skill but also pride and interest in the work of the hands. It is true that in the productive departments of plants engaged in mass-production specialists rather than general mechanics are needed. Nevertheless there is great need of craftsmen among these specialists. No labor is so elementary that the spirit of craftsmanship is not needed for the best results.

> We are inclined to feel that the benefits of standardization apply mainly in the field of production. This is not so. They are quite as important both in the field of selling and of buying.
>
> The carrying in stock of the wide variety of sizes and grades that have grown up in a given field under the influence of the blind forces of demand, however casual, and competition, however misguided, has not only tied up an immense amount of capital but has taxed storage facilities and slowed up delivery. It is on record that an agricultural-implement house has recently been unable to make delivery of three carloads of wagons in spite of the fact that it had 12,000 wagons in stock. It is not too much to say that in most lines of business the variety that is found in stocks could be cut down to one-tenth of what it now is and serve perfectly well all reasonable demands. But it is the buyer quite as much as the producer and distributor that profit by standardization. The ordinary buyer is not an expert and he is therefore very largely at the mercy of the seller. He is not able to form an independent judgment of the quality and value of the goods that are for sale and he must therefore either buy in the dark or he must follow the advice of the seller. But if goods are standardized and marked so that they can be identified, it is possible for the buyer to familiarize himself with these standard lines, particularly if the unnecessary variety has been eliminated. He thus becomes an intelligent buyer; his purchases have greater utility and his discrimination reacts favorably upon the distributor and producer.
>
> And now having given you a very sketchy picture of the possibilities of standardization, I will tell you something about the agencies that are engaged in bringing it about.
>
> Unquestionably the most significant and promising event in the recent development of the standardization movement has been the entrance into the field of the Department of Commerce through the Division of Simplified Practice, newly organized by Secretary Hoover and in charge of Mr. W. A. Durgin, recently of the Commonwealth Edison Company of Chicago.

> The other outstanding factors in the situation are doubtless the Bureau of Standards, which for years has done such fine fundamental work, the U. S. Chamber of Commerce, Division of Fabricated Production, which has been active in arousing interest among trade organizations; and the American Engineering Standards Committee; although there are a multitude of other bodies which are taking an important interest in the movement.
>
> When a standard is approved by the American Engineering Standards Committee, it becomes known as an American Standard or as a Tentative American Standard and through no mandatory process, but because of the standing and representative character of the American Engineering Standards Committee, such standards become to a considerable extent adopted by industry and the Government. The American Engineering Standards Committee has approved nineteen standards and has sixty two other projects under way.

No standard is ever widely adopted because of the standing or representative character of the body which promulgates it. In the final analysis, a standard is adopted or rejected on its own intrinsic merits. The character of the body which issues them has much to do with their early trial, but their final acceptance depends entirely upon their worth.

Earle Buckingham.

Southern Appalachian Water Power Conference Establishes Permanent Organization

At a meeting held in Asheville, N. C., June 20 to 22, 1922, a permanent Southern Appalachian Water Power Conference was established to study the water-power resources of the Southern Appalachian region and their relation to industrial growth and navigation. Joseph Hyde Pratt, director of the North Carolina State Geological Survey was elected as the first president. The other officers are Lincoln Green, vice-president of the Southern Railway, vice-president; J. A. Switzer, secretary; and Professor Thorndyke Saville of the University of North Carolina, assistant secretary and treasurer. All the states south of the Ohio and Potomac rivers and east of the Mississippi are to be gathered into this Conference.

O. C. Merrill, secretary of the Federal Power Commission, presided over the Conference Sessions at which the speakers stressed the importance of basic information about stream flow, rainfall, etc., in order to hasten the development of water power with its resulting effect on the future of industry and transportation.

Charles E. Waddell of Asheville, N. C., in a communication to Secretary Rice of the A.S.M.E., emphasized the remarkable interest shown by the body of public-utility executives and engineers who gathered to discuss the subject of Southern Appalachian Water-Power Resources.

American Construction Council Organizes

Under the initial chairmanship of Secretary of Commerce Herbert Hoover, the American Construction Council was formally organized in Washington, D. C., on June 19, 1922. More than 200 men, representing 54 associations interested in the construction industry, attended the meeting.

The purpose of the Council is to place the construction industry on a high plane of integrity and efficiency and to correlate the efforts toward betterment through a conference association, representative of the whole industry and dedicated to the improvement of the service which the construction industry renders. It has included in its organization all the elements of industry, each with voting power. There are eleven groups: architects, engineers, general contractors, sub-contractors, construction labor, manufacturers, dealers, financial, bond and insurance interests, public utility construction departments, construction departments of federal, state and municipal governments, and building exchanges. Each group has four representatives on the executive board.

In his address at the opening session Chairman Hoover said that he believed the Council would help to stabilize the industry and eliminate undue speculation. He characterized the movement as one of the most important steps taken in the history of the industry. Walter Gordon Merritt, speaking on Determining the Proper Relations between the Several Elements of the Construction Industry, said that the Council must function so that constant coöperation between employer and employee must replace the "periodic armistices" which are now the history of their relations. He declared that the trouble with the industry now is due not to lack of organization but to organization with selfish motives. The Council must replace selfishness by a sense of responsibility to the public.

The second day of the meeting was taken up with discussion of what the Council might do to further the aims of the several groups. Committees were appointed on: code of ethics, seasonal unemployment, apprenticeship, building codes, transportation rates, publicity, simplification, standardization and waste elimination, and methods to be pursued in gathering statistics.

In discussing the finances of the organization, it was freely expressed that the Council would not be living up to its opportunities if in three years its annual budget was less than $250,000. No conclusion on the method of financing, other than by dues, was reached.

Upon the adjournment of the meeting the executive board went into session and elected Franklin D. Roosevelt, formerly Assistant Secretary of the Navy, president, and John B. Larner, president of the Washington Loan & Trust Co. and vice-president of the American Bankers' Association, treasurer.

Calvert Townley, Past-President of the American Institute of Electrical Engineers, spoke at the opening session, representing the engineering profession. The executive board members of the engineers' group are: C. T. Main, Boston; B. J. Arnold, Chicago; Peter Junkersfeld, New York; and C. F. Loweth, Chicago.

Engineering Council Takes Up Forest Conservation

It is self-evident that the preservation of forests is vital to future hydroelectric development as well as to the timber supply, soil conservation and flood retardation. These are all of importance to our civilization and of extreme interest to engineers. The American Engineering Council has a committee which will investigate conditions and take suitable action looking toward proper state and national legislation for forest preservation. This committee consists of Charles H. MacDowell of Chicago, chairman, S. H. McCrory of the Departmant of Agriculture, Washington, D. C., W. H. Hoyt of Duluth, Minn., and J. C. Ralston of Spokane, Wash.

The committee is investigating forestry conditions in all the states and has already received reports of the existing situation together with recommendations of the state forestry for measures of relief in what is described as "a critical period" in the development of a national policy of reforestation. Many of these recommendations center on fire prevention, development of nurseries, roadside tree planting, the supplying of proper stock for state and private reforestation, encouraging private reforestation through elimination of excessive taxes, new planting on public lands not suitable for tillage, whether federal or state owned, support of certain forestry bills now in Congress, and the encouragement of reforestation by coöperation between federal and state authorities.

France Awards Dr. A. E. Kennelly Cross of Legion of Honor

For distinguished services rendered as exchange professor in engineering to the French Republic, the Cross of the Legion of Honor has recently been awarded to Dr. A. E. Kennelly, professor of electrical engineering at Harvard University and the Massachusetts Institute of Technology. This honor may be conferred for meritorious service to the French Republic in military or civil life.

Dr. Kennelly was the first exchange professor sent to France from America under the scheme of regular annual exchange of professors in engineering and applied science, inaugurated last fall between the French University Administration and seven American institutions. The French representative in America, Professor J. Cavalier, rector of the University of Toulouse, and an authority on metallurgical chemistry, has recently returned to France after a year spent at the seven coöperating institutions, Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Pennsylvania and Yale.

The award of the Cross of the Legion of Honor to Dr. Kennelly is an indication of the success of the scheme for an exchange professorship in engineering. The undertaking will undoubtedly increase the mutual understanding between French and American engineers, and have a broadening effect on the profession.

NEWS OF OTHER SOCIETIES

American Society for Testing Materials

Thirty-five standing committees of the American Society for Testing Materials, all of which had been at work during the year revising present specifications and formulating new ones, presented reports at the twenty-fifth annual meeting of the Society held in Atlantic City June 26–30. Study of materials and test methods, for the first time in the history of the Society, took preference over specification work. The most important single item of the program so far as this new phase of activity is concerned was two sessions in which impact testing of materials and fatigue phenomena were discussed. The papers and discussions brought out the fact that there is not available as much definite information on impact testing as is desirable, and the Society plans to remedy this deficiency by making a thorough study of the subject in the future.

Sessions were held on Non-ferrous Metals and Corrosion, Steel, and Wrought, Gray and Malleable Iron. At the latter session revised specifications for foundry pig iron and for chilled cast iron were suggested by Committee A-3 of which Richard Moldenke, a member of the A.S.M.E., is chairman.

The newly elected President, G. K. Burgess, in his address said that the executive committee is considering ways and means of further circulating the Proceedings of the Society in foreign countries so that the American standards may become more generally known. An indication of the extent to which the standards are used in this country is shown by the fact that last year $18,000 worth of the Society's literature was sold.

The annual golf tournament was won by F. G. Breyer and the tennis tournament by R. W. Seabury. Officers elected in addition to the President, Mr. Burgess, are W. H. Walker, Vice-president, and W. K. Hatt, J. R. Onderdonk, D. M. Buck, and W. M. Corse, new members of the Executive Committee.

American Railway Association

The third annual meeting of the American Railway Association was held in Atlantic City June 14–21. The Mechanical Division held its sessions during the first three days. Reports were presented on the cost of labor and materials, arbitration, tank cars, loading rules, train lighting and equipment, car construction, couplers and draft gears, brake-shoe and break-beam equipment, train-brake and signal equipment, and car wheels.

The exhibition this year was one of the largest ever attempted by the Railway Supply Manufacturers' Association. In addition to machine tools and shop equipment, practically all kinds of railway equipment were exhibited, from complete locomotives and cars to the small devices used in the construction of railway rolling stock. There were in all about 350 exhibitors and 100,000 square feet devoted to exhibit space.

The attendance was large and representative of the membership of the division, which comprises the former Master Car Builders and Master Mechanics Associations. Headquarters were at the Marlborough-Blenheim Hotel, where the technical sessions were held.

American Foundrymen's Association

The twenty-sixth annual convention and exhibition of the American Foundrymen's Association, held in Rochester, N. Y., June 5 to 9, marked an epoch in the history of the Association in that it presented the first specially planned international session. Representatives of the foundry associations of Great Britain, France and Belgium took part in the session, which was a signal success. The feature among the technical papers at this meeting was the exchange paper from a member of the British Foundrymen entitled American Versus British Cast Iron, by F. J. Cook, Rudge-Littley, Ltd., Birmingham, Eng., Past-President of the Institute of British Foundrymen.

Two sessions were held on steel-foundry subjects and eleven papers and reports were presented. Interesting sessions were held on gray-iron topics, malleable iron and molding sand, industrial relations, and four sessions on non-ferrous matters were held as joint meetings with the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers which was holding a concurrent meeting.

The attendance and registration at both the technical sessions and exhibition were large, having been exceeded on only two previous occasions. The exhibition, although not the largest, was one of the most representative ever held. There were 173 exhibitors and the compact arrangement and the impression of unity were favorable factors. The exhibition was held in Exposition Park, not far from the buildings in which the technical sessions were held.

Officers elected for next year include C. R. Messinger, President; G. H. Clamer, Vice-president; and C. B. Connelley, Fred Erb, L. W. Olson and A. B. Root, Jr., Directors.

Society of Automotive Engineers

The semi-annual meeting of the Society of Automotive Engineers was held at White Sulphur Springs, West Va., June 20 to 24. A feature of the meeting was the report from a sub-committee on methods of numbering cars and engines so that obliteration or change of the numbers would be impossible without easy detection. The committee had had samples made up to test several of the most promising suggestions, but admitted that it had been somewhat surprised by the ease with which all of them had been beaten by the Underwriter's Laboratories.

At the meeting of the Standards Committee, reports were presented from the following divisions: Agricultural Power Equipment, Axle and Wheel, Electrical Equipment, Engine, Iron and Steel, Lighting, Non-ferrous Metals, Parts and Fittings, Passenger-car Body, Screw Threads, Springs and Stationary Engines. Special sessions were devoted to research, passenger cars, fuels and engines, aeronautics and motor buses. Mechanical problems were considered in papers by G. E. A. Hallett on Methods of Developing Aircraft Engines; by P. M. Held on Overhead Camshaft Passenger-Car Engines; and by H. M. Crane on A New System of Spring Suspension for Automotive Vehicles.

Considerable interest was aroused by a message from Secretary of Commerce Hoover offering the aid of his Division of Simplified Practice to the S. A. E. in securing the adoption of their standards. The message was presented by R. M. Hudson, of the Division. The report of the research director of the Society, Dr. H. C. Dickinson, was another of the interesting features of the meeting.

American Institute of Electrical Engineers

The thirty-eighth annual convention of the American Institute of Electrical Engineers was held at Niagara Falls June 26–30. The opportunity to visit and inspect the vast industrial developments which are operated by the power of Niagara Falls proved a lure to electrical engineers, and the attendance recorded, 950, was far in excess of expectations.

The address of welcome was delivered by A. Munro Grier, president of the Canadian Niagara Power Co., at the opening general session. A. P. M. Fleming addressed the Convention, representing the Institute of Electrical Engineers of Great Britain and the British National Committee of the International Electrotechnical Commission and the British Electrical Standards Association.

More than thirty technical papers, dealing with many phases of electrical engineering, were presented at the sessions, and discussion of these papers proved a valuable part of the Convention. Tuesday afternoon was devoted to a series of papers on the Queenton hydroelectric plant. Wednesday afternoon, set aside for a visit to the plant which contains the largest hydroelectric units ever built, was one of the high spots of the week. On Thursday morning a group of eight papers relating to cable insulation were presented, and Thursday evening was given over to a symposium on engineering education.

The officers of the Institute for next year are: President, F. B. Jewett of New York; Vice-Presidents, G. Faccioli, of Pittsfield, Mass., Prof. W. I. Slichter, of Columbia University, R. F. Schuchardt, of Chicago, H. W. Eales, of St. Louis, and H. T. Plumb of Salt Lake City; Managers, H. M. Hobart, of Schenectady, N. Y., Ernest Lunn of Chicago and G. L. Knight of Brooklyn. George A. Hamilton of Elizabeth, N. J., was reëlected Treasurer and F. L. Hutchinson of New York, Secretary.

John Fritz Medal for 1922 Awarded Senator Marconi

Wireless Inventor Receives Signal Honor before Distinguished Audience

BEFORE the largest gathering ever assembled on a similar occasion, the John Fritz Medal was presented to Senator Guglielmo Marconi on Thursday evening, July 6, at the Engineering Societies Building in New York City. The presentation of this Medal for 1922 attracted the interest of press and public in this and other countries, and the decision of the John Fritz Medal Board of Award in singling out the great Italian as medallist for his invention of wireless telegraphy has met with popular approval. The occasion of the formal conferring of the Medal was convincing evidence of the significance and influence of engineering in international affairs.

Previous to the presentation ceremonies, Senator Marconi was the guest of the Board of Award at a dinner at the Engineers' Club. Arrangements for the meeting were made by Prof. Comfort A. Adams of Harvard University, and Charles F. Rand of New York, chairman and secretary, respectively, of the John Fritz Medal Board of Award. Professor Adams presided at the meeting and read messages from other medallists, distinguished engineers and public men of America and Europe. The speakers included James R. Sheffield, prominent New York lawyer and president of the Union League Club; Michael I. Pupin, professor of electromechanics at Columbia University and famous for his inventions in the wireless art; and Elihu Thomson, former medallist, who presented the Medal to Marconi.


Underwood and Underwood

SENATOR GUGLIELMO MARCONI

Accepting the Medal, Senator Marconi said:

"I am extremely grateful for the very kind and flattering remarks which have been made in regard to myself and my work by the distinguished gentlemen who have been good enough to speak here tonight. It is indeed a great distinction and encouragement to further efforts, being received as I am, I may say, invariably received in this great country, and to meet here amongst my friends those who represent the best intellect in science and applied science as exemplified in the persons composing the great national engineering societies of America.

"I have long realized that in America more than anywhere else the most cordial and generous encouragement is given to any honest endeavor to apply science to useful and practical purposes.

"I consider myself fortunate that much of my early work in radio has been carried out in this country, for I cannot help feeling that you realize that wireless communication has become useful and often necessary on sea and on land, besides tending to increase and simplify the facilities for closer communications between distant peoples on this earth, thus contributing, I hope, to make goodwill take the place of the unrest and mutual suspicion which unfortunately seems at present to be a dominating feeling amongst the nations.

"It is a great honor for me to be admitted, through your award, to the ranks of the eminent men upon whom the John Fritz Medal has been bestowed. I beg to express my very high appreciation of this honor, and to offer my most grateful thanks for the distinction thus conferred upon me."

Senator Marconi is the nineteenth recipient of the John Fritz Medal. The award was established in 1902 as a memorial to the great engineer and metallurgist whose name it bears, and is presented for notable achievement in applied science. The Medal Fund was contributed by friends of Mr. Fritz and its administration was assigned to the Four National Engineering Societies.

The first award of the Medal was made to John Fritz on his eightieth birthday in 1902. Since that time eighteen awards have been made to men of the very highest distinction in the engineering profession. They include: Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Charles T. Porter, Alfred Noble, Sir William Henry White, Robert W. Hunt, John Edison Sweet, James Douglas, Elihu Thomson, Henry M. Howe, J. Waldo Smith, George W. Goethals, Orville Wright, Sir Robert A. Hadfield, Charles Prosper Eugene Schneider, and Guglielmo Marconi.

Four of the former medallists were present at the ceremonies in honor of Marconi. They were Dr. Elihu Thomson, prolific inventor in the field of applied electricity, Dr. J. Waldo Smith, who solved the problem of supplying New York City with water, Gen. George W. Goethals, builder of the Panama Canal, and Dr. Orville Wright, who with his brother Wilbur developed the first successful aeroplane. Attention was called to the presence of these four distinguished guests by the Chairman, and they were loudly acclaimed by the audience.

Professor Adams read messages of regret from Vice-president Coolidge, Herbert Hoover, Thomas Edison, Guido Sabetta, Charge d'Affairs of Italy at Washington, Sir Robert Hadfield of London, and Eugene Schneider of Paris.

The speakers of the evening dwelt upon different aspects of Marconi's life work and its meaning to human society. Mr. Sheffield pictured the personal side of the inventor, outlining his early life, his struggles and his ultimate triumph. He declared, "What Galileo was to his age, what Newton was to the law of gravitation, what Morse was to the telegraph, Bell to the telephone and Westinghouse to the airbrake, Marconi has been and is to the development of the wireless. His name will ever be linked to this most elusive, most fascinating and most marvelous of all modern achievements—the science and the art of miraculous radio."

Professor Pupin said: "No poet or philosopher of today would be sufficiently daring to predict with any degree of accuracy the future expansion of this new science. Preparations are now being made to transmit articulate speech from the new world to the old; these preparations will end in a great success, I am sure, and after this success who will deny the possibility that before many years have passed the word spoken in this great engineering hall will be heard in every other engineering hall on the face of the globe?....This will be the growth from the seed which Senator Marconi dropped into a fertile field."

The meeting was regarded among engineers as a forward step in developing and promoting closer relations between Italy and America and advancing the general idea of a world engineering union.

Proposed Standard for Malleable-Iron Screwed Fittings

Historical

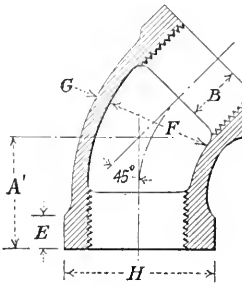
The Sectional Committee on the Standardization of Pipe Flanges and Fittings, which is sponsored by the Committee of Manufacturers on Standardization of Fittings and Valves, the Heating & Piping Contractors National Association, and The American Society of Mechanical Engineers, has completed the preliminary report reproduced below and desires now to submit it to Industry for general review and criticism.

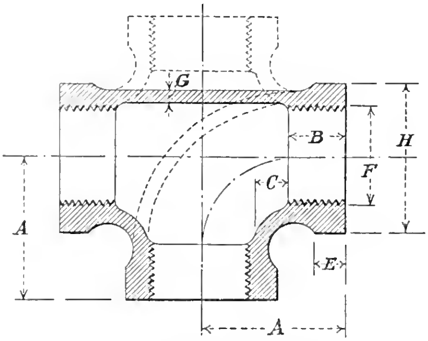
At the beginning of the committee's investigation a good deal of effort was directed toward the setting up of a standard for 150-lb.

DIMENSIONS OF STRAIGHT FITTINGS (INCHES)

	SIZE		1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8
A	CENTER TO END - ELLS, TEES & CROSSES		0.69	0.81	0.95	1.12	1.31	1.50	1.75	1.94	2.25	2.70	3.08	3.42	3.79	4.13	4.50	5.13		
A′	CENTER TO END - 45 DEG ELLS		0.68	0.73	0.80	0.88	0.98	1.12	1.29	1.43	1.68	1.95	2.17	2.39	2.61	2.83	3.05	3.46		
B	LENGTH OF THREAD - MINIMUM		0.25	0.32	0.36	0.43	0.50	0.58	0.67	0.70	0.75	0.92	0.98	1.03	1.08	1.13	1.18	1.28	1.43	1.47
C	TAP CLEARANCES ELLS, TEES & CROSSES		0.237	0.220	0.252	0.270	0.285	0.262	0.250	0.290	0.322	0.340	0.350	0.390	0.460	0.500	0.539	0.538		
D	$\frac{\text{O D OF PIPE}}{2}$		0.203	0.270	0.338	0.420	0.525	0.658	0.830	0.950	1.188	1.437	1.750	2.000	2.250	2.500	2.781	3.312	3.812	4.312
E	WIDTH OF BAND - MINIMUM		0.200	0.215	0.230	0.249	0.273	0.302	0.341	0.368	0.422	0.478	0.548	0.604	0.661	0.717	0.780	0.900	1.012	1.125
F	INSIDE DIAMETER	MINIMUM	0.405	0.540	0.675	0.840	1.05	1.315	1.660	1.900	2.375	2.875	3.500	4.000	4.500	5.000	5.563	6.625	7.625	8.625
		MAXIMUM*	0.435	0.584	0.719	0.897	1.107	1.335	1.730	1.970	2.445	2.975	3.600	4.100	4.600	5.10	5.663	6.725	7.725	8.725
G	THICKNESS - MINIMUM		0.090	0.095	0.100	0.105	0.120	0.134	0.145	0.155	0.173	0.210	0.231	0.248	0.265	0.281	0.300	0.336	0.370	0.403
H	OUTSIDE DIAM. OF BAND - MINIMUM		0.693	0.844	1.015	1.197	1.458	1.771	2.153	2.427	2.963	3.589	4.285	4.843	5.401	5.955	6.583	7.767	8.883	9.995

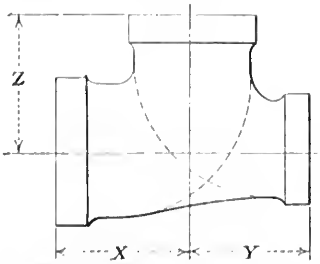
* MAXIMUM DIAMETER EQUALS OUTSIDE DIAMETER OF PIPE PLUS ONE DEPTH OF THREAD





CENTER TO END DIMENSIONS OF REDUCING FITTINGS (INCHES)

		READ "CENTER" OUTLET															
	SIZE	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6
READ "END" OUTLET	1/8	0.69	0.76	0.85	0.93	1.03	1.17	1.34	1.47	1.69	2.04	2.33	2.58	2.85	3.19	3.47	4.00
	1/4	0.74	0.81	0.90	0.98	1.08	1.22	1.39	1.52	1.74	2.09	2.38	2.63	2.90	3.24	3.52	4.05
	3/8	0.81	0.88	0.95	1.03	1.13	1.27	1.44	1.57	1.79	2.14	2.43	2.68	2.95	3.29	3.57	4.10
	1/2	0.90	0.97	1.04	1.12	1.22	1.36	1.53	1.66	1.88	2.23	2.52	2.77	3.04	3.38	3.66	4.19
	3/4	0.98	1.05	1.12	1.20	1.31	1.45	1.62	1.75	1.97	2.32	2.61	2.86	3.13	3.47	3.75	4.28
	1	1.04	1.11	1.18	1.26	1.37	1.50	1.67	1.80	2.02	2.37	2.66	2.91	3.18	3.52	3.80	4.33
	1 1/4	1.12	1.19	1.26	1.34	1.45	1.58	1.75	1.88	2.10	2.45	2.74	2.99	3.26	3.60	3.88	4.41
	1 1/2	1.19	1.26	1.33	1.41	1.52	1.65	1.82	1.94	2.16	2.51	2.80	3.05	3.32	3.66	3.94	4.47
	2	1.27	1.34	1.41	1.49	1.60	1.73	1.90	2.02	2.25	2.60	2.89	3.14	3.41	3.75	4.03	4.56
	2 1/2	1.41	1.48	1.55	1.63	1.74	1.87	2.04	2.16	2.39	2.70	2.99	3.24	3.51	3.85	4.13	4.66
	3	1.54	1.61	1.68	1.76	1.87	2.00	2.17	2.29	2.52	2.83	3.08	3.33	3.60	3.94	4.22	4.75
	3 1/2	1.64	1.71	1.78	1.86	1.97	2.10	2.27	2.39	2.62	2.93	3.18	3.42	3.69	4.03	4.31	4.84
	4	1.76	1.83	1.90	1.98	2.09	2.22	2.39	2.51	2.74	3.05	3.30	3.54	3.79	4.13	4.41	4.94
	4 1/2	1.82	1.89	1.96	2.07	2.18	2.31	2.48	2.60	2.83	3.14	3.39	3.63	3.88	4.13	4.41	4.94
	5	1.94	2.01	2.08	2.19	2.30	2.43	2.60	2.72	2.95	3.26	3.51	3.75	4.00	4.25	4.50	5.03
	6	2.10	2.17	2.24	2.32	2.43	2.56	2.73	2.85	3.08	3.39	3.64	3.88	4.13	4.38	4.63	5.13



Proposed American Standard for Crosses, Tees, 90 Deg. and 45 Deg. Ells, Both Straight and Reducing, for 150-Lb. Working-Steam Pressure

---

Note: To illustrate the use of the Table for Reducing Fittings, let it be assumed that the Center to End Dimensions of a 6 x 4 x 5 Tee are required: Then for X dimension read opposite 6 and under 5 = 4.63 in. Then for Y dimension read opposite 4 and under 5 = 4.41 in. For Z* dimension read opposite 5 and under 6 = 5.03 in. Dimension Z is determined by using largest run opening.

malleable screwed fittings, in which each dimension should bear a definite relation either to the outside diameter of pipe, or to the American Standard Pipe thread elements, or to a combination of both. This scheme as contemplated would produce a fitting shorter and lighter than a majority of those in common use. Considerable progress was made along this line of effort, and no doubt a satisfactory line of fittings might have been arrived at in this way. Fittings so designed, however, would not "line up," some sizes being considerably shorter than customarily made. It was, therefore, feared that they would be criticised by consumers and would be objectionable from the manufacturers' standpoint in that they could only be tapped with the American thread.

For these reasons it became the unanimous opinion of the members of the committee that the standard fitting should not depart greatly from those in common use and should be of such dimensions that the castings could be tapped with either American threads or with other commonly used pipe threads (British) without change in cores and without interference of tools.

Descriptive

The above schedule of dimensions fulfills these requirements. Fittings made to this schedule will have dimensions equal to or greater than the minimum dimensions contained in the British Engineering Standards Association Report C. A. (M) 1637, and will have the following outstanding features:

1 Can be tapped either British or American Standard pipe thread both as to gage and length of threads in all sizes except the $2^{1}/_{2}$-in. which can be tapped American Standard pipe thread only, British $2^{1}/_{2}$-in. pipe being 3-in. O. D. whereas American pipe is only 2.875 in. O. D.

2 In casting the cores can be made from the same coreboxes for both malleable- and cast-iron fittings thus reducing the investment necessary for the production of a line of malleable- and cast-iron fittings.

3 Will not depart materially from dimensions of fittings already produced by some manufacturers which have demonstrated excellent appearance and serviceability

4 Can be varied in thickness of wall and size of bead, from the minimum which is considered the lightest advisable for the service for which they are recommended to any weight found necessary by any manufacturer, as the exigencies of his foundry and shop practice may require and still conform to the standard.

Engineering and Industrial Standardization

Safety Code for Conveyors and Conveying Machinery under Way

An important step toward the solution of an accident problem has just been accomplished through the decision of the American Engineering Standards Committee that the development of a Safety Code for Conveyors and Conveying Machinery be undertaken.

The introduction of mechanical conveyors in many industries has eliminated a large proportion of the accidents resulting from the manual handling of materials, but it has at the same time introduced new hazards, many of which can be prevented by a more general agreement among both users and manufacturers of conveying equipment as to safe practices in the manufacture, installation, and operation of such equipment.

The American Society of Mechanical Engineers and the National Bureau of Casualty and Surety Underwriters have been appointed joint sponsors for this code. All interested national organizations will be asked to coöperate in the formulation of the code. This code, the American Engineering Standards Committee announces, will be intended as a guide for the safe operation and maintenance of conveyors and conveying machinery coming under the following main divisions: gravity, belt, chain, flight bucket, apron, screw and jigging conveyors, car hauls, aerial cableways, overhead trolley, and pneumatic tubes.

All shafting, pulleys, belts, link belts, chains, gears, sprockets, couplings, clutches, etc., used on and in connection with conveyors and conveying machinery will be covered in the Mechanical Power Transmission Code now in preparation.

Big Standardization Program Proposed for Electric Railway Field

A standardization program of considerable importance to the iron and steel, lumber, electrical, construction, chemical, railway and railway-supply industries is presented in the submission by the American Electric Railway Association of 13 standards for approval by the American Engineering Standards Committee.

The specifications submitted to the A.E.S.C. follow:

For Approval as American Standards

9-in. Girder Grooved Rail
7-in. Girder Grooved Rail
9-in. Girder Guard Rail
7-in. Girder Guard Rail
Joint Plates for 7-in. Girder Grooved and Girder Guard Rails
Joint Plates for 9-in. Girder Grooved and Girder Guard Rails
Specification for Galvanizing or Sheradizing on Iron and Steel

For Approval as Tentative American Standards

7-in. 80-lb. Plain Girder Rail
7-in. 91-lb. Plain Girder Rail

For Approval as Recommended American Practice

Specification for Materials for use in the Manufacture of Special Track Work
Specification for 600-Volt Direct-Current Overhead-Trolley Construction.

Four special committees will be appointed by the American Engineering Standards Committee to determine whether the A.E.R.A. specifications are the standards which should be adopted for universal use in the United States; the Committee's decision will, of course, be predicated on its finding as to the desirability of national standardization of the products enumerated. The principal organizations concerned will be asked to name representatives on these special committees.

One special committee will be asked to conduct the investigation with respect to the acceptability to the industry of the specification for 600-volt direct-current overhead-trolley construction; another committee will conduct the investigation concerning the specifications for wood poles and tubular poles; a separate committee will study the specifications for galvanizing or sherardizing on iron and steel; and a fourth committee will go into the subjects of the remaining nine related specifications. The findings of these committees will be reported to the American Engineering Standards Committee as soon as the investigations are completed.

Meanwhile, the American Engineering Standards Committee requests the technical press, industrial associations, and technical bodies interested in these specifications to send to its headquarters at 29 West 39th Street, New York City, any available information as to the extent to which these specifications are meeting the needs of the industries concerned.

In submitting these standards, J. W. Welsh, executive secretary of A.E.R.A. wrote to the American Engineering Standards Committee as follows: "The committees in which the various specifications were prepared have been composed of men chosen for known experience and ability, and include electric-railway operating and construction engineers, producers and consulting engineers."

Colors for Traffic Signals to be Standardized

The day is not far off when red, green and yellow, when used as traffic signals, will each have its distinctive meaning and this meaning will be uniform all over the country, according to the decisions reached at the first fully representative conference ever held on the subject in this country. When that day arrives the annual toll of deaths and serious injuries resulting from traffic

accidents will be reduced by the elimination of accidents caused by the confusion or misunderstanding of signals.

This conference on the standardization of colors for traffic signals was recently held in New York under the auspices of the American Engineering Standards Committee. There were present representatives of practically all of the big national engineering societies, safety associations, electric- and steam-railway interests, automobile dealers, manufacturers' and users' associations, police and traffic departments, insurance companies, and several departments of the federal government.

The conference agreed unanimously "that there should be national uniformity in the use of colors for signals" and that the detailed technical work involved in bringing about such uniformity should be carried out by a thoroughly representative sectional committee under the auspices and procedure of the American Engineering Standards Committee. Included in the scope of the work as defined were the following:

- The use of colored lights on all highway vehicles
- Their use on all signals along highways and at curbs, both permanent and temporary
- Their use for highway-crossing signals or steam and electric railways
- A coördinated relation of color, form, position and number of signals
- A coördinated relation to systems of flashing, moving or other similar lights
- Colors for non-luminous as distinguished from luminous signals
- Recommendations on the use of colors for emergency exit signals
- Methods of specifying or defining colors for signals purposes
- Any other closely related matters which, in the opinion of the sectional committee, form a part of the subject to be considered

Mr. A. H. Rudd, on behalf of the American Railway Association, presented a paper in which were summarized the general facts of the situation affecting the steam railroads, and suggested lines along which they would like to see standardization progress. While signal systems of different railroads differ in some respects, fundamentals are largely standardized. For the operation of trains these include: red for danger (stop); yellow for caution; and green for clear.

A paper by Mr. H. B. Flowers gave the experience of the American Electric Railway Association. The standard use for signals in electric-railroad practice is: red for stop; yellow for proceed with caution; and green for proceed at schedule speed. Blue, purple and white are also used in a restricted way, for conveying special information or for safe-guarding special conditions.

A suggestion that yellow light be used in place of red for the tail light of automobiles brought forth spirited discussion during which Mr. Alden L. McMurtry of the Department of Vehicles of Connecticut said: "It is very easy to place the entire responsibility for automobile accidents on the automobile driver while, as a matter of fact, the responsibility for conditions which exist rest not merely on the motorist, but also on the pedestrian and upon the steam and electric railways.

"Pedestrians often cause automobile accidents by ignoring traffic rules. Watchmen are not always at grade crossings when the signs say they should be there; and grade-crossing gates are, at times, down for considerable periods when trains are not going through. National uniformity in colors for traffic signals is extremely desirable, but if major changes are to be made, as for example, a change in the color of tail lights for automobiles, it would take at least two years to get such changes into operation because legislation would be required in most states."

On the motion of Dr. M. G. Lloyd of the U. S. Bureau of Standards, a resolution was adopted declaring it to be the sense of the conference that any sectional committee of the A.E.S.C. which takes up the standardization of colors for signals should endeavor to coördinate such standardization with existing standards for traffic purposes, such as those used in water and aerial navigation and on steam and electric railways.

The conference did not advocate the substitution of green for red as a danger signal, as was erroneously reported in certain of the daily papers through a misinterpretation of discussion at the conference. On the contrary, the ideas expressed at the conference were emphatically that red should be used to indicate danger and for no other purpose. In conformity therewith, it was suggested that green be substituted for red as the color for lights for emergency exits of public buildings as indicating paths that lead to safety.

No final technical decisions were reached at the conference, these being left to be worked out in detail by a thoroughly representative sectional committee.

C. Russ Richards Welcomed at Lehigh University

C. Russ Richards, Mem. Am.Soc.M.E., president-elect of Lehigh University, was given a "welcome dinner" by the alumni of that institution in the University Commons on Friday evening June 9. Dr. Richards was introduced to this new constituency by William C. Dickerman, Mem. Am.Soc.M.E., an alumni member of Lehigh's Board of Trustees. In a felicitous address Mr. Dickerman described the two-years' successful search for a man who could unite faculty, alumni, student body and trustees. Dr. Richards was given a great "hand" when he rose to respond. He modestly stated that he had not had time nor opportunity to formulate any hard-and-fast policy or plan. He intimated that any reorganization would grow up out of conferences and after a painstaking ascertainment of the existing situation.

Dr. Richards excited the sympathy of all present by referring to Seth Low's definition of a college president as one "who gives and receives pain." He then sketched out in frank fashion his own faith as to the essentials of a technical education, especially as to the importance of thoroughness and the personal touch between student and teacher. He said that he did not want an enrollment in Lehigh much above what it was, 1,000, but would rather have it an outstanding institution of its class in which a breadth of knowledge and an understanding of men would be given recognition alongside of the more technical studies. He protested against undue specialization at the expense of breadth of education and pleaded for a study of the problems of life and of men. He believed that engineers should stand between labor on the one hand and the employer on the other and that there is less importance in what we teach than in how we teach it. After expressing the hope that the library could be much enlarged and saying that he intended to stress research he closed with an eloquent appeal for educational experiments, neither radical nor revolutionary, in order to develop a system which would train for leadership.

Dr. Richards will be the sixth president of Lehigh University, Drs. Copper, Leavitt, Lamberton, Drown and Drinker preceding him. He is the second engineer in the line. Dr. Drown was a mining engineer, Dr. Leavitt a minister, Drs. Copper and Lamberton learned in belles lettres, while Dr. Drinker was a lawyer. Dr. Richards will finish out the present academic year as Dean of the School of Engineering at the University of Illinois, and take up his new duties in South Bethlehem on September 1.—M. L. C.

Dr. W. H. Maw Elected President, Institution of Civil Engineers

Dr. William Henry Maw, Past-President of the Institution of Mechanical Engineers, Past-President of the Royal Astronomical Society, Fellow of the Royal Geographical Society, and member of the A.S.M.E., has been elected President of the Institution of Civil Engineers of Great Britain.

Dr. Maw has been a joint editor of London *Engineering* since 1866, and it is largely due to his editorial policies through over half a century that this paper has received world wide recognition as a leader in the field of engineering journalism.

Dr. Maw received his early engineering training as a railroad engineer in the Works of the Great Eastern Railway. He served notably in the War, being a member of the Advisory Panel of the Munitions Inventions Department in the British Ministry of Munitions. He is the author of several books on engineering subjects, including railroad and marine engineering, and of astronomical papers. He was a member of the Royal Commission for the St. Louis Exposition in 1904. Dr. Maw is a veteran engineer. He was born in 1838, and has been a member of the A.S.M.E. since 1913.

LIBRARY NOTES AND BOOK REVIEWS

L'Azote. By Louis Hackspill. Masson et Cie; Gauthier Villars et Cie, Paris, 1922. (Encyclopédie Léauté.) Paper, 5×8 in., 271 pp., illus. 14 fr.

As a member of military commissions of chemical control in Germany, the author acquired an intimate knowledge of the nitrogen industry and had an opportunity to study thoroughly the commercial plants at first hand. His book deals with the different processes, giving the history of each and describing the reactions and apparatus used. The various processes are also compared critically from the economic point of view.

Building Contracts. By Edwin J. Evans. E. P. Dutton & Co., New York, 1922. (Directly useful technical series.) Cloth, 6×9 in., 304 pp. $5.

A book on business management for contractors, dealing with the various matters that chiefly affect the administration of a contractor's business, and giving suggestions as to the best means of mobilizing and organizing the available forces for the financial and constructional success of the work. Adapted to conditions and practices of the building trade in England, but may be suggestive in this country.

Coal. By Elwood S. Moore. John Wiley & Sons, Inc., New York, 1922. Cloth, 6×9 in., 462 pp., illus., maps, tables, $5.

Prepared to satisfy the demand for a convenient modern summary of the voluminous scattered literature on coal. Covers quite fully such topics as the properties, origin, uses and general distribution of coal, while discussing only in a more general way such subjects as mining machinery and the details of distribution and character of local deposits.

Dynamics of the Aeroplane. By René Devillers. Translated by W. J. Walker. New impression. Lond., E. & F. N. Spon., Ltd., London, 1922. Cloth, 6×9 in., 302 pp., 15s.

The author's investigation is concerned with the effects upon the equilibrium of an airplane of the movement of its center of gravity and that about its center of gravity; or in other words of the different paths of flight and of its stability. The theoretical considerations are considered and the mathematical formulas evolved, but the principal aim has been to condense experimental results into simple technical form which the engineer can put to immediate use. All current formulas have been reduced to nomographic form, the book being, according to the translator, the first in English to adopt that method throughout.

Electric-Power Systems. By William T. Taylor. Sir Isaac Pitman & Sons, Ltd., London and New York, 1922. (Pitman's technical primer series.) Cloth, 4 × 6 in., 107 pp., $0.85.

This little book is an extremely brief introductory statement of the main technical facts and principles governing modern practice in the larger electric power systems. General circuit conditions are considered; the most important methods and problems in generation, transmission and distribution practice are explained; and special attention is paid to system operation, to the various "system factors" used, and to the importance of keeping reliable operating records.

Essai D'Optique sur la Gradation de la Lumiere. By Pierre Bouguer. Gauthier-Villars et Cie, Paris, 1921. (Les maitres de la pensée scientifique.) Paper, 5×7 in., 129 pp., 3fr.

This classic of the literature of optics is an account of Bouguer's study of certain important optical problems connected with the radiation of light and its absorption by various substances. It is the work which first set forth the basis of photometry, and led to the invention of the photometer by the author in 1748. The present edition reproduces the original text of 1729.

Industrial Fatigue and Efficiency. By H. M. Vernon. E. P. Dutton & Co., New York, 1921. Cloth, 6×9 in., 264 pp., tables, $5.

The author, who is an investigator for the Industrial Fatigue Research Board of Great Britain, presents a fairly complete account of our present knowledge concerning industrial fatigue and its influence on efficiency. The information adduced relates only to shop practice, as laboratory investigations have not, in the author's opinion, afforded much evidence of practical value.

Introduction to Electrodynamics. By Leigh Page. Ginn & Co. Boston and New York, 1922. Cloth, 6×8 in., 131 pp., $2.

The object of this book is to present a logical development of electromagnetic theory founded upon the principle of relativity. So far as the author is aware, the universal procedure has been to base the electrodynamic equations on the experiments of Coulomb, Ampère and Faraday, even books on the principle of relativity going no farther than to show that these equations are covariant for the Lorentz-Einstein transformation. As the dependence of electromagnetism on the relativity principle is more intimate than this covariance suggests, he believes it more logical to derive the electromagnetic equations directly from this principle. The book covers topics appropriate for a one-year graduate course in electrodynamics and electromagnetic theory of light. It should interest those who are looking for a logical rather than a historical account of the science.

General Economic Geology. By William Harvey Emmons. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 516 pp., illus., $4.

This volume is an introduction to the study of mineral deposits, for use by students with a knowledge of the elements of general geology and mineralogy. It embraces the geology of mineral fuels, structural materials and other non-metals, and of the metals. The first chapter includes introductory matter, definitions and an outline of the classification of mineral deposits. It is followed by a treatment of coal, petroleum and the solid bitumens. Then follows a more detailed discussion of the classification and genesis of mineral deposits, which is succeeded by sections on non-metals and metals. Numerous footnotes call attention to the principal sources of information on each topic.

La Matiere et l'Energie selon la Theorie de la Relativite et la Theorie des Quanta. By Louis Rougier. New edition, revised and enlarged. Gauthier-Villars & Co., Paris, 1921. Paper, 7×10 in., 112 pp., 9.50 francs.

This book calls attention to the most paradoxical and least discussed consequence of the principle of relativity, that which attributes mass, weight and structure to energy. What we call matter thus becomes only a particular case of energy. The old duality of ponderable and imponderable makes way for that of the electro-magnetic field or *energy*, of which radiation and matter are simple modalities, and of the field of gravitation of *space* as defined by Einstein. Professor Rougier presents these theories in this work.

Metal Cutting Tools. By A. L. De Leeuw. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 328 pp., illus., diagrams, $3.

The book is intended to bring before the reader the principles that must be applied in selecting, designing, maintaining and, especially, in using metal-cutting tools. It is intended for engineers, foremen, time-setters and mechanics. But slight use is made of mathematics, and mathematical knowledge is not essential for an understanding of most subjects considered.

Maschinenuntersuchungen und das Verhalten der Maschinen im Betriebe. By A. Gramberg. Second edition, revised and enlarged. J. Springer, Berlin, 1921. Cloth, 6×9 in., 681 pp., illus.

Volume two of the author's treatise on methods for testing machines, the first volume of which is devoted to measuring apparatus. This volume discusses methods of testing and the behavior of machines while running. The subjects treated include boiler tests, fuel tests, heat conductivity, steam turbines and reciprocating

engines, exhaust steam utilization, internal combustion engines, pumping machinery, blowers, air compressors and refrigerating machines. A section is devoted to regulation and governing. An introductory section discusses the economic and legal aspects of tests. The work is intended to assist in the selection of proper tests, to describe correct tests and to indicate how the results of costly tests can be fully analyzed.

Mechanical Stokers. By Joseph G. Worker and Thomas A. Peebles First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth 6×9 in., 258 pp., illus., tables, diagrams, $3.

Although stokers are treated in books on boilers and power-plant equipment, there has been no work treating the stokers as a separate unit until the appearance of the present volume. It treats the phenomena of combustion in relation to stokers, describes mechanical stokers and modern practice in stoker installation and use, and discusses the selection of stokers for different fuels and differing conditions. The authors have endeavored to give reliable unbiased opinions and facts from field experience in design, installation and operation.

Modern Gas Tractor. By Victor W. Page. Fourth edition, revised and enlarged. The Norman W. Henley Publishing Co., New York, 1922. Cloth, 5×7 in., 590 pp., illus., diagrams, $3.

The object of the author has been to present the principles of design in a simple manner and to show how these principles have been followed in various types of construction, so that the advantages of the various methods may be intelligently analyzed by the average farmer and mechanic. The book is intended to assist in the selection of the best mechanism for individual requirements. Chapters on maintenance and repair are included.

Notes Economiques D'un Metallurgiste. By Camille Cavallier. Gauthier-Villars et Cie, Paris, 1921. Paper, 6×9 in., 153 pp., 3 fr. 50.

These brief economic discussions, by a French iron manufacturer, treat various present problems of French industry, particularly metallurgy. Such questions as the comparison between the foreign trade of France and Germany, the participation of manufacturers in national affairs and the relations of the heads of enterprises with capital and labor are treated, and the causes of and remedies for the present economic crisis are discussed in the light of long experience in industry.

Organic Chemistry. By Victor von Richter. Vol. II. Chemistry of the carbocyclic compounds. P. Blakiston's Son & Co., Philadelphia, 1922. Cloth, 6×9 in., 760 pp., $8.

After an interval of six years since the appearance of volume one, the second volume of this translation, dealing with the carbocyclic or closed carbon chain compounds, is now available. The translation follows the 11th German edition, prepared in 1912. The outstanding feature of this work is the large number of compounds listed, with outlines of the methods for preparing them and accounts of their important properties. No other book of its size gives such an exhaustive list. Because of this comprehensiveness, the book is most useful for reference, particularly when the large encyclopedias are not accessible.

Principles of Electrical Engineering. By William H. Timbie and Vannevar Bush. John Wiley & Sons, Inc., New York, 1922. Cloth, 5×8 in., 513 pp., illus., $4.

This textbook, written for students of college grade, with a knowledge of calculus and physics, aims to provide a substantial first course in the subject which will present rigorously, yet in understandable form, the basic principles underlying modern electrical engineering, to be followed by detailed courses in direct and alternating current machinery. Special features are the stressing of the subject of the magnetic circuit; the use of the electron theory as a basis for explanation; the inclusion of the subjects of thermionic omission, conduction through gases, electrolytic conduction and high-frequency phenomena; a novel approach to the subject of the behavior of dielectrics and numerous live problems.

Principles of Mechanical Refrigeration. By H. J. Macintire. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×8 in., 252 pp., illus., diagrams, $2.50.

Based on a "study course" of twenty articles published in *Power* during 1920. The book is intended to cover the entire field of refrigeration in an elementary manner, with little use of mathematics. Analogies to steam machinery and steam cycles are used to explain the action of refrigeration.

Steam Power Plant Auxiliaries and Accessories. Terrell Croft, editor. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×8 in., 447 pp., diagrams, illus., $3.

This book is intended to give data that will assist the power-plant engineer to select proper auxiliary equipment and install, operate and maintain it so that preventable losses will be kept as low as possible and power will be generated at the least cost. The subjects treated include pumps, boiler-feeding apparatus, feed-water heaters, economizers, condensers, cooling ponds and towers, steam piping, steam separators and steam traps. The treatment is simple, non-mathematical and descriptive.

Steel Foundry. By John Howe Hall. Second edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 334 pp., illus., diagrams, tables, $4.

Mr. Hall's object has been to set forth the metallurgy of the steel foundry from the point of view of the engineer interested in prescribing the cheapest means of producing objects of sufficient excellence for the purposes for which they are intended. His book considers the classes of steel castings in demand today and their characteristics from a manufacturing point of view; the types of steel-making processes in use and the characteristics that govern the selection of one or another for making the sort of castings desired; and shop procedure in the light of its influence on quality and cost. The revision has introduced new data on electric-furnace practice, on molding sands, heat treatment and other phases of foundry practice.

Thermal Stresses in Chilled Iron Car Wheels. By G. K. Burgess and R. W. Woodward. Government Printing Office, Washington, 1922. (Technologic papers of the Bureau of Standards, No. 209. Paper, 7×10 in., 34 pp., plates, diagrams, $0.05.

Describes a method for testing car wheels under conditions nearly like those encountered in descending long grades, and gives the results obtained from a series of tests. Twenty-eight wheels of varying weight and design were tested, sixteen of which cracked in the plate. The tests suggest the possibility of improving the design of these wheels.

COMPOUNDING THE COMBUSTION ENGINE

(Continued from page 527)

he believes they will serve to mark a definite turning point in combustion-engine construction. Meanwhile he agrees with the discussion that it is to be regretted that he did not have the performance, say, the fuel consumption, of a larger than 7-in. cylinder to base reports on when the paper was written. Larger engines are, however, usually better than smaller engines and certainly much better than minute engines in this regard. The smallness of the 7-in. cylinder has been referred to several times, but let us examine the performance of this little engine. It has given 0.302 and 0.305 lb. of 16 to 22 Baumé fuel per indicated horsepower-hour in spite of the fact that it has all the imperfections of an experimental engine. This the author does not hesitate to submit as being a fairly good performance for this size of machine, being about the same as that recently reported on the *William Penn* engines with their ponderous $29^{1}/_{8}$-in. cylinders. Entirely unnecessary wire drawing exists at two points in this engine, which was found to rise to larger proportions than was expected and has been eliminated in later designs. Other than this, the mechanical losses in this engine are extremely low, as referred to in the paper.

To those who profess to see no virtue in compounding, it may be said that if the thermal units were being excessively absorbed by the chilled walls or are going astray in the many ways claimed by such critics, they most emphatically would never reach the indicator. This, the author feels, is a more complete answer to the various points raised than is sometimes realized.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Mines. An Inventory of Results of Accident Prevention, C. A. Allen. Trans. Amer. Inst. Min. & Met. Engrs. issued with Min. & Metallurgy, May 1922, no. 1135 M, 9 pp., 8 figs. Facts and figures in effort to reduce fatalities in Utah.

ACETYLENE

Generating Plant. Acetylene Generator, Messer & Co. Type (Überflur-Azetylenentwickler, Bauart Messer & Co.). Zeit. für komprimierte u. flüssige Gase, vol. 22, no. 2, 1922, pp. 17–21, 3 figs. Detailed description. Freedom from risk, automatic charging of carbide, its complete gasification.

AERONAUTICAL INSTRUMENTS

Operation Recorders. Showing An Aviator How He Flies. Aviation, vol. 12, no. 23, June 5, 1922, pp. 658, 659, 2 figs. Three special instruments developed by N.A.C.A. for accurately recording aviator's operations and performance of aeroplane in flight. See also Aerial Age, vol. 15, no. 11, May 22, 1922, p. 249.

AERONAUTICS

Aerial Laws and Safety Survey. Aerial Laws and Survey of Safety in Flight Urged by Aeronautical Chamber of Commerce. Aerial Age Weekly, vol. 15, no. 11, May 22, 1922, pp. 246–247. Report of Aeronautical Chamber of Commerce points out meager capital, insufficient terminal facilities, popular doubt as to reliability, and need of aerial code, as hindrances to development.

AIR COMPRESSORS

Foundry. The Compressor for Foundry Purposes. Compressed Air Mag., vol. 27, no. 6, June 1922, pp. 159–161, 5 figs. Lubricating system, method of regulation, air receiver and aftercooler have much influence upon operation of pneumatic devices.

AIR FILTERS

Visco. A New Form of Air Filter. Engineer, vol. 133, no. 3456, Mar. 24, 1922, pp. 339–340, 2 figs. Describes Visco air filter, in which filtering medium consists of an innumerable mass of short rings cut from very thin coppered steel tubing, coated with film of mineral oil termed Viscinol. See also Elec. Rev., vol. 90, no. 2321, May 19, 1922, p. 717.

AIR PUMPS

"Delas" Air Extractor. Tests of a "Delas" Air Extractor. Elec. Ry. & Tramway Jl., vol. 46, no. 1130, May 12, 1922, pp. 205, 207–208, 3 figs. Results of test on Delas air extractor, manufactured by Société Condenseurs Delas, with regard to its use in reducing steam consumption.

AIRCRAFT

Commercial. More Business at Less Cost Marks Commercial Aircraft Growth. Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1165–1173. Survey of operations in U. S. Practical utility definitely demonstrated. Expansion averages about 20 per cent.

Performance Testing. Performance Testing of Aircraft, T. M. Barlow. Aeronautical Jl., vol. 26, no. 137, May 1922, pp. 152–176, 21 figs. Outline of method carried out in England with special reference to routine at R.A.F. Aeroplane Experimental Establishment, Martlesham Heath.

Power Requirements of. Some Power Requirements of Aircraft, D. Roesch. Armour Engr., vol. 13, no. 4, May 1922, pp. 223–234, 7 figs. General discussion, with special reference to helicopter.

Radio Antennae. Radio Antennae of Aerial Vehicles (Sulle antenne radiotelegrafiche dei veicoli aerei), Algeri Marino. Elettrotecnica, vol. 9, no. 11, Apr. 15, 1922, pp. 242–247, 6 figs. Discusses differences from terrestrial antennae.

AIRPLANE ENGINES

Bavarian Motor Works 185-Hp. Performance of B.M.W. 185-Horsepower Airplane Engine, S. W. Sparrow. Nat. Advisory Committee for Aeronautics, Report no. 135, 1922, 10 pp., 22 figs. Deals with test made in altitude chamber of Bur. of Standards upon a Bavarian Motor Works engine, having six water-cooled cylinders with bore of 5.90 in., stroke of 7.09 in., and compression ratio of 6.7.

Bristol "Lucifer," 100 Hp. The 100 Hp. Bristol "Lucifer" Passes its Type-Tests. Flight, vol. 14, no. 19, May 11, 1922, pp. 267–268, 2 figs. Description of tests showing fine performance of this air-cooled engine.

Design. Aeronautical Engines, Their Evolution and Actual Tendencies (Les moteurs d'aviation, évolution, tendances actuelles), Martinot-Lagarde. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 134, no. 3, Mar. 1922, pp. 187–222, 23 figs. Commercial and military engines; characteristics of aeronautical engines, their mechanical construction, efficiency; engines for high altitudes; supercharging; etc.

Efficiency. Useful Work of High-Speed Explosion Engines (Het nuttig effect der moderne snelloopende explosiemotoren), I. Bauly. Ingenieur, vol. 37, no. 13, Apr. 1, 1922, pp. 244–257, 7 figs. Review of literature by engineer of Dutch Aeronautical Service, discussing useful mechanical work, useful thermic effect, fuels and combustion, heat balance of aero engines, etc.

Estimating Performance in Flight. Method for Estimating Power and Fuel Consumption of Normal Compression Aviation Engines in Flight at Various Altitudes. Air Service Information Circular, vol. 4, no. 317, Mar. 15, 1922, 6 pp. Object of report is to furnish standard method for estimating performance.

Starters, Buzzer. Fifty-Hour Endurance Flight Test of Auxiliary Starting Device (Buzzer Starter) for the Liberty Engine. Air Service Information Circular, vol. 4, no. 302, Feb. 15, 1922, 1 p., 1 fig. Results of test to determine durability of "buzzer" starter in actual flight service.

AIRPLANE PROPELLERS

Deformation During Flight. Determination of the Amount of Deformation of the Propeller Blades During Flight (Bestimmung der Deformationsgrösse von Schraubenblättern im Marsche), R. Katzmayr. Motorwagen, vol. 25, no. 12, Apr. 30, 1922, pp. 223–225, 4 figs. Discusses two methods, one by fixing an incandescent bulb at end of propeller blade, and other by using a source of light visible in proportion to number of revolutions.

AIRPLANES

Fuel Tanks, Safety. Safety Fuel Tanks for Aeroplanes. India-Rubber Jl., vol. 63, no. 18, May 6, 1922, pp. 17–19, 5 figs. Air Ministry prize of £1400, in official competition for petrol tanks used in aircraft won by I.R.G.P. Co. with an interesting rubber covered tank. Describes tests and the successful Silvertown tank. See also Aeroplane, vol. 22, no. 19, May 10, 1922, pp. 336 and 338.

Irwin "Meteorplane." The Irwin "Meteorplane." Aviation, vol. 12, no. 21, May 22, 1922, p. 599, 2 figs. Small single-seater tractor biplane designed to meet demand for small light-weight airplane of conventional design; 2-cylinder air-cooled engine; 15 hp. at 1900 r.p.m.

Static Test. Report of Static Test of Ski for an SE-5 Airplane. Air Service Information Circular, vol. 4, no. 322, Mar. 15, 1922, 1 p., 2 figs. Results of test conducted for purpose of determining structural strength of SE-5 ski. Description of ski.

Stress Analysis of JL-6. Study of Stress Analysis of the JL-6. Air Service Information Circular, vol. 4, no. 332, Mar. 15, 1922, 2 pp. Methods used in design of German airplane developed by Hugo Junker.

Tires and Wheels. Discussion of Airplane Tires and Wheels. Air Service Information Circular, vol. 4, no. 303, Feb. 15, 1922, 11 pp., 8 figs. Notes on wheel designs, rims, wheel lacing, hub attachment, tires, physical tests of wheels and of tires, designers' limitations, etc. Presents charts showing load deflection for airplane tires of standard sizes.

Vickers Commercial. The Vickers "Vulcan" Eight-Passenger Commercial Biplane. Flight, vol. 14, no. 18, May 4, 1922, pp. 253–254, 255–258, 22 figs. Description of plane nearing completion at Weibridge works, equipped with 360-hp. Rolls-Royce "Eagle VIII" engine.

Wing Spars. The Design of Wing Spar Sections, E. P. Warner. Aviation, vol. 12, no. 22, May 29, 1922, pp. 626–627, 2 figs. Develops formulas and gives curves.

AIRSHIPS

German. The German Airship (Das deutsche Luftschiff), Werner v. Langsdorff. Schiffbau, vol. 23, nos. 31 and 33, May 3 and 17, 1922, pp. 910–942 and 985–990, 10 figs. May 3: Detailed description of development and construction of Parseval type. May 17: Describes equipment in detail and gives list of Parseval ships from 1906–1916.

Semi-Rigid. Italian Semi-Rigid Airships (Il dirigible semirigido italiano), G. Arturo Crocco. Rivista Marittima, vol. 55, no. 3, Mar. 1922, pp. 901–927, 9 figs. Developments from France and Lebaudy types; horsepower and load; possibilities of aerial navigation.

ALLOYS

See ALUMINUM ALLOYS, COPPER ALLOYS, FERRONICKEL, MAGNESIUM ALLOYS, PHOSPHOR BRONZE.

ALUMINUM

Solders for. Investigation of Some Solders for Aluminum. Air Service Information Circular, vol. 3, no. 298, Feb. 15, 1922, 1 fig. Determination of effect of small additions of aluminum, copper, magnesium, on alloys of tin-zinc base used for aluminum soldering.

Uses. Aluminum and Its Utilization (Die Verwendungsgebiete des Aluminiums), J. Czohralski. Zeit. fur Metallkunde, vol. 14, no. 1, Jan. 1922, pp. 1–7, 8 figs. Chemical and mechanical properties of aluminum and aluminum alloys and selection of alloys for particular purposes.

ALUMINUM ALLOYS

Aluminum-Silicon. New Aluminum-Silicon Alloys, R. E. Search. Metal Industry (N. Y.), vol. 20, no. 5, May 1922, pp. 183–185. Description of "Aladar," "Aludar" and "Silumin" all alloys of aluminum and silicon, and their origin.

Properties. Properties of Aluminum Alloys. Am. Mach., vol. 56, no. 22, June 1, 1922, pp. 805–806. Why these alloys make good castings; saving in cost shown in relative weights; advantages of melting

Note.—The abbreviations used in indexing are as follows:

Academy	(Acad.)
American	(Am.)
Associated	(Assoc.)
Association	(Assn.)
Bulletin	(Bul.)
Bureau	(Bur.)
Canadian	(Can.)
Chemical or Chemistry	(Chem.)
Electrical or Electric	(Elec.)
Electrician	(Elecn.)
Engineer[s]	(Engr.[s])
Engineering	(Eng.)
Gazette	(Gaz.)
General	(Gen.)
Geological	(Geol.)
Heating	(Heat.)
Industrial	(Indus.)
Institute	(Inst.)
Institution	(Instn.)
International	(Int.)
Journal	(Jl.)
London	(Lond.)
Machinery	(Machy.)
Machinist	(Mach.)
Magazine	(Mag.)
Marine	(Mar.)
Materials	(Matls.)
Mechanical	(Mech.)
Metallurgical	(Met.)
Mining	(Min.)
Municipal	(Mun.)
National	(Nat.)
New England	(N. E.)
Proceedings	(Proc.)
Record	(Rec.)
Refrigerating	(Refrig.)
Review	(Rev.)
Railway	(Ry.)
Scientific or Science	(Sci.)
Society	(Soc.)
State names	(Ill., Minn., etc.)
Supplement	(Supp.)
Transactions	(Trans.)
United States	(U. S.)
Ventilating	(Vent.)
Western	(West.)

range, thermal conductivity, rigidity, and shrinkage.

AMMONIA

Pressure-Total Heat Diagram. The Pressure-Total Heat Diagram for Ammonia. H. J. Macintire and G. H. Bohn. Ice & Refrigeration, vol. 62, no. 5, May 1922, pp. 392–394, 2 figs. Simple graphical representation of properties of saturated and superheated ammonia, based upon Bur. of Standards and Goodenough-Mosher data, illustrating various refrigeration cycles, etc.

AMMONIA COMPRESSORS

Compound. Compound Ammonia Compression, G. A. Horne. A.S.R.E. Jl., vol. 8, no. 6, May 1922, pp. 455–487, 3 figs. Methods of intercooling. Cylinder ratios for compound ammonia compression. Horsepower curves.

Cylinder Design. Compressor Cylinder Design, J. H. H. Voss. Refrig. World, vol. 57, no. 5, May 1922, pp. 11–15, 11 figs. Importance of providing effective valve area in order to prevent waste of power through excess cylinder pressure. Table for calculating correct valve area.

Valves for High-Speed. Valves for High-Speed Ammonia Compressors, J. H. H. Voss. Power, vol. 55, no. 16, Apr. 18, 1922, pp. 619–621, 8 figs. Summarizes desirable points of construction that should be incorporated in design of every light plate valve if used on ammonia compressors.

ANEMOMETERS

Thermometric. The Thermometric Anemometer, J. S. G. Thomas. Lond., Edinburgh & Dublin Philosophical Mag., vol. 43, no. 256, Apr. 1922, pp. 688–698, 3 figs. Calibration curves of low-capacity anemometer of thermometric type for velocities of a few cm. per sec. and upward, and variations caused by heat losses due to conduction and radiation.

APPRENTICES, TRAINING OF

Systems. Trends in Management, William Leavitt Stoddard. Factory, vol. 28, no. 5, May 1922, pp. 528–529, 548 and 550, 2 figs. Deals with apprenticeship plan, and describes certain systems in the United States.

ARTILLERY

Cartridge Cases, Testing. Testing Artillery Cartridge Cases, J. Burns Read and S. Tour. Am. Inst. Min. & Met. Engrs. Trans., advance paper, no. 1151-N, Mar. 1922, 53 pp., 44 figs.; also (abstract) in Min. & Metallurgy, no. 184, Apr. 1922, pp. 33–35, 3 figs. Summary of metallurgical information and experience gained by Ordnance Dept. during war in manufacture of artillery cartridge cases. Describes tests to which artillery cartridge cases were put.

ASBESTOS

Fire Prevention. The Part Asbestos Plays in Fire Prevention, Maurice J. Hoover. Fire & Water Eng., vol. 71, no. 20, May 17, 1922, pp. 899–900, 905 and 920, 6 figs. Nature provides certain non-burnable materials which can be used for building purposes; advantages of asbestos for roof covering; importance of interior fireproofing.

ASH HANDLING

Plants. Pneumatic Ash Handling Plant (Pneumatische Entaschungsanlagen), Philippi. Archiv fur Warmewirtschaft, vol. 3, no. 4, Apr. 1922, pp. 63–66, 9 figs. Details of construction of small and large plants and advantages of pneumatic conveying.

Sluicing and Pumping. Pumping Ashes. Eng. & Indus. Management, vol. 7, no. 15, June 1, 1922, pp. 481–482, 1 fig. Sluicing process for removal of ashes.

ATOMS

Isotopy. Recent Results of the Investigation of the Atom (Neuere Ergebnisse der Atomforschung), Karl Przibram. Elektrotechnik u. Maschinenbau, vol. 40, no. 18, Apr. 30, 1922, pp. 205–210, 2 figs. Discusses question of isotopy of certain elements which, in spite of different radioactive behavior and different atomic weights, show exactly same chemical properties.

AUTOGENOUS WELDING

Safety Device. A New Safety Device for Autogenous Welding (Eine neue Rückschlagsicherung als Ersatz für Wasservorlagen in Schweissereibetrieben), Theo Kautny. Autogene Metallbearbeitung, vol. 15, no. 7, Apr. 1, 1922, pp. 93–96, 2 figs. Describes device for preventing oxygen from entering acetylene supply pipe, which might lead to explosion.

AUTOMOBILE ENGINES

Boring Machines for Crankcase. Boring and Running-In Machine for Motor-Omnibus Crankcases. Engineering, vol. 113, no. 2941, May 12, 1922, pp. 586–588, 11 figs. Description of recently invented tool by which through four simultaneous operations three crankcases can be finished per hour.

Cams and Poppet Valves. Experiments on Cams and Poppet Valves, G. E. Scholes. Automobile Engr., vol. 12, no. 163, May 1922, pp. 151–157, 16 figs. Introduces formulas and charts. Paper read before Inst. Automobile Engrs.

Crankshafts, Machining. Machining a Case Hardened Mack Crankshaft, Fred H. Colvin. Am. Mach., vol. 56, no. 16, Apr. 20, 1922, pp. 585–587, 9 figs. Hard and long-wearing surfaces secured by case hardening. Straightening, turning and grinding operations, balancing, final straightening and inspection.

Machining the Peerless Crankshaft, Fred H. Colvin. Am. Mach., vol. 56, no. 17, Apr. 27, 1922, pp. 621–623, 6 figs. Machining crankshaft for eight cylinder motor, double connecting rods require long crankpin bearings. Details of oiling and methods of drilling oil holes.

Cylinders, Casting. Cylinder Casting. Eng. Production, vol. 4, no. 86, May 25, 1922, pp. 493–496, 10 figs. Methods used in Midland Motor Cylinder Co., Ltd., near Birmingham.

Cylinders, Renewing. Renewing Cylinders, Paul Dumas. Motor Age, vol. 41, nos. 20 and 21, May 18 and 25, 1922, pp. 16–20 and 16–20, 17 figs. May 18: Equipment and tooling-up. May 25: Parts machining and fitting.

Ignition. Automobile Ignition, Chas. Baxter. Engineering, vol. 113, no. 2941, May 12, 1922, pp. 578–579, 10 figs. Investigation with view to bringing out relative methods of magneto and coil for battery systems.

Regrinding Parts. Regrind Automobile Engine Parts, F. B. Jacobs. Abrasive Industry, vol. 3, no. 4, Apr. 1922, pp. 118–121, 6 figs. Worn cylinders are reground and fitted with oversize pistons and rings; crankshaft regrinding must be performed accurately.

AUTOMOBILE FUELS

Alcohol. Alcohol Motor Fuel Research. Motor Transport, vol. 34, no. 898, May 15, 1922, pp. 600–601, 6 figs. Encouraging interim report issued by Empire Motor Fuels Committee of Imperial Motor Transport Council.

AUTOMOBILE INDUSTRY

Renault Works, France. The Works of the Société Anonyme Renault. Engineering, vol. 113, no. 2943, May 26, 1922, pp. 639–643, 11 figs. Description of 640,000-sq. yd. plant which manufacturers own iron and steel castings, rolls metal to their own dimensions; develops 15,000 b.hp.

AUTOMOBILES

American in Argentine. The American Automobile Holds Dominant Place in Argentine Republic. Automotive Industries, vol. 46, no. 19, May 11, 1922, pp. 1024–1025. American car will hold its position because of many requirements, giving service, and low price.

Axles, Rear. A Dual Reduction Rear Axle, Fred H. Colvin. Am. Mach., vol. 56, no. 18, May 4, 1922, pp. 663–665, 12 figs. Cutting-off, drilling, boring and milling methods on a forged axle. Fixtures which facilitate easy handling.

Brake Couplings. Are Cables Superior to Rods for Brake Couplings? M. W. Bourdon. Automotive Industries, vol. 46, no. 20, May 18, 1922, pp. 1059–1060, 8 figs. European makers claim cables stronger. Sunbeam, Minerva, Ansaldo, Lorraine-Dietrich, and La Licorine furnish some excellent examples of current practice.

Cubitt Car, British. British Cubitt Car Designed to Compete with American Products, M. W. Bourdon. Automotive Industries, vol. 46, no. 19, May 11, 1922, pp. 1006–1009, 8 figs. New British model designed for quantity production to compete with low-priced American cars in home market. Has 4-cylinder $3\frac{1}{8} \times 5\frac{1}{2}$-in. engine 4 speeds, worm drive and cantilever springs.

Design. Modern Tendencies in Automobile Construction (Zur Kritik der neuen Richtlinien im Automobilbau), R. Conrad. Motorwagen, vol. 25, nos. 4, 5 and 6, Feb. 10, 20 and 28, 1922, pp. 63–73, 83–87 and 105–115, 52 figs. Feb. 10: Hydraulic gears; gears in constant engagement with relay couplings; possiblities of standardization. Feb. 20: Construction of light pistons and cylinders for two- and four-stroke engines. Feb. 28: Describes some recent two-stroke engines; suction and compression; improvements in driving; adding new speeds for slow driving; etc.

Differential. With and Without the Differential, Louis Coatalen. Autocar, vol. 48, no. 1385, May 6, 1922, pp. 741–743. Reply to Granville E. Bradshaw's rejoinder. Evolution of touring car is based on racing practice; why solid axle is used on some racings cars; used on small cars because it permits better spring suspension.

Manufacture. Better Cars at Lower Price; A Production Achievement, J. E. Schipper. Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1147–1149 and 1157. Marketing and production closely allied. Machine-tool development important. Careful shop planning major factor in ability to join quality with quantity production.

Short-Ashby Light Car. The Short-Ashby Light Car. Auto, vol. 27, no. 1115, May 18, 1922, pp. 405–408, 9 figs. Excellent example of friction-driven car, with some interesting mechanical features. Ruby 4-cylinder engine, 8 hp.

Sport. The Design of Sporting Cars, F. Gordon Crosby. Autocar, vol. 48, no. 1380 and 1381, Apr. 1 and 8, 1922, pp. 521–523 and 578–580, 12 figs. Apr. 1: Describes special type of body combining comfort with smart appearance. April 8: Difficulties in connection with convenient and aesthetic mounting of important accessories.

Starter Armature. Novel Starter Amature Eliminates Use of Soldered Commutator Joint. Automotive Industries, vol. 46, no. 21, May 25, 1922, p. 1108, 2 figs. Closed end of armature coil located at what is usually commutator end. Separate commutator dispensed with. Two armature bearings are placed closer together. Simplified construction greatly reduces production cost.

Surrey Light Car. The Surrey Light Car. Auto, vol. 27, no. 1116, May 25, 1922, pp. 425–427, 10 figs. Vehicle of sound design with good record of competitive achievement; Coventry-Simplex "O. E." type, 4-cylinder monobloc 10.5 hp. engine.

Suspension Design. The Design of Motor Car Suspensions, A. A. Remington. Automobile Engr., vol. 12, no. 163, May 1922, pp. 139–141, 2 figs. Consideration of factors involved and some conclusions.

Suspension Springs. European Makers Adopt Quarter Elliptic Springs for Light Cars, M. W. Bourdon. Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1153–1157, 18 figs. Modifications in original application have been found necessary in practice. Standard and Wolseley offer good examples of "safety leaf." Carrow shows use of radius rod in construction.

AVIATION

Air Ports, Organization of. The Organization of Airports. Aviation, vol. 12, no. 23, June 5, 1922, pp. 660–662, 4 figs. Information division, air service issues revised specifications and rules for ground organization.

Gliders. See FLIGHT, Soaring.

Light, Use in. The Use of Light as an Aid to Aerial Navigation, L. F. Blandy. Illuminating Engr., vol. 15, no. 2, Feb. 1922, pp. 42–58 and (discussion) 58–63, 8 figs. Lights carried on aircraft, internal and external; aerodrome lighting; ground illumination; aerial light houses.

B

BATTERIES

E.M.F. at Low Temperatures. Electromotive Force of Cells at Low Temperatures, G. W. Vinal and F. W. Altrup. Sci. Papers of Bur. of Standards, no. 434, Apr. 17, 1922, pp. 627–634, 2 figs. Experiments of temperatures as low as —170 deg. cent. when high values of voltage were sometimes observed and polarity was often reversed.

BEAMS

Calculation. Expansion of the Clapeyron Equation (Erweiterung der Clapeyronschen Gleichung), Edgar Schmidt. Eisenbau, vol. 13, no. 4, Apr. 21, 1922, pp. 71–77, 7 figs. Assumes statically indeterminate main systems for derivation of this equation to simplify work of calculating beams with *n* supports.

Deflection. Some Problems in Deflection of Beams, Ewart S. Andrews. Concrete & Constructional Eng., vol. 17, no. 4, Apr. 1922, pp. 235–243, 4 figs. Gives derivation of formulas for deflection of beams for two cases not usually dealt with in textbooks.

BELTING

Leather. Power Transmission by Belting, P. F. O'Shea. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 814–816, 4 figs. Characteristics of leather belting and charts for simplifying calculations.

Leather, Laboratory Tests. Method of Tests on Leather Belt and Laboratory Equipment, L. W. Arny. Belting, vol. 20, no. 5, May 1922, pp. 31–32, 2 figs. How research into many perplexing problems is conducted by leather belting exchange foundation at Sibley College of Mech. Eng., Cornell.

Steel. Machinery Driven by Steel Belt, John D. Knox. Iron Trade Rev., vol. 70, no. 16, Apr. 20, 1922, pp. 1114–1116, 6 figs. Endless steel bands rolled from seamless tubing have wide application for transmitting power; slippage is overcome by facing pulleys with cork; relation of pulley speeds is discussed.

BLAST-FURNACE GAS

Cleaning Methods, Comparison. Gas Cleaning Methods Compared, N. H. Gellert. Iron Trade Rev., vol. 70, no. 20, May 18, 1922, pp. 1401–1406, 4 figs. Analysis of relative merits of dry and wet cleaning systems with formulas and tabular data supplying specific information; concludes that hot-cleaned gas effects a fuel economy.

Value of Clean. The Value of Clean Blast-Furnace Gas, N. H. Gellert. Mech. Eng., vol. 44, no. 5, May 1922, pp. 305–310, 3 figs. Savings resulting from use of clean gas in hot-blast stove and boiler operation. Superiority of dry cleaning over wet cleaning. Possibilities held out by electrical cleaning process.

Washing Losses. Analyzing Gas Washing Losses, H. T. Watts. Iron Trade Rev., vol. 70, no. 17, Apr. 27, 1922, pp. 1179–1181. Causes of heat losses in wet washing of blast furnace gas are outlined and amount of loss is calculated. Effects of stoves and vapor content are considered.

BLAST FURNACES

Charging. Notes on Blast Furnace Filling, D. E. Roberts. Engineering, vol. 113, no. 2941, May 12, 1922, pp. 599–603, 16 figs. Relative advantages of skip and bucket systems. Paper read before Iron & Steel Inst.

Filling. Notes on Blast-Furnace Filling, D. E. Roberts. Iron & Steel Inst. advance paper no. 9, meeting May 1922, 17 pp., 14 figs. partly on supp. plates. Description of skip and bucket methods of mechanical charging.

Lining Failures. Lining Failures Caused by Zinc, P. O. Menke. Iron Trade Rev., vol. 70, no. 20, May 18, 1922, pp. 1409–1410. This element in ores and limestone causes deterioration; effect is accumulative; water cooling above mantle seems to accelerate action; recommends heavier plates.

Remodeling. Rebuilds Eastern Blast Furnace, Richard Peters, Jr. Iron Trade Rev., vol. 70, no. 18, May 4, 1922, pp. 1258–1260, 4 figs. Thomas Iron Co. in modernizing historic plant at Hokendauqua, Pa. completely reconstructs stack no. 3; new equipment includes buildings, power plant and auxiliary apparatus; provision is made for future expansion.

BOILER FEEDWATER

Characteristics. The Story of Feed Water, M. F. Newman. Combustion, vol. 6, no. 6, June 1922, pp. 273-278, 5 figs. Impurities which cause trouble and suggested plan for feedwater.

Heating. Heating Feedwater by Steam From Turbines (Réchauffage de l'eau d'alimentation par prélèvement de vapeur aux turbines), R. de Kergaradec. Génie Civil, vol. 80, no. 17, Apr. 29, 1922, pp. 380-383, 2 figs. Makes calculations of savings effected, draws attention to some modifications required in boiler equipment.

BOILER FIRING

Oil-Firing System. The New Körting Oil Firing System (Neue Körting-Oelfeuerungen), Pradel. Petroleum, vol. 18, no. 13, May 1, 1922, pp. 481-486, 5 figs. Describes new steam jet or compressed air centrifugal atomizer recently put on market, and gives examples of its application.

Oil-Fuel. Oil Firing Sixty-four Boilers at Amoskeag. Power, vol. 55, no. 24, June 13, 1922, pp. 920-923, 3 figs. Features of installation at Manchester, N. H., which eliminates factors of coal firing objectionable in textile plant.

BOILER MAKING

Babcock & Wilcox French Plant. The Works of the French Babcock & Wilcox Co., Engineering, vol. 113, no. 2944, June 2, 1922, pp. 674-676, 7 figs. Description of plant covering 153,000 sq. yd. and containing 8 large buildings in which all operations are carried on.

BOILER OPERATION

Colfax Station. Boiler-Room Performance and Practice of the Colfax Station, Duquesne Light Company, C. W. E. Clarke. Mech. Eng., vol. 44, no. 5, May 1922, pp. 295-300, 8 figs. Description of plant of Duquesne Light Co., Cheswick, Pa., and some details of its operation and performance.

Efficiency. New Practical Industrial Method of Using Boilers (Nouvelle méthode industrielle pratique pour l'exploitation rationnelle des générateurs de vapeur), H. Carra. Chaleur & Industrie, vol. 3, nos. 23 and 24, Mar. and Apr. 1922, pp. 1049-1056 and 1158-1164, 9 figs. Discusses essentials of combustion and analysis of losses in heat production, measurement and control of these losses, leading to quasi-automatic control.

BOILER PLANTS

Production Cost. Production Costs and Boiler Plants, W. S. Johnston. Combustion, vol. 6, no. 6, June 1922, pp. 285-288. General discussion of expenses with suggestions for plant enlargements or renewals as deduced from modern achievements.

BOILER PLATES

Cracks. Formation of Cracks in Boiler Plates, B. Strauss and Ad. Fry. Forging & Heat Treating, vol. 8, no. 5, May 1922, pp. 225-229, 23 figs. Force influence figures developed by new etching method permit recognition of brittleness. Tests show that rolled plates should be finished at as high a temperature as possible. Translated from Stahl und Eisen, Aug. 18, 1921.

BOILER TUBES

Charcoal Iron. Installing and Maintaining Charcoal Iron Locomotive Boiler Tubes, C. H. Woodroffe and C. E. Lester. Ry. Mech. Engr., vol. 96, no. 5, May 1922, pp. 274-278, 13 figs. Use of welding in tube work, with particular reference to recommended maintenance practice in enginehouses. Describes effective flue-shop equipment and layout.

BOILERS

Centralized Combustion Control. Centralized Combustion Control for Boilers. Power, vol. 55, no. 20, May 16, 1922, pp. 771-774, 8 figs. Operation of automatic control for bank of boilers thereby maintaining constant character of combustion at all loads.

Developments. Recent Boiler Developments, V. Z. Caracristi. Steam, vol. 29, no. 5, May 1922, pp. 123-128. Removal of limitations as to pressure, size and output by recent development; covers any present-day power.

Seams, Efficiency of. Calculating the Efficiency of Boiler Seams, R. J. Finch. Boiler Maker, vol. 22, no. 5, May 1922, pp. 126-129, 5 figs. Tables reduce chance for error and facilitate work; points where failure is likely to occur.

Steam Heating. Water Returns to Steam Heating Boilers. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 3, Apr. 1922, pp. 328-342, 1 fig. Proper return connections to heating boilers when set in battery of two or more, and application of check valves. Report prepared by representatives of engineering staffs of insurance companies writing steam-boiler insurance in United States.

[See also LOCOMOTIVE BOILERS, MARINE BOILERS.]

BOILERS, WATER-TUBE

Spearing. Spearing Water-tube Boiler. Elec. Rev., vol. 90, no. 2320, May 12, 1922, pp. 652-655, 6 figs. Characteristics including sectional headers, downcomer pipes, reservoir mud drum.

Vertical. Thermal Principles in the Construction of Modern Vertical Water-Tube Boilers (Bau- und wärmetechnische Grundsätze für den Bau neuzeitiger Steilrohrkessel), Berner. Wärme, vol. 45, no. 11, Apr. 7, 1922, pp. 165-169, 14 figs. Discusses these principles in connection with a Muller boiler, including circulation of water and steam, superheating, boiler settings, results of efficiency tests.

BRASS

Cartridge, Physical Properties of. Physical Properties of Cartridge Brass, C. Upthegrove and W. G. Harbert. Trans. Amer. Inst. Min. & Met. Engrs. issued with Min. & Metallurgy, May 1922, no. 1161-N, 10 pp., 8 figs. Some data bearing on effect of anneal previous to final reduction or rolling on hardness.

Corrosion and Dezincing. Selective Corrosion and Dezincing of Brass Parts (Selektive Korrosionen und Entzinkungerscheinungen an Messingteilen), F. v. Wurstemberger. Zeit. für Metallkunde, vol. 14, nos. 1 and 2, Jan. and Feb. 1922, pp. 23-29 and 59-69, 26 figs. Explains dezincing as a double process of an anodic dissolution of metal and a cathodic precipitation of copper; elimination of corrosion.

BRONZES

Manganese. Occurrence of Blue Constituent in High-strength Manganese Bronze, E. H. Dix, Jr. Trans. Amer. Inst. Min. & Met. Engrs. issued with Min. & Metallurgy, May 1922, no. 1158-N, 16 pp., 19 figs. Study of this feature discovered during investigation of high-strength manganese bronze by Eng. Division of Air Service.

Manganese Bronze in Engineering Work. Iron Age, vol. 109, no. 22, June 1, 1922, pp. 1513-1515, 5 figs. How it is made in large foundry; its properties in castings and rolled form; typical installations.

C

CALCULATING MACHINES

Mercedes-Euclid. A Machine That Thinks (Mitteilungen aus der Praxis). Technische Blätter, vol. 12, no. 20, May 20, 1922, pp. 204-206, 3 figs. Describes Mercedes-Euclid arithmetical machine and gives details of its operations in adding, subtracting and multiplication.

CAR WHEELS

Cast-Iron. Metal for Cast Iron Car Wheels, Y. A. Dyer. Iron Age, vol. 109, no. 22, June 1, 1922, pp. 1504-1506. Three distinct compositions embodied in one mass: white, gray and mottled; care necessary in blending cupola charges.

Chilled-Iron. An Investigation of the Properties of Chilled Iron Car Wheels, J. M. Snodgrass and F. H. Guldner. Univ. Ill. Bul. no. 129, vol. 19, May 1, 1922, pp. 9-95, 44 figs. Requirements of car wheels and tests of this type.

Thermal Stresses in Chilled Iron Car Wheels, G. K. Burgess and R. W. Woodward. Technologic Papers of Bur. of Standards, no. 209, Mar. 18, 1922, pp. 193-226, 26 figs. Stresses calculated from strain-gage measurements.

Cushion, Flanged. Flanged Cushion Wheel of New Design. Elec. Traction, vol. 28, no. 5, May 1922, pp. 420-421, 4 figs. New type of Mead cushion wheel for passenger coaches has features which have proven to be practical.

Tire Rolling. A New Departure in Tire Rolling. Ry. Gaz., vol. 36, no. 18, May 5, 1922, pp. 735-736, 6 figs. Describes system for production of railway tires which has recently been installed by leading firm of manufacturers.

CARBURETORS

Setting for Airship Engine. The Determination of a Carburetor Setting for the Liberty Engine for Dirigible Use. Air Service Information Circular, vol. 4, no. 311, Mar. 15, 1922, 8 pp., 2 figs. Results of test to develop a carburetor setting for Liberty 12-cylinder engine adapting it for dirigible service.

CARS, FREIGHT

Corrugated Steel Roof. A Self-Supporting Corrugated Steel Freight Car Roof. Ry. Age, vol. 72, no. 19, May 13, 1922, pp. 1129-1130, 2 figs. Describing new design placed on market by Sharon Pressed-Steel Company.

CASE-HARDENING

Carburizing. Recommended Practice in Carburizing, S. P. Rockwell. Am. Mach., vol. 56, no. 22, June 1, 1922, pp. 811-812. Suggestions for selection of carburizing material; methods of testing it; best materials for different kinds of work; design and use of carburizing pots. Paper read before Am. Gear Mfrs. Assn.

Penetrability of Carbon. The Penetration of Carbon Into Metals and Mixed Crystals of Iron (Ueber die Diffusion des Kohlenstoffs in Metalle und die Mischkristalle des Eisens), Gustav Tammann. Stahl u. Eisen, vol. 42, no. 17, Apr. 27, 1922, pp. 654-658, 9 figs. Coefficient of penetrability of carbon and effect of molybdenum, cobalt, manganese, tungsten, etc., on depth of penetration.

Steel, Quality of. Effect of Quality of Steel on Case-Carburizing Results, H. W. McQuaid and E. W. Ehn. Forging & Heat Treating, vol. 8, nos. 5-6, May and June, 1922, pp. 243-247, 274-278, 46 figs. Effect of non-metallic impurities and alloy elements on final results in hardening of case-carburized steel. Paper presented Feb., 1922 at A.I.M.E.

CAST IRON

Carburization. A Study of Carburization in Manufacture of Synthetic Cast Iron, C. E. Williams and C. E. Sims. Amer. Electrochem. Soc., advance paper, no. 13, meeting Apr. 27-29, 1922, 8 figs. Investigation of factors which influence carburization.

Chemical Composition. Cast Iron and Its Chemical Composition, O. Smalley. Foundry Trade Jl., vol. 25, nos. 298 and 299, May 4 and May 11, 1922, pp. 323-326, and 343-345, 16 figs. Study of little known elements in cast iron which have kept mechanical characteristics from being controlled. Paper read before Inst. of British Foundrymen.

Electrical Melting. Melts Gray Iron Electrically, W. E. Cahill. Foundry, vol. 50, no. 10, May 15, 1922, pp. 420-421. Cheap current makes it profitable to melt both iron and steel for castings electrically; power consumption figures given; iron produced has uniformly fine grain.

Synthetic, Carburization of. Carburize Synthetic Cast Iron, Clyde E. Williams and C. E. Sims. Foundry, vol. 50, no. 10, May 15, 1922, pp. 390-393 and 422, 8 figs. Experiments made in introducing commercial forms of carbon, details of operation and results; effects of slags and various elements contained in iron are studied.

CASTING

Continuous. Improving Casting Methods in Steel Works (Amélioration des procédés de coulée dans une aciérie), Lucien Dujardin. Outillage, Tome 256, no. 16, Apr. 22, 1922, pp. 475-477, 6 figs. Discusses continuous casting in order to increase production, and describes foundry arrangements necessary.

CASTINGS

Centrifugal. Producing Centrifugal Castings, Leon Cammen. Iron Trade Rev., vol. 70, no. 17, Apr. 27, 1922, pp. 1188-1193, 3 figs. Methods of making hollow metal objects and machine used are described. Uniform cooling of poured metal makes manufacture of thin tubes possible; believes process may be applied to plate making. Presented at A.S.M.E. Spring Meeting May 1922.

CEMENT

Alumina. Alumina Cement; Its Development, Use and Manufacture, Henry S. Spackman. Eng. News-Rec., vol. 88, no. 20, May 18, 1922, pp. 831-834. History and properties of high strength, quick setting cement now being produced commercially in France.

CEMENT MANUFACTURE

Clinker Burning. Heat Distribution in Burning Cement Clinker, Elliott H. Whitlock and Charles E. Burgoon. Concrete, vol. 20, no. 5, May 1922, pp. 111-118, 14 figs. Study of variable conditions with view to improving efficiency of operation from engineering standpoint.

Segregation. Segregation, Charles Catlett. Concrete, vol. 20, no. 5, May 1922, pp. 119-124. Results of original investigation and segregation as applied to cement industry.

CENTRAL STATIONS

Calumet Plant, Chicago. Calumet to Reinforce Industrial Section of Chicago System, Elec. World, vol. 79, no. 22, June 3, 1922, pp. 1111-1114, 6 figs. New station of Commonwealth Edison Co. has 15,089 sq. ft. boilers with integral economizers and forced-draft chain grates; steam is bled from prime movers for heat balance. See also Elec. Ry. Jl., vol. 59, no. 22, June 3, 1922, pp. 897-901, 6 figs.

Calumet Station, Commonwealth Edison Co. Power, vol. 55, no. 22, May 30, 1922, pp. 842-850, 10 figs. Initial installation, 60,000 kw. Steam supplied to turbines at 300 lb. pressure and 200 deg. superheat. Seven 15,089 sq. ft. boilers designed for 350 lb. and 250 deg. superheat. Other features of installation.

Economic Operation. Economic Production of Power and the Technical Side of Super-Central Stations (La production économique de l'énergie et la technique des super-stations centrales), A.-R. Garnier. Technique Moderne, vol. 14, nos. 2, 3 and 4, Feb., Mar. and Apr. 1922, pp. 63-69, 106-112 and 167-170, 9 figs. Feb.: Modern tendencies in mass production of power, including steam driving of turbines, superheat, handling of fuel, air preheating. Mar.: Technical aspects of superpower stations, including simplification of conduits, increase in power per unit, turbines and their characteristics. Apr.: Discusses electrical equipment, especially close connection between turbine and generator.

Operation. Performance of Equipment and Trends in Station Practice. Elec. World, vol. 79, no. 20, May 20, 1922, pp. 1033-1035, 1 fig. Analysis of turbine outages and operating data for powdered-fuel, Diesel and oil plants constitute important part of report of N.E.L.A. Com. on Prime Movers this year.

Superpower. The Gennevilliers Central Station (La Centrale de Gennevilliers). Special Number of Chaleur & Industrie, pp. 14-54, 29 figs. Details of superpower station constructed by Union d'Électricité, especially boiler-room equipment, condensers, economizers, boilers, etc.

CHAIN DRIVE

Tooth Grinding. Grinding Inverted Tooth Chain Wheels. Eng. Production, vol. 4, no. 85, May 18, 1922, pp. 474-475, 4 figs. Outline of method by which flanks of inverted-tooth chain-wheel teeth may be accurately ground to correct dimensions and angles, and machinery for grinding wheels of any pitch, width, and number of teeth.

CHARTS

Construction. Principles of Constructing Charts (Coup d'oeil sur les principes fondamentaux de la nomographie), M. d'Ocagne. Révue Générale des Sciences, vol. 33, no. 8, Apr. 30, 1922, pp. 230-239, 9 figs. Discusses cases in which more than three variables can be reduced to graphic presentation on a plane.

CHROMIUM STEEL

Spontaneous Passivity. Spontaneous Passivity of Chromium Steels (Die spontane Passivität der Chromstähle), G. Tammann. Stahl u. Eisen, vol. 42, no. 15, Apr. 13, 1922, pp. 577-578, 1 fig. Behavior of chromium steels and electrolytes and protective effect of chromium.

CLUTCHES

Magnetic. Magnetic Clutches for Machine Driving, C Sylvester. Eng. Production, vol. 4, no. 86, May 25, 1922, pp. 491–492, 2 figs. Notes on their design application and working

COAL

Combustion. The Combustion of South African Coals in Boiler Furnaces, E. P. Reim. So. African Eng., vol 33, nos 3 and 4, Mar. 31 and Apr. 29, 1922, pp. 40, 73 75 Mar. 31: Origin and mode of formation of coal, impurities. Apr. 29: Describes combustion characteristics. From paper read before Chem., Metallurgical & Min. Soc. of So. Africa.

Recovery from Ashes. Recovering Coke and Coal From Ashes Die Wiedergewinnung von Koks and Kohle aus Feuerungsruckständen). F. Schulte. Glauckauf, vol. 58, no. 18, May 6, 1922, pp 534–537, 5 figs. Recovery systems of Weber, Hessel, Schilde, and Ullrich, and their advantages and disadvantages.

Spontaneous Combustion. Microscopical Examination of Batt, James Lomax. Colliery Guardian, vol. 123, no. 3199, Apr. 21, 1922, pp. 975–977 (includes discussion), 21 figs. Microscopical research carried on for describing the various forms of pyrites or iron disulphide found in coal, its origin and probable effects in relation to spontaneous combustion. Paper read before Manchester Geological & Min. Soc See also Iron & Coal Trades Rev., vol. 104, no. 2825, Apr. 21, 1922, pp. 577–578.

COAL HANDLING

Conveyor, Shaking. Horizontal Reciprocating Conveyor and Screen on a New Principle, Alphonse F. Brosky. Eng. & Indus. Management, vol. 7, no. 13, May 4, 1922, pp. 407–410, 10 figs. This device is manipulated by revolving weights and spring supports whereby compound motion is obtained and coal is caused to travel forward continuously. By duplicating opposing parts useless vibration is prevented.

Conveyors. Tells How Conveyor Saved Money for Plant, A. MacLean. Black Diamond, vol. 68, no. 18, May 6, 1922, p. 429, 1 fig. Description of Barber-Greene Conveyor which operated for five years without requiring repairs and handles coal and ashes at thirteen cents a ton, including labor.

Docks. The Coaling Devices of the Suisted Elevator Company at the Victoria and Albert Docks, Geo. F. Zimmer. Eng. & Indus. Management, vol. 7, no. 14, May 18, 1922, pp. 435–440, 7 figs. Description of machines designed by Suisted Elevator Co. and ultimate successful accomplishment.

Industrial Plants. Coal and Ash Conveying for Boiler Rooms (Bekohlung und Entaschung im Kesselbetriebe), R. Dub. Fördertechnik u. Frachtverkehr, vol. 15, nos 9 and 10, Apr. 28 and May 12, 1922, pp. 123–127 and 138–144, 16 figs. Apr. 28: Storing and conveying of coal from factory coal pile by means of conveyors, cranes, etc. May 12: Mechanical feeding of coal to boiler house in a number of large central stations.

Power. Handling Coal by Power, James B. Hayden. Combustion, vol. 6, no. 6, June 1922, pp. 268–272, 6 figs. Desirability of mechanical devices and suggestions for planning same.

COKE

Blast Furnace and Foundry. Testing of Coke for Blast Furnace and Foundry Purposes (Vorschläge zur Prufung des Kokses fur Hochofen- und Giessereizwecke), Heinrich Koppers. Stahl u. Eisen, vol. 42, no 15, Apr. 13, 1922, pp. 569–573, 4 figs. Properties of metallurgical coke, ease of combustion, porosity, and different requirements of coke for blast furnaces and foundries.

COKE OVENS

Piette. Piette Coke Oven Consumes a Little Over One-Third of the Heat in Its Gases, Hector Prud'-Homme. Coal Age, vol. 21, no. 24, June 15, 1922, pp. 1003–1005, 1 fig. Makes almost 70 per cent of coal into coke, about 5½ lb. of ammonia, 7 gal. of tar and 3½ gal. of benzine; long oven life anticipated.

COMBUSTION

Spontaneous. Spontaneous Combustion and Friction, Walter L. Wedger. Fire & Water Eng., vol. 71, no. 15, Apr. 12, 1922, pp. 603 604 and 614. Notes on substances subject to spontaneous ignition; coal, fibers and wood charcoal said to be very susceptible; friction fires caused by foreign substances.

COMPRESSED AIR

Motive Power, as. Compressed Air as Motive Power (Energiewirtschaft beim Pressluftbetriebe), A. Hinz. Glückauf, vol 58, no. 20, May 20, 1922, pp. 581 589, 4 figs. Discusses storing of compressed air for power purposes and examines mathematically process in air compressors, piston compressors and turbo-compressors, and determines their efficiency.

Pneumatic Mail Dispatch. Pneumatic Tubes in the United States for Mail—German Types (Rohrposten für Briefbeutel in den Vereinigten Staaten von Nordamerika, deutsche Bauarten), Schwaighofer. Organ für die Fortschritte des Eisenbahnwesens, vol 77, no. 5, Mar. 1, 1922, pp. 65 70, 5 figs. Discusses postal tube services in Chicago, New York, Philadelphia and St. Louis, and makes comparison with German parcel tubes.

COMPRESSORS

Ammonia. See AMMONIA COMPRESSORS.

CONCRETE

Abrasion Test. New Laboratory Abrasion Test for Concrete, C. H. Scholer. Cement & Eng. News, vol 34, no. 4, Apr. 1922, pp. 23 24, 4 figs. Test being developed by Engineering Experiment Station of Kansas State Agricultural College, 9-in spheres of concrete cast and tested after proper aging and curing. Tested in standard brick rattler using standard abrasive charge.

Central-Plant-Mixed. Central-Plant-Mixed Concrete Tested for Safe Haul, James W. Brooks. Contractors' & Engrs.' Monthly, vol 4, no 4, Apr. 1922, p. 48. Description of tests made to determine safe maximum length of haul.

Fastening Machinery to. Fastening Machinery to Concrete, G. H. Radebaugh. Brick & Clay Rec., vol. 60, no. 11, May 30, 1922, pp. 848–851, 12 figs. Practices which have been found successful in working with hard concrete; procedure outlined step by step.

COPPER ALLOYS

Cupro-Nickel, Cold-Work and Recrystallization. The Internal Mechanism of Cold-Work and Recrystallisation in Cupro Nickel, Frank Adcock. Metal Industry (Lond.), vol. 20, nos. 16 and 17, Apr. 21 and 28, 1922, pp. 372–374 and 392–394, 21 figs. Experiments for gathering information on process of cold-work and recrystallization of metals.

CORE OVENS

Electric vs. Oil-Fired. Core-oven Tests, F. L. Wolf and A. A. Grubb. Am. Inst. Min. & Met. Engrs. Trans. advance paper, no. 1152-N, Apr. 1922, 13 pp., 2 figs.; also (abstract) in Min. & Metallurgy, no. 184, Apr. 1922, pp. 37–38, 2 figs. Describes tests to obtain information regarding costs, efficiency, etc. of baking cores in oil-fired oven and two electric ovens installed in 1920 in core room of Ohio Brass Co. Power and fuel costs favor oil, while quality and uniformity of bake, core losses, convenience and cost of tending, favor electricity.

CORROSION

Ferrous Metals. Corrosion of Ferrous Metals, Robert Abbott Hadfield. Engineering, vol. 113, no. 2936, Apr. 7, 1922, p. 419. Preparation of various ferrous metals used in corrosion research of Instn. Civ. Engrs. together with their physical and mechanical properties, and general considerations on subject of corrosion. (Abstract.) Paper read before (British) Instn. Civ. Engrs.

Prevention by Deactivation of Water. Control of Corrosion by Deactivation of Water, Frank N. Speller. Franklin Inst. Jl., vol. 193, no. 4, Apr. 1922, pp. 515–542, 13 figs. Outline of present status of corrosion prevention by deactivation and deaeration of water.

Sea-Water. Reducing Corrosion by Sea Water, Robt. Hadfield. Iron Trade Rev., vol. 70, no. 21, May 25, 1922, pp. 1481–1483, 3 figs. British conduct extensive investigation to determine best type of steel for under-water structural work; non-rusting steel containing 12 to 14 per cent chromium is found to be most satisfactory.

Water-Carrying Vessels, Prevention. Corrosion and Its Prevention in Vessels Carrying Water, J. R. McDermet. Am. Soc. Heat. & Vent. Engrs., vol. 28, no. 4, May 1922, pp. 407–416. Suggestions for reducing corrosion in water piping, boiler economizers, boilers, steam piping or water tanks.

COUPLINGS

Flexible. Universal Joints and Flexible Couplings; Their Kinds and Uses on Boats, Wm. Atkin. Motor Boat, vol. 19, no. 11, June 10, 1922, pp. 15–17, and 28, 12 figs. Consideration of necessity for flexible couplings.

CRANES

Electric. Electric Cranes At the Swiss Federal Railway Shops at Bellinzona. Engineering, vol. 113, no. 2943, May 26, 1922, pp. 653–654, 4 figs. Arrangement of two 80-ton electric traveling cranes for handling heavy electric locomotives.

Harbor. Cranes and Tipping Wagons for Loading and Unloading Ships (Kran und Kipper als Mittel zum Laden und Löschen von Wasserfahrzeugen), Wintermeyer. Fördertechnik u. Frachtverkehr, vol. 15, no. 8, Apr. 14, 1922, pp. 110–114, 11 figs. Discusses various types of cranes, electric drive, conveying platforms, etc.

Selection and Development of Double Cranes for Harbors (Über Wahl und Ausbildung von Doppelkranen fur Häfen), E. Krahnen. Fördertechnik u. Frachtverkehr, vol. 15, no. 8, Apr. 14, 1922, pp. 114–116, 8 figs. Describes new type of crane to expedite loading and unloading of ships. Combined Sction of two neighboring cranes.

Wharf, Hydraulic. Hydraulic Wharf Cranes. Shipbldg. & Shipg. Rec., vol. 19, no. 21, May 25, 1922, p. 684, 1 fig. Description of six 30-cwt. luffing cranes for port of London authority.

CUTTING TOOLS

Action of. The Action of Cutting Tools, E. G. Coker and K. C. Chakko. Engineering, vol 113, no. 2940, May 5, 1922, pp. 564 569, 18 figs. Investigation of most efficient action of various tools for shaping metals and means of determining stresses set up.

Experiments. An Account of Some Experiments on the Action of Cutting Tools, E. G. Coker. Engineer, vol. 133, no. 3462, May 5, 1922, pp. 503 505, 12 figs. Means of studying stress distribution in cutting tools by polarized light

D

DETONATION

Study of. The Background of Detonation, Stanwood W. Sparrow. Nat. Advisory Committee for Aeronautics Tech. Notes, no. 93, Apr. 1922, 17 pp., 5 figs. Consideration of several features of detonation problem which, it is claimed, have received comparatively little attention.

DIESEL ENGINES

Beardmore-Tosi The Beardmore-Tosi Marine Diesel Engine. Engineering, vol. 113, no. 2938, April 21, 1922, pp. 488–489, 4 figs. Description of main engines of single-screw motorship Pinzon

Marine. North British Diesel Machinery for 2,000-ton Twin-Screw Vessels. Mar. Engr. & Naval Architect, vol. 45, no. 536, May 1922, pp. 204–206 and 207, 3 figs. Two sets of engines for British India Steam Navigation Co. vessels Dumra and Dwarka, developing 500 b.hp. on each of twin shafts and built by North British Diesel Engine Works, Glasgow.

Merchant Marine and Electrical Industries. Use of Diesel Engines in the Merchant Marine and in Electrical Industries (Les applications du moteur Diesel dans la marine de commerce et leurs conséquences au point de vue de l'industrie électrique), Yves Le Gallou. Révue Générale de l'Électricité, vol. 11, no. 15, Apr. 15, 1922, pp. 535–543. Conditions under which Diesel engines are used on board ship, for propulsion and for driving auxiliaries; its effect on development of electrical industry.

Power Plants. Diesels at Southend. Elec. Times, vol. 61, no. 1594, May 4, 1922, pp. 429–430, 3 figs. Rapid increase in demand for electric power met by successive installations of Diesel engines.

Power Plants, Application in. Diesel Engines and Examination into Their Economic Application (Dieselmotoren, Eine Untersuchung über ihre wirtschaftliche Verwendung), Alfred Büchi. Schweizerische Bauzeitung, vol. 79, nos. 18 and 19, May 6 and 13, 1922, pp. 230–235 and 239–243, 11 figs. May 6: Compares hydroelectric with Diesel-electric power generation. May 13: Discusses Diesel engine installation in connection with water power works and gives cost calculation for water power only and water power with Diesel engines.

Submarine Type for Power Plants. Submarine Diesel Engines at Southend, Elec. Rev., vol. 90, no. 2321, May 19, 1922, pp. 688–690, 3 figs. Description of engines taken from dismantled German submarines and generating units which they operate.

Water-Works Power. Diesel Engines to Furnish Power for Water-Works, W. DeWitt Vosbury. Eng. News-Rec., vol. 88, no. 19, May 11, 1922, pp. 793–794, 2 figs. New station at Gloucester, N. J. to be equipped with motorized pumps and high-economy, oil-engine-driven generators.

E

ELECTRIC COMMUNICATION

Aurora, Effects of. Effects of Aurora on Telegraphs, Telephones and Wireless in New Zealand. Telegraph & Telephone Age, no. 11, June 1, 1922, pp. 248–249. Report by A. Gibbs, deputy chief telegraph engr., on effects of auroral phenomenon generally, and those during exceptionally brilliant display.

ELECTRIC DRIVES

Installation. Protected Motor Service, T. W. C. Hartmann. Elec. Rev. & Indus. Engr., vol. 80, no. 5, May 1922, pp. 227–228, 257 and 262, 4 figs. Recent installation at Keystone Spring Works where electric drive has speeded up machine production.

ELECTRIC FURNACES

Carbon Steel. Electric Furnace Practice on Carbon Steel, L. J. Barton. Western Machy. World, vol 13, nos. 4 and 5, Apr. and May 1922, pp. 134–137 and 173–175, 2 figs. April: Basic Operation; Two-slag practice in production of electric steel, with details of charging, melting down, chemical and other factors. May: Slagging and details of reducing period. Effects of high lime temperature tests. Finishing of heat

Cast-Iron Production. Cast Iron as Produced in the Electric Furnace, and Some of Its Problems, George K. Elliott. Am. Electrochem. Soc. advance paper, no 9, for meeting Apr. 27–29, 1922, pp. 75–87. Review of literature of electric-furnace cast iron. Discusses conditions favorable to electric furnace, and expresses preference for duplex process with basic-hearth electric furnace. Describes desulphurization and deoxidization; etc.

Electric Furnace Iron and Steel. Intermittent and Alternating Operations, W. E. Cahill. Am. Electrochem. Soc. advance paper, no. 6, for meeting Apr. 27 29, 1922, pp. 49–54. In Treadwell, Alaska, cast iron is made more cheaply in electric furnace than in cupola. Analyses figures show that from charges of all-scrap cupola-melted iron electric furnace produces metal of greatly reduced sulphur content.

Fiat. The Fiat Electric Furnace. Engineering, vol. 113, no. 2936, Apr. 7, 1922, pp. 421–422, 5 figs. partly on p. 424. Three-phase type, having a hearth slightly conductive, neutral and connected to earth. One of characteristic features is the Fiat economizer, or electrode holders.

Italian. Italian Electric Furnaces in Brazil (Forni elettrici italiani nel Brasile), Ettore Thover. Forno Elettrico, vol. 3, no. 9–10, Sept. 15-Oct. 15, 1921, pp. 115–119, 4 figs. Describes the Bassanese electric furnace plant at Juiz de Fora (Minas Geraes) having four 3-ton 400 kw. furnaces.

Metal-Melting. An A.C. Metal Melting Furnace (Ein elektrischer Metall-Schmelzofen für den Anschluss an Drehstrom), E. Fr. Russ. Elektro-

technische Zeit., vol. 43, no. 15, Apr. 13, 1922, pp. 497–499, 7 figs. Its development and practical application; can be directly connected to rotary current; furnace contains three electrodes allowing equal phase distribution.

Non-Ferrous. Metal Electric Furnaces, A. Glynne Lobley. Metal Industry (Lond.), vol. 20, nos. 14 and 15, Apr. 7 and 14, 1922, pp. 322–325 and 333–341 and (Discussion) 341–342, 6 figs. Examples of number of uses for electric furnaces not in iron and steel industry. Portion of report before Sheffield Section of Inst. of Metals.

Shaft and Open-Top. A Comparison Between Shaft and Open Top Furnaces in the Manufacture of Pig Iron Electrically from Iron Ore, R. C. Gosrow. Am. Electrochem. Soc., advance paper, no. 8 for meeting Apr. 27–29, 1922, pp. 63–74. Notes on stack and open-top type of furnace and combination open-stack type.

Types. Electric Furnaces and Electrometallurgy, Recent Patents (Les fours electriques et l'electrometallurgie d'apres les brevets recents), L. Jumau. Revue Générale de l'Électricité, vol. 11, nos. 12 and 13, Mar. 25 and Apr. 1, 1922, pp. 436–441 and 463–468, 11 figs. Mar. 23: Describes Foley induction, Greiner resistance, Ferron, Moore, and other furnaces. Apr. 1: Electrodes, electric furnaces used in manufacture of steel and production of oxides of nitrogen.

ELECTRIC LOCOMOTIVES

Condensing Turbine. The Ramsay Condensing Turbine Electric Locomotive. Engineer, vol. 133, no. 3456, Mar. 24, 1922, pp. 328–329, 2 figs. Characteristics of experimental locomotive built by Armstrong, Whitworth & Co., Ltd.: Length overall, 69 ft. 7 in., max. width, 8 ft. 3 in., total weight, including 2200 gal. water for cooling purposes and 4 tons coal, 130 tons 15 cwt.; tractive force, 22,000 lb., turbo-generator, 890 kw., at 3600 rev., voltage, 600. See also Ry. Rev., vol. 70, no. 19, May 13, 1922, p. 667.

Metropolitan Ry., London. 1,200-Hp. Electric Locomotives for the Metropolitan Railway. Engineering, vol. 113, nos. 2936 and 2938, Apr. 7 and 21, 1922, pp. 409–412 and 477–481, 32 figs. partly on supp. plate. Locomotives are 0-4-4-0 type and each have two bogie trucks of carriage type on which body is carried. Max. speed on non-stop runs is 60 mi. per hr., electric supply is at 500 to 600 volts on third-rail system, and insulated negative return rail is laid in center of track; motors are of standard series-wound type with commutating poles. Describes control gears.

ELECTRIC PLANTS

Lausanne, Switzerland. Electric Installations of the City of Lausanne (Les installations electriques de la ville de Lausanne), G. Canderay. Bul. Technique de la Suisse Romande, vol. 47, nos. 19, 21, 23, 24, Sept. 17, Oct. 15, Nov. 12 and 26, 1921, pp. 217–223, 7 figs., 241–248, 9 figs., 265–269, 8 figs. partly on pp. 270–272, 285–287, 3 figs., and vol. 48, nos. 6, 7 and 9, Mar. 18, Apr. 1 and 29, 1922, pp. 61–65, 5 figs., 73–78, 12 figs., and 103–105, 3 figs. partly on p. 102. Sept. 17: Discusses barrage of the Rhone and work connected with extension of plants. Oct. 15: Discusses work at Bois Noir; water header, turbines, alternators, transformers, etc. Nov. 12 and 26: Switching arrangements; servo-motors; cost details of construction work. Mar. 18: Describes transmission lines, poles, etc., also equipment of Pierre-de-Plan works. Apr. 1 and 29: Describes new Pierre-de-Plan works for receiving, transforming and distributing 50,000-volt current.

Waste-Fuel Utilization. Electricity from Limburg Waste Fuels (Electriciteitsopwekking uit Limburgsche afvalbrandstoffen), A. J. Ter Linden. Ingenieur, vol. 37, no. 15, Apr. 15, 1922, pp. 282–297, 26 figs. Use of low-grade fuels, brown coals, etc.; hand and mechanical stoking; results of tests that were made.

ELECTRIC RAILWAYS

Electrolysis and Inductive Interference. Effects of Electric Power Used for Traction, Chas. F. Scott. Ry. Elec. Engr., vol. 13, no. 4, Apr. 1922, pp. 113–116, 1 fig. Question of inductive interference and electrolysis as related to railway electrification.

Three-Coach Trains. Three-Coach Electric Trains of the London and North Western Railway. Tramway & Ry. World, vol. 51, no. 24, May 18, 1922, pp. 234–242, 29 figs. Description of suburban service, operating at 630 volts and several new and interesting features in connection therewith.

ELECTRIC WELDING, ARC

Structural Steel. Arc Welded Steel Building, B. C. Tracey. Welding Engr., vol. 7, no. 5, May 1922, pp. 24–25, 5 figs. Savings in time, labor and material; methods of making joints, welded joints pass tests.

The Arc Welding of Structurel Steel, E. S. Humphrys, Jr. Iron Age, vol. 109, no. 21, May 25, 1922, pp. 1422–1425, 7 figs. Tests made to determine reliability of welded joints and limiting conditions of various types of joints.

Utility. Utility Arc Welding. Engineer, vol. 133, no. 3458, Apr. 7, 1922, pp. 378–381, 8 figs. Describes what has been accomplished by small engineering firm by means of arc welding with considerable saving in time and money.

ELECTRICAL MACHINERY

Export Prospects for Latin America. Market Prospects for Electric Apparatus in Latin America and in Spain, Philip S. Smith. Elec. World, vol. 79, no. 15, Apr. 15, 1922, pp. 724–727, 4 figs. Opportunity in mining, agricultural and manufacturing fields. Status of power house, substation, transmission and railway electrification. Outlook for motor drive.

ENGINE HOUSES

Turntables. Railway Turntables. Ry. Engr., vol. 43, no. 508, May 1922, pp. 198–200, 5 figs. Technical consideration of energy required to move them and advantages of ball bearings for reducing friction.

EVAPORATORS

Vacuum, Marine Type. Vacuum Type of Evaporator Being Extensively Used on German Ships. Nautical Gaz., vol. 102, no. 19, May 13, 1922, p. 585. New device works automatically and requires very little watching. Has proved its efficiency on freighters. How operated in harbors.

EXHAUST STEAM

Utilization. The Utilization of Exhaust Steam from Electric Generating Stations, and Coal Economy, C. Ingham Haden. Instn. Elec. Engrs. Jl., vol. 60, no. 307, Mar. 1922, pp. 265–271 and (discussion) 273–286, 2 figs. Suggests combination of heat distribution with generation of electric current as possible means of using coal to better advantage, and proposes conversion of some of existing generating stations. Describes installations already carried out.

The Utilization of Waste Heat from Electrical Generating Stations, F. H. Whysall. Instn. Elec. Engrs. Jl., vol. 60, no. 307, Mar. 1922, pp. 271–272 and (discussion) 273–286, 1 fig. Suggestions based on author's personal experience of practical difficulties encountered.

F

FATIGUE

Failure By. Failure By Fatigue. Engineering, vol. 113, no. 2939, April 28, 1922, pp. 525–526. Doubts as to mathematical theory of elasticity; discussion and means of determining fatigue tendencies of material.

FERRONICKEL

Brittleness at Low Temperatures. On the Brittleness of Ferronickel at Low Temperatures (Étude de la fragilite des Ferronickels aux basses temperatures), P. Chevenard. Révue de Métallurgie, vol. 19, no. 4, Apr. 1922, pp. 209–214, 3 figs. Experiments to produce metal which would not become brittle at temperature of liquid air, to be used for accessories of liquid-air machines, and results.

FIRE ENGINES

Standardization. Standardization of Fire Engines (Zur Normung der Motorspritzen), Hupeden. Feuerwehrtechnische Zeit., vol. 10, no. 3, Mar. 20, 1922, pp. 31–38, 6 figs. Discusses pump construction, quantity of water handled, motor construction and specifications generally.

Tilling-Stevens. New Tilling-Stevens Fire Engines. Motor Transport, vol. 34, no. 898, May 15, 1922, pp. 581–582, 5 figs. Three new fire pump vehicles have just been completed at Maidstone Factory, comprising large and medium self-propelling chassis and lightweight trailer.

FIREBRICK

Testing. New Methods for Determining Compression Strength and Softening of Firebrick at High Temperatures (Neue Verfahren zur Bestimmung der Druckfestigkeit und Erweichung feuerfester Ziegel bei hoben Temperaturen). Tonindustrie-Zeitung, vol. 46, no. 57, May 16, 1922, pp. 561–563. Reviews present methods and shows that there is as yet no uniform method of testing.

FLIGHT

Soaring. Experiments on Soaring Flight (Études éxpérimentales sur le Vol a Voile), P. Idrac. Aerophile, vol. 30, nos. 1–2, 3–4 and 5–6, Jan. 1–15, Feb. 1–15 and Mar. 1–15, 1922, pp. 4–9, 35–44 and 67–76, 46 figs. Discusses prolonged flight by birds without movement of wings and theories advanced to explain it; tests made; irregularities in wind velocity; vertical component of wind velocity; makes caclulation from experiments.

The "First Experimental Congress for Motorless Flight." Flight, vol. 14, no. 19, May 11, 1922, pp. 273–274, 1 fig. French soaring and gliding competition.

FLOW OF OIL

Pipes. Flow of Oil in Pipes. Lubrication, vol. 8, no. 4, Apr. 1922, pp. 45–48, 1 fig. Investigation of properties of oil and their effects on flow through pipes.

FLUE-GAS ANALYSIS

Unburned-Gas Determination. Incomplete Combustion and Furnace Control (Unvollkommene Verbrennung und Feuerungskontrolle), D. Haarmann. Feuerungstechnik, vol. 10, no. 16, May 15, 1922, pp. 173–176, 1 fig. Shows that CO determination of flue-gas should be supplemented by analysis for unburned gases.

FORGING

Hydraulic Bulging. Hydraulic Bulging and Bending. Machy. (Lond.), vol. 20, nos. 497, 498 and 499, Apr. 6, 13 and 20, 1922, pp. 8–12, 42–45 and 75–77, 43 figs. Apr. 6: Manufacture of gramophone swan necks and horn elbows. Apr. 13: Manufacture of telephone receiver cases. Apr. 20: Tooling for production of motor side lamp.

FOUNDATIONS

Bracing. Caisson Cofferdam Foundation With Special Bracing, T. Kennard Thomson. Eng. News-Rec., vol. 88, no. 22, June 1, 1922, pp. 914–918, 6 figs. Deep cellar substructure in filled ground, First Nat. Bank of Jersey City; Caissons braced by built-up struts during excavation; toe wall holds caissons against sliding; waterproofing.

FOUNDRIES

Blast Meter, Use of. Use of a Blast Meter in Foundry Practice, Louis L. Vayda. Iron Age, vol. 109, no. 23, June 8, 1922, pp. 1581–1586, 5 figs. Measurement of air blast volume important in cupola control; methods of measurement.

Brass. Brass Foundry Equipment, William H. Parry. Metal Industry (N. Y.), vol. 20, no. 5, May 1922, pp. 179–180. List of materials and supplies required for brass foundry melting five tons of metal per day.

Electricity in. Foundry Employs Electricity for Melting and Annealing, Herbert R. Simonds. Iron Trade Rev., vol. 70, no. 22, June 1, 1922, pp. 1567–1570, 8 figs. Description of units employed by Eastern manufacturer shows electrical equipment affects economies.

Motor Castings. A New Canadian Motor Foundry Plant. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1068–1070, 6 figs. How old plant was made into new one, designed with view to future expansion. Machine molding a feature in plant of Hiram Walker & Sons Metal Products Co., Ltd., Walkerville, Ont.

Textile Machinery. A New Textile Machinery Foundry. Iron Age, vol. 109, no. 22, June 1, 1922, pp. 1499–1503, 7 figs. Machine molding and machine sand handling are features; old foundry transformed into cleaning room.

FOUNDRY EQUIPMENT

Pneumatic Tools. Pneumatic Tools in Foundry Practice, Jas. W. Anderson. Compressed Air Mag., vol. 27, no. 6, June 1922, pp. 163–166, 9 figs. Increased production resulting from adoption.

FUEL ECONOMY

France. Reducing the Cost of Motive Power (Réduction des depenses de force motrice), Ch. Molette. Outillage, Tome 259, no. 19, May 13, 1922, pp. 604–605. Generally discusses question of efficiency and shows that in nearly all cases a saving of from 10 to 20 per cent can be effected.

N. C. & St. L. Ry. Keen Competition Key to Fuel Economy on N. C. & St. L. Ry., J. B. Hill. Ry. Rev., vol. 70, no. 20, May 20, 1922, pp. 701–705, 7 figs. Rivalry based on individual and divisional fuel performance records improves entire operation of railroad.

Wabash Railroad. How the Wabash Railroad is Organized for Fuel Economy, J. B. Hurley. Ry. Rev., vol. 70, no. 20, May 20, 1922, pp. 705–708. Practical supervision, individual performance records and monthly meetings result in large fuel saving.

FUELS

See AUTOMOBILE FUELS, COAL, COKE, GASOLINE, LIGNITE, OIL FUEL, PULVERIZED COAL.

FURNACES, BOILER

Air Preheaters. European Preheater for Furnace Air. Power, vol. 55, no. 16, Apr. 18, 1922, pp. 615–616, 3 figs. Describes type of air heater, known as Thermix, manufactured by Émile Prat-Daniel, Paris, which is said to be finding extensive employment in Europe.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HOT-AIR

Developments. Recent Developments in Warm Air Furnace Heating, F. R. Still. Am. Soc. Heat. & Vent. Engrs., vol. 28, no. 4, May 1922, pp. 385–395, 5 figs. Valuable suggestions sponsored by Warm Air Furnace Code Committee, including formulas and charts and some facts about circulation stimulators.

FURNACES, METALLURGICAL

Low-Heat Gas-Fired. Furnaces Utilize Low Heat Gases, R. J. Weitlaner. Iron Trade Rev., vol. 70, no. 19, May 11, 1922, pp. 1332–1334, 6 figs. Application of split-flame principle and employment of regenerators similar to those used with open hearths enable German furnaces of recent design to operate efficiently on inferior grade fuels.

G

GAGES

Gage Blocks. Measurement of Primary Standards by the Interferometer Method. Machy. (Lond.), vol. 20, no. 503, May 18, 1922, pp. 189–193, 6 figs. Checking gage blocks by N. P. L. comparator; an extremely sensitive mechanical apparatus for testing accuracy of precision slip gages.

Gage-Block Comparator. Comparator for Checking Precision Gage-blocks, Franklin D. Jones. Machy. (N. Y.), vol. 28, no. 9, May 1922, pp. 689–693, 6 figs. Extremely sensitive mechanical apparatus, which has proved very effective at plant of Pratt & Whitney Co. for testing accuracy of precision gage blocks.

GAS

Low-Heat-Unit. Advantages of Low Heat Unit Gas, Edward L. Richa. Gas Age-Rec., vol. 49, no. 21, May 27, 1922, pp. 651–654, 659 and 660. Relative advantages to gas company and consumer of lower-heat-unit gas. Paper written for Southern Gas Assn. Annual Mtg.

GASOLINE

Water, in. Determination of Water in Gasoline as Received—Exposed to Atmosphere, to Humid Atmosphere, and Saturated with Water. Air Service Information Circular, vol. 4, no. 320, Mar. 15, 1922, 2 pp., 1 fig. Investigation to ascertain whether, sufficient amounts of water can be absorbed by gasoline to cause corrosion, and investigation of several methods for determining water in gasoline.

GEAR CUTTING

Hobbing Spur Gears. Cutting Spur Gears by Hobbing. Machy. (N. Y.), vol. 28, no. 9, May 1922, pp. 716–721, 5 figs. Setting up gear-hobbing machines; examples from practice; application of multiple-threaded hobs; cutting small pinions.

Internal Spur. Cutting Internal Spur Gears, F. D. Jones. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 776–779, 8 figs. Milling internal gear teeth with formed cutters; generating teeth on gear shaper; use of form-copying gear planer.

Mass Production. Mass Production in Gear-Cutting, Joseph Horner. Engineering, vol. 113, nos. 2935, 2937, 2938, Mar. 31, Apr. 14, Apr. 21, 1922, pp. 379–380, 443–445 and 477, 5 figs. Discusses methods associated with mass production of all kinds of gears, embracing such matters as division of operations between roughing and finishing, mounting of several blanks in series when practicable, and use of multiple cutters.

Spur. Cutting Spur Gears on Gear Planers. Machy. (Lond.), vol. 20, no. 502, May 11, 1922, pp. 153–162, 18 figs. Use of machines operating with planing action and forming gear teeth by generating from rack-shaped cutter. Sunderland system of gear generation.

Turbine Reduction Gears. Turbine Reduction Gearing and its Production, J. H. Melloy. Engineer, vol. 133, no. 3462, May 5, 1922, pp. 495–496, 3 figs. Means of attaining greatest accuracy in cutting, thereby obtaining silence, and smooth running, (Abstract) read before North-Western Section of Instn. Mech. Engrs.

GEARS

Bevel. The Assembling of Bevel Gears, Charles H. Logue. Am. Mach., vol. 56, no. 16, Apr. 20, 1922, pp. 580–584, 14 figs. Adjustment of pinion and of gear produce different results. Gears should be cut with allowance for backlash. Bottoming of teeth.

The Gleason System of Bevel Gears, F. W. McMullen and T. M. Durkan. Am. Mach., vol. 56, no. 23, June 8, 1922, pp. 849–853, 8 figs. Quietness in operation, strength and durability considered; limiting undercut; preference for low pressure angle; pressure causes wear.

The Gleason Works System of Bevel Gears, F. E. McMullen and T. M. Durkan. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 788–792, 8 figs. Description of Gleason improvement in design of form of tooth consistent with strength and wear.

New System of Bevel Gearing Developed by Recent Research, F. E. McMullen and T. M. Durkan. Automotive Industries, vol. 46, no. 20, May 18, 1922, pp. 1064–1068, 8 figs. Quietest form of tooth consistent with strength and durability. Addendum and dedendum for any pitch varies with ratio; usually different for pinion and gear. Pressure angle depends on number of teeth ratio. Paper read before Am. Gear Mfrs. Assn.

Chain. Chain Gearing. Machy. Market, no. 1124, May 19, 1922, pp. 23–25, 6 figs. Industrial applications. Facts about inverted-tooth type and larger sizes of roller chain and their uses.

Chattering. Nodal Arrangements of Geared Drives, J. H. Smith. Engineering, vol. 113, nos. 2936 and 2937, Apr. 7 and 14, 1922, pp. 438–440 and 467–469, 1 fig. Results of author's investigation of chattering of gearing. Deals with dynamics of geared drives; dynamically equivalent masses and shafts; equations of motion; effect of tooth-form irregularities. Results and general conclusions relating to critical speeds; simplification of geared drives; arranging periodicity of disturbing torques. Paper read before (British) Instn. Nav. Architects.

Comparator for Testing Teeth. Inspecting Gear and Gear Cutters at One Hundred Magnifications, Ralph E. Flanders. Iron Age, vol. 109, no. 17, Apr. 27, 1922, pp. 1137–1138 and 1183, 5 figs. Describes invention for use in connection with Hartness projection comparator for testing gear teeth. (Abstract.) Paper read before Am. Gear Mfrs.' Assn.

Helical. A Chart to Aid the Figuring of Helical Gears, W. C. Steuart. Am. Mach., vol. 56, no. 17, Apr. 27, 1922, pp. 630–633, 12 figs. Relation between elements of helical gears. Method of constructing "spiral" gear protractor. More rapid solution of problems in helical gearing.

Hot Rolling. The Hot Rolling of Gears, Reginald Trautschold. Forging & Heat Treating, vol. 8, no 5, May 1922, pp. 216–219, 2 figs. Recent developments in and perfecting of process for successful production of gears by rolling blanks heated to forging temperature. Economy of process. See also Blast Furnace & Steel Plant, vol. 10, no. 5, May 1922, pp. 270–273, 2 figs.

Hydraulic Transmission. Recent Types of Hydraulic Transmission Gear. Eng. & Indus. Management, vol. 7, no. 11, Apr. 6, 1922, pp. 323–327, 5 figs. Discusses main requisites of efficient hydraulic gear and describes Williams-Janney, Hele-Shaw, and Constantinesco systems.

Machining. Tooling Equipment for Ball Races, Camshaft and Cluster Gears. Machy. (Lond.), vol. 20, no. 504, May 25, 1922, pp. 225–229, 14 figs. Examples of concentrated tooling.

Production, Estimating. Estimating Modern Gear Production, Gustave E. Spies. Am. Mach., vol. 56, no. 22, June 1, 1922, pp. 799–804, 7 figs. Charts and a slide rule that make estimating easy; use of disk cutters and hobs; extra travel of cutters; examples of estimate sheets.

Proportions. Proportions of Industrial Gears, G. E. Katzenmeyer. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 799–802, 4 figs. Formulas and tables which are used in developing standardized industrial gears.

Spur. Backlash in Hobber Spur Gears. Machy. (Lond.), vol. 20, no. 502, May 11, 1922, pp. 163–165, 5 figs. Amount of backlash recommended to provide for unavoidable inaccuracies in machining and heat-treatment.

Strength and Proportions. Strength and Proportion of Industrial Gears, G. E. Katzenmeyer. Am. Mach., vol. 56, no. 18, May 4, 1922, pp. 666–671, 7 figs. Charts for determining strength of industrial gears. Formulas and symbols used and practical examples.

Teeth, Grinding. Gear Tooth Grinding Process Reduces Heat Treatment Distortion Dangers, Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1162–1164, 3 figs. Finishing grinding gear teeth after heat treatment big factor in eliminating noise; permits resurfacing gears already finished cut to size and surfacing of gears which have grinding stock.

The Grinding of Gear Teeth and Its Future in the Industry, R. S. Drummond. Am. Mach. vol. 56, no. 21, May 25, 1922, pp. 779–781. Application of ground gear teeth in automotive industry; overcoming effects of heat treatment; elimination of noisy gearing by grinding. Paper read before Am. Gear Mfrs. Assn.

Testing, Optical. Testing Gear and Gear-Cutter Teeth, R. E. Flanders. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 817–819, 6 figs. Description of screw-thread comparator for quickly detecting imperfections. (Abstract.) Paper read before Am. Gear Mfrs. Assn. convention.

[See also REDUCTION GEARS.]

GRINDING

Automotive Engine Parts. Grinds Automotive Engine Parts, N. H. Westervelt. Abrasive Industry, vol. 3, no. 4, April 1922, pp. 99–103, 6 figs. Grinding machines are employed extensively for finishing cylindrical and plane surfaces accurately; careful inspection is necessary.

H

HANDLING MATERIALS

German Mechanical Devices. Development of Mechanical Handling Devices in Germany During and Since the War, George Frederick Zimmer. Eng. & Indus. Management, vol. 7, no. 11, Apr. 6, 1922, pp. 334–340, 13 figs. Deals with mechanical handling devices for blast furnaces.

Port Development, and. Material Handling in Its Relationship to Port Development. Engrs. & Eng., vol. 1, no. 3, Mar. 1922, pp. 65–77 and 96. Symposium of following articles: Design of a Port to Take Full Advantage of Mechanical Equipment, by Carroll R. Thompson; What Has Been Done and What We Should Plan to Do, by Fred Jasperson; What Can Be Done with Ship's Gear, S. C. Loveland. Discussion.

[See also ASH HANDLING, COAL HANDLING.]

HEAT

Conservation. Thermotechnical Control of Works (Wärmetechnische Überwachung der Betriebe), H. Strache. Elektrotechnik u. Maschinenbau, vol. 40, nos. 16 and 17, Apr. 16 and 23, 1922, pp. 184–187 and 198–201, 5 figs. Apr. 16: Discusses means for better utilization of fuels, including heat balance and efficiency of boilers, flue gases, CO_2 determination, etc. Apr. 23: Discusses various instruments for analyzing flue gases, draft gages, temperature measurement, selection of coal.

HEATING AND VENTILATING

Individual Units. Individual Heating and Ventilating Units, James Mackay. Domestic Eng. (Chicago), vol. 99, nos. 5 and 6, Apr. 29 and May 6, 1922, pp. 189–191 and 231–232, 11 figs. Notes on construction, installation and operation.

Research. Rietschel's Work and Its Continuation (Das Werk Rietschels und seine Fortführung), K. Brabbée. Gesundheits-Ingenieur, vol. 45, no. 16, Apr. 22, 1922, pp. 205–215, 25 figs. Reviews experimental work in heating and ventilating which was carried out by Rietschel and gives examples of results obtained.

HEATING, ELECTRIC

Industrial. Industrial Electric Heating for Factories, Wirt S. Scott. Elec. Jl., vol. 19, no. 5, May 1922, pp. 203–208, 8 figs. Pointing out the many possibilities as yet partially or entirely undeveloped.

HEATING, STEAM

Central Stations. Commission for the Utilization of Fuel—4th Report (Commission d'Utilisation du Combustible). Annales des Mines, vol. 1, no. 3, Mar. 1922, pp. 192–256. Gives report of First Sub-committee on actual practice at central steam heating stations, discussing their general character, types of boilers, superheating, economizers, air preheating, feedwater, etc.

HELICOPTERS

See AIRCRAFT, Power Requirements of.

HELIUM

Production. The Industrial Production of Helium, S. G. Roberts. Sci. Am., vol. 126, no. 5, May 1922, pp. 308–309, 5 figs. Improvements in past five years toward development of non-explosive airship.

HYDRAULIC MACHINERY

Rams. Hydraulic Rams, E. W. Anderson. Instn. Mech. Engrs. Proc., no. 2, 1922, pp. 337–355, 3 figs. Description of Anderson ram developed from experiments by author.

HYDRAULIC TURBINES

High-Speed Runners. Developments in High-Speed Runners for Hydraulic Turbines, Frank H. Rogers. Power, vol. 55, no. 17, Apr. 25, 1922, pp. 640–643, 8 figs. Limitations of Francis-type runners; comparison of different types of high-speed propeller runners; location of turbine with respect to tailwater; use of inverted-type and ejector-type turbines in low-head plants.

Mixed-Flow. The American Mixed-Flow Turbine and Its Setting, Arthur T. Safford and Edward Pierce Hamilton. Am. Soc. Civil Engrs. Proc., vol. 48, no. 4, Apr. 1922, pp. 753–808, 34 figs. Review of developments of turbine runner and of water-wheel setting.

Surge Tanks. Surge Tanks, B. F. Jakobsen. Am. Soc. Civil Engrs. Proc., vol. 48, no. 4, Apr. 1922, pp. 853–869, 15 figs. Distinction between surge-tank acceleration and deceleration and difference in requirements for medium-high head and high-head plants.

HYDROELECTRIC DEVELOPMENTS

Colorado River. Tentative Plan for the Construction of a 780-Foot Rock-Fill Dam, on the Colorado River, at Lee Ferry, Arizona, E. C. LaRue. Am. Soc. Civil Engrs. Proc., vol. 48, no. 4, Apr. 1922, pp. 835–852, 7 figs. Discusses practicability of constructing rock-fill dam in Colorado River; designed to raise water 700 ft. above river bed.

Colorado River Project. The World's Greatest Electrical Project, C. H. Peirson. Universal Engr., vol. 35, no. 5, May 1922, pp. 29–31. Plan to develop two and one-half million hp. of electric energy for power purposes.

HYDROELECTRIC PLANTS

Auxiliaries, Selection of. Selection of Auxiliaries for Hydro-Electric Power Stations, F. H. Rogers. Power, vol. 55, no. 20, May 16, 1922, pp. 775–777, 4 figs. Pumping statements for governor fluid. Lubrication statements for bearings. Small water wheels for auxiliary power.

Developments. Hydro-Electric Developments Involve an Expenditure of $150,000,000. Elec. World, vol. 79, no. 19, May 13, 1922, pp. 951–953, 2 figs. Construction in progress under licenses granted by Federal Power Commission involves almost 1,750,000 hp. Big Creek project largest for which license has been granted.

Kern River, California. Hydroelectric Installation on the Kern River, Ely C. Hutchinson. Universal Engr., vol. 35, no. 5, May 1922, pp. 23–26, 7 figs. Two turbo-generators arranged for dual operation at either 50 or 60 cycles; unique equipment for efficient use of water supply. (Abstract.) Paper presented at meeting of San Francisco Section of A.S.M.E.

New Brunswick. New Hydro Plant in New Brunswick. Contract Rec., vol. 63, no. 20, May 17, 1922, pp. 474–477, 5 figs. Unique installation just completed at Musquash River near St. John. Actually 2 plants in one. Work of New Brunswick Power Commission.

Smoky Falls, Ont. Smoky Falls Development on the Sturgeon River, C. C. Irvine. Can. Engr., vol. 42, no. 15, Apr. 11, 1922, pp. 377–379, 4 figs. Details of hydroelectric plant for Spanish River Pulp and Paper Mills at Smoky Falls, Ont. Present installation of 5200 hp. in two units with provision for two more units. Details of turbines and generators.

Western, Special Problems. Western Hydroelectric Development Meets Special Problems. Jl. Elec. West. Industry, vol. 48, no. 10, May 15, 1922, pp. 400–402. Western practice in meeting special conditions of water-power development on this coast analyzed in comprehensive report of hydraulic power committee of Pacific Coast electrical association.

I

IMPACT TESTING

Methods. A Discussion of Impact Testing Methods and the Results Obtained, John M. Lessells. Am. Soc. for Steel Treating Trans., vol. 2, no. 8, May 1922, pp. 659–672, 22 figs. Value of this method which shows up characteristics in heat-treated steel and not evident from conventional tests.

INDUSTRIAL MANAGEMENT

Bosses. Management that Includes Bosses in the Office and in the Shop, Frank E. Gooding. Elec. Rev. & Indus. Engr., vol. 80, no. 5, May 1922, pp. 260–261. Influence of industrial engineering on earnings of capital and labor. Conservation of materials, plant and equipment, and labor. Discussion at meeting of Soc. Indus. Eng.

British Factory. Scientific Management in the British Factory, Wm. J. Hiscox. Am. Mach., vol 56, no. 23, June 8, 1922, pp. 837–838. Considered by some a revolutionary movement; why it cannot be adopted as a whole; methods not popular with organized labor.

Cost Recording and Production Control. Cost Recording and Production Control in Drop-Forging Plants, H F Ouler. Machy (N Y) vol 29 no 10, June 1922, pp. 807-809, 3 figs. Description of system of management which has proven very successful in two drop-forging plants.

Divergence Charts. Divergence Charts and Their Uses, G. W. Greenwood. Management Eng., vol 2, no. 6, June 1922, pp 347 350 4 figs. Means of presenting absolute differences between two magnitudes from month to month, and value of same.

File Factory, Organisation of. The Organisation of File Factories, H. G. Smith. Eng. & Indus. Management, vol. 7, no. 15, June 1, 1922, pp. 473-477. Development of organisation from point when manufacturer orders raw material. Lecture before Sheffield File Trades Technical Soc.

Foundry Control. Co-ordinating Foundry Control, D. M. Avey. Iron Trade Rev., vol 70, no 22, June 1, 1922, pp. 1563-1566, 7 figs. How five large castings manufacturing plants solved problem of executive control involved through combining direction of general shop practice and research under one directing head.

Inspection Methods. Inspection Methods, E. Fairbrother. Eng. Production vol 4, no 78, 79 and 80, Mar 30, Apr 6 and 13, 1922, pp. 303-306, 314-319 and 338 343, 33 figs. Development and practice. Notes on duties of an inspector, location of inspection department in factory. A system is described. Paper presented before Instn. Production Engrs.

Locomotive-Shop Schedules. Scheduling Operations in a Locomotive Repair Shop. Boiler Maker, vol. 22 no. 5, May 1922 pp 121 125 and 138, 8 figs. Planning and routing repair operations and material; checking work as completed according to department schedules, eliminating delays by means of foremen check sheets.

Manager's Problems. Solving the Manager's Present Day Problems, John H. Van Deventer. Indus. Management, vol. 63, no 6, June 1922, pp. 321 324. Fixity and flexibility as factors in organization.

Organization for Small Plant. A Workable Organization Plan for the Small-Plant Manager, M. B. Bartlett. Factory, vol 28, no. 6, June 1922, pp. 640-643, 662 and 664, 3 figs. Practical system covering cost and purchase records, routine adaptable to most small plants.

Personnel Department, Duties of. Duties of a Personnel Department in an Industrial Plant, Bruce F. Brown. Jl Elec. & West. Industry, vol. 48, no. 11, June 1, 1922, pp. 443-444. How one successful western industry has solved industrial problems among its workers by developing scope of its personnel department.

Production Planning. Planning with Equipment Standards, Chester D. Buoy. Indus. Management, vol. 63, no. 6, June 1922, pp. 363-365, 2 figs. Effective means of putting accurate and complete equipment standard data at service of planning department.

Production Regulation. Managing Production According to the Business Cycle, Ernest F. DuBrul. Management Eng., vol. 2, no. 6, June 1922, pp. 343-346, 1 fig. Fitting supply to demand in booms and depressions, analyzing business cycles.

Records, Equipment and Inspection. Equipment and Inspection Records. Elec. Rev. & Indus. Engr., vol. 80, no. 5, May 1922, pp. 211-213 and 216, 3 figs. Description of simple system which can be modified to suit large or small shop requirements.

Slow Sales. The Factory Cure for Slow Sales, E. L. Wayman. Factory, vol. 28, no. 6, June 1922, pp. 631-635, 2 figs. Investigation into production results in improvement in sales.

Stock Control. Flexible Stock Control at Lower Cost, H. J. Whitten. Factory, vol. 28, no. 5, May 1922, pp. 536-538 and 552, 3 figs. Notes on modern scientific store methods.

Works Organization. Works Organization—T. E. Pattinson. Eng. & Indus. Management, vol. 7, nos. 12, 13 and 14, Apr. 20, May 4 and 18, 1922, pp. 354-356, 388-391 and 430-431, 19 figs. Discusses ways of dealing with scrap and gives scrap charts. Machine-shop layout and operation. Paper read before Instn. Production Engrs.

INDUSTRIAL ORGANIZATION

Modern. Modern Industrial Organization, Hugo Hirst. Electrician, vol. 88, no. 2297, May 26, 1922, pp. 625-626. Some views gathered from 35 years' experience along this line. Based on address before Assn. Civil Servants.

INDUSTRIAL TRUCKS

Steam. Garrett Under-Type Steam Wagon. Engineer, vol. 133, no. 3458, Apr. 7, 1922, pp. 384-386, 13 figs. partly on supp. plate and p. 388. Features of interest of six-ton steam wagon are employment of pressed steel frame, double-chain drive, pedal speed regulator, and employment of Timken roller bearings.

INSULATION

Refrigerating Field. The Economic Thickness of Insulation in the Refrigerating Field, P. Nicholls. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 3, Apr. 1922, pp. 343-358, 6 figs. Espense caused by leakage of heat, and formulas whcih include all definite expense factors. Consideration of case of walls of ice and cold-storage houses.

INTERNAL-COMBUSTION ENGINES

Hesselmans. A New Internal-Combustion Engine (En ny förbränningsmotor), E. Hubendick. Teknisk Tidskrift, vol. 52, no. 16, Apr. 22, 1922, pp. 259-266, 15 figs. Describes in detail the Hesselmans engine, its construction, and results of tests made with it.

[See also AIRPLANE ENGINES, AUTOMOBILE ENGINES, DIESEL ENGINES, OIL ENGINES, SEMI-DIESEL ENGINES.]

IRON

Spontaneous Ignition of Aluminum and. Spontaneous Ignition of Iron and Aluminum Chips (Die Selbstentzündung von Eisen- und Aluminiumspänen). Wärme- und Kälte-Technik, vol. 24, no. 8, Apr. 15, 1922, p. 97. Discusses the danger and recommends storage under water.

IRON INDUSTRY

Lorraine and Luxemburg. German Development of Iron Industries in Lorraine and Luxemburg to the End of 1918 (Stand des deutschen Ausbaues der lothringischen und luxemburgischen Eisenindustrie bis zum Jahre 1918), Walther Haug. Stahl u. Eisen, vol. 42, no. 19, May 11, 1922, pp. 728 734, 8 figs. Detailed description of development of blast-furnace works Karlshütte, Diedenhofen, and condition of works at end of 1918.

L

LADLES

Geared Design. Design Affects Ladle Operation, A. W. Gregg. Iron Trade Rev., vol 70, no. 23, June 8, 1922, pp. 1648-1650, 4 figs. Different types of gearing have direct relation to ease in handling and safety; merits and disadvantages of worm, spur and helical worm gears; care of equipment emphasized. From paper read before Am. Foundrymen's Assn.

LATHES

Automatic. Milling Eight Transmission Covers At One Time, J. H. Moore. Can. Machy., vol. 27, no. 18, May 4, 1922, pp. 33-35, 8 figs. Describes automatic lathe designed for rapid production of duplicate parts in large quantities.

Turret. Saving Money by Means of the Turret Lathe, H. Alton. Can. Machy., vol 27, no. 21, May 25, 1922, pp. 17-20, 10 figs. Production increased by efficient chucks and work-holding fixtures; indexing devices with ample wearing surface most suitable; machining hydraulic shock absorber; operations on bronze valve.

LIGHTHOUSES

Kerosene Lights. Developments in the Use of Paraffin for Coast Lighting. Engineering, vol. 113, no. 2940, May 5, 1922, pp. 541-544, 4 figs. Description of "Matthews," "Lux" and "Hood" burners; intensity of illumination and economy of each.

LIGHTING

Buildings. The Lighting of Public Buildings, A. L. Powell and Edgar Parker. Illuminating Eng. Soc. Trans., vol. 16, no. 9, Dec. 30, 1921, pp. 533-550, 13 figs. Lighting of art galleries, statuary, museums, libraries, municipal, county and state buildings, and banks. Bibliography.

Illumination Requirements for Workshops of Optical and Precision Instruments (Die lichttechnischen Anforderungen an die Beleuchtung von Optiker- und Feinmechaniker-Werkstätten) H. Lux. Deutsche Optische Wochenschrift, vol. 8, nos. 19 and 20, May 7 and 14, 1922, pp. 350-353 and 372-373, 1 fig. Discusses standards of German Illumination Soc. on general and local lighting, daylight and artificial lighting, etc.

Factory. Lighting the Factory, S. G. Hibben. Factory, vol. 28, no. 5, May 1922, pp. 523-526, 6 figs. Discusses harnessing daylight with refracting prisms, curtains and ground glass; and substituting for artificial light in whole or in part.

Industrial. Industrial Illumination. Eng. & Indus. Management, vol. 7, no. 14, May 18, 1922, pp. 450-451, 453, 455 and 457-460, 11 figs. Effect of good lighting on production; choice of lamps and fittings; correct light distribution; increasing workers' efficiency; economy in workshop.

Signs, Legibility. Factors that Determine Sign Legibility, C. A. Atherton. Elec. World, vol. 79, no. 21, May 27, 1922, pp. 1061-1064, 6 figs. Distance at which electrical announcements can be read may be diminished by brightness of lamps; atmospheric absorption compensates for brightness; mathematical relation of factors as determined by research.

Street. Highway Lighting, H. H. Ashinger. Elec. Jl., vol. 19, no. 5, May 1922, pp. 194-195, 2 figs. Design features of lighting units.

Improved Lighting System to Be Installed on Lincoln Highway, H. H. Bell. Elec. World, vol. 79, Apr. 15, 1922, pp. 731-732, 5 figs. Among features which it is intended shall mark completed work are concentration of light on roadway, flexibility of arrangement and reasonable cost of installation and maintenance.

The Value of Improved Street Lighting, C. H. Shepherd. Elec. Jl., vol. 19, no. 5, May 1922, pp. 187-190, 4 figs. Bringing out importance of proper street illumination and value to community

LIGNITE

Burning. Direct Drying of Brown Coal by Flue Gases and Firing the Dried Coal in Powder Form (Unmittelbare Trocknung der Rohbraunkohle mittels Feuergasen und Verheizung der getrockneten Kohle in Staubform), Max Weiss. Technische Blätter, vol. 12, No. 18, May 6, 1922, pp. 185-186, 3 figs. Describes installation of this kind in operation at Becker steel works at Willich.

LOCOMOTIVE BOILERS

Firebox Crown Stays. Stresses in the Firebox Crown Stays of Locomotive Boilers. Engineering, vol 113, no 2939, April 28, 1922, pp 514 515, 4 figs. Staybolts directly connected to shell plating of cylindrical form as means of eliminating secondary stresses. Formulas and tables showing stresses.

LOCOMOTIVES

British and American. British and American Locomotive Design and Practice, P. C. Dewhurst. Engineer, vol 133, no. 3456, Mar 24, 1922, pp. 335-336. Comparison of systems. See also Ry. Gaz., vol. 36, no. 14, Apr 7, 1922, pp. 593-596. (Abstract.) Paper read before Instn. Mech. Engrs.

British 4 6-2. 4 6 2 Type Passenger Locomotive for the Great Northern Railway. Engineering, vol. 113, no 2937, Apr. 14, 1922, pp. 454-456, 6 figs. Engine has three cylinders, 20 in. by 26 in., and coupled wheels 80 in. in diam.; grate area, 41 25 sq. ft., coupled with firebox heating surface, 215 sq. ft. Boiler is of conical type, with front-ring barrel diam. of 69 in.

Construction. Locomotive Construction. Eng. Production, vol. 4, nos 79 and 80, Apr. 6 and 13, 1922, pp. 321-327 and 347-351, 28 figs. Methods in Great Western Works at Swindon, England.

Design and Practice. British and American Locomotive Design and Practice, P. C. Dewhurst. Ry. Engr., vol 43, no. 508, May 1922, pp. 169-172. Summary of paper read at recent meeting of Inst. of Mech. Engrs.

Decapod. Russian "Decapod" Locomotives, A. Lipetz. Ry. Engr., vol. 43, nos. 505 and 507, Feb. and Apr. 1922, pp. 51-54 and 136-137, 9 figs. Describes new 2-10-0 type locomotive built in America to conform with Russian Ministry of Railways specification.

4-Cylinder Compound Rack Type. Four-Cylinder Compound Rack Type Locomotives (Cl+Z) at the Höllental Railroad in Baden (Die Vierzylinderverbund-Reibungs- und -Zahnradlokomotiven (Cl+Z) auf der badischen Höllentalbahn). Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 15, Apr. 15, 1922, pp. 361-366, 13 figs. Design; construction; equipment; performance; operation.

Power Transmission in. Power Transmission in Locomotives From the Engine to the Wheels (Di alcuni dei principali biellismi per trasmissione del movimento dai motori alle ruote nelle locomotive a motori rotanti), Andrea Caminati. Elettrotecnica, vol. 9, no. 10, Apr. 5, 1922, pp. 222-230, 19 figs. Principles of individual transmission, and for various combinations of wheels.

Tests. Results of Tests With Steam Locomotives (Versuchsergebnisse mit Dampflokomotiven), R. Sanzin. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 251, 1921, 37 pp., 28 figs. Describes tests carried out with special runs to determine maximum tractive power and gives particulars as to fuel, evaporation, etc.

Turbine, Application of. Application of the Turbine to Locomotive Practice. Can. Ry. & Mar. World, no. 292, June 1922, pp. 280-281. Various recent experiments in application of turbines to locomotives.

Turbine Type. Turbine Locomotive Saves 52 Per Cent in Fuel. Ry. Age, vol. 72, no. 22, June 3, 1922, pp. 1295-1296, 1 fig. Describes many novel features of design brought out by Ljungstrom Turbine Co. of Sweden.

Uniflow, Developments. Recent Developments in the Unaflow Locomotive. Ry. Mech. Engr., vol. 96, no. 5, May 1922, pp. 247-250, 7 figs. Exhaust ejector effect overcomes handicap of high compression and reduces size of cylinders.

LUBRICATING OILS

Viscosity. Influence of Viscosity on Operation of Oiling Systems, W. F. Osborne. Power, vol. 55, no. 21, May 23, 1922, pp. 820-821. Mechanical considerations where oil is to be used; effect of viscosity.

LUBRICATION

Filtering Methods. Modern Filtering Methods for Lubricating Systems, W. F. Osborne. Power, vol. 55, no. 24, June 13, 1922, pp. 930-931, 3 figs. Advantages and disadvantages of five general methods.

M

MACHINE TOOLS

Attachments. Attachments for Surfacing, Boring, and Drilling Machines. Engineer, vol. 133, no. 3458, Apr. 7, 1922, p. 395, 5 figs. Describes series of attachments now being made by H. W. Kearns & Co., Ltd., Broadheath, including vertical milling, flange-drilling and grinding attachments and dial traverse indicators.

Automatic. Automatic Machines Replace Hand Labor. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1057-1060, 8 figs. Element of human error eliminated and production costs reduced with special equipment at plant of Bock Bearing Co., Toledo.

Design. Methods of Machine Tool Design, A. L. DeLeeuw. Am. Mach., vol. 56, nos. 16 and 17, Apr. 20 and 27, 1922, pp. 577-579 and 617-620, 3 figs. Points out that usual machine-design methods do not always apply in designing machine tools. Apr. 20: Definition, classification and requirements of a machine tool. Apr. 27: Design of commercial and single-purpose machines contrasted. Shorthand symbols for designer.

Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach. vol. 56, no. 19, May 11, 1922, pp. 702-705, 6 figs. Methods employed in designing tools for turret lathes. Use of layouts and

sketches, familiarity with machines necessary for designer.

Design Standards. Tool Design Standards, H. P. Losely. Machy. (N. Y.), vol. 28, no. 9, May, 1922, pp. 713–715, 2 figs. Development of standard instruction sheets for use of tool designers.

Railway Shops. Machine Tools in the Railway Shop. Eng. Production, vol. 4, nos. 76, 77, 78, 79, 80, 81, 82 and 83, Mar. 16, 23, 30, Apr. 6, 13, 20, 27 and May 4, 1922, pp. 244–248, 279–283, 293–297, 329–332, 352–357, 366–370, 398–403 and 427–432, 106 figs. Review of latest practice in machine-tool and other equipment designed for use in railway shops. Describes representative types of modern equipment.

MACHINE WORK

Optical Instruments, Use in. Use of Optical Instruments in Machine Work. Am. Mach., vol. 56, no. 19, May 11, 1922, pp. 697–701, 19 figs. Microscope and projector used to check location and contour of work. Accurate gear and rack cutting; an eyepiece with radial lines.

MAGNESIUM

Use in Foundry. Magnesium and Its Use in the Foundry (Le Magnésium et son utilisation en Fonderie), J. Gaillard. Fonderie Moderne, no. 1, Jan. 1922, pp. 17–21. Substitution of aluminum by magnesium, and chemical properties of latter; magnesium alloys; etc.

MAGNESIUM ALLOYS

Dowmetal. Dowmetal and Its Applications, J. A. Gann. Am. Soc. for Steel Treating Trans., vol. 2, no. 7, Apr. 1922, pp. 607–615 and (discussion) 615–619, 14 figs. Describes series of magnesium alloys produced by the Dow Chemical Co., commercially known as dowmetal. Characteristics and uses.

MARINE BOILERS

Economic Equipment and Operation. Possibilities of Further Economy in Marine Boilers, John Reid. Engineering, vol. 113, no. 2937, Apr. 14, 1922, pp. 472–475, 8 figs. Author suggests certain remedies for heat losses in Scotch boilers and indicates how they may be applied. Paper read before (British) Instn. Nav. Architects.

MATERIALS

Pressure Effect on Physical Properties. Change of the Physical Properties of Materials with Pressure, Erskine D. Williamson. Franklin Inst. Jl., vol. 193, no. 4, Apr. 1922, pp. 491–513, 8 figs. Tools employed in experiments. Change of electrical resistance with pressure; effect of pressure on thermoelectromotive force at junction of two metals; conductivity of solutions; effect of pressure on compressibility; and on viscosity of liquids.

MEASUREMENTS

Flattening of Measuring Bodies. The Validity of the Hertzian Formulas for the Calculation of the Flattening of Measuring Bodies (Ueber die Gültigkeit der Hertzschen Formeln zur Berechnung der Abplattung von Messkörpern), G. Berndt. Zeit. fur technische Physik, vol. 3, nos. 1 and 3, 1922, pp. 14–21 and 69–78, 2 figs. Investigation of validity of Hertz's formulas for calculation of deformation of unlevel surfaces of measuring bodies.

MEASURING INSTRUMENTS

Selection and Use. The Selection and Use of Instruments in Industrial Plants, Frederick J. Schlink. Management Eng., vol. 2, no. 6, June 1922, pp. 337–342, 6 figs. Importance of care in selection and use, and suggestions.

METALS

Kinetic Theory and Thermal Energy. On the Kinetic Theory of Solids (Metals) and the Partition of Thermal Energy, B. M. Sen. Lond., Edinburgh, & Dublin Philosophical Mag., vol. 43, no. 256, Apr. 1922, pp. 672–687, 1 fig. Part I: Investigation of theory of solid state with rough working model of 14 molecules placed on sphere about each individual molecule at center. Part II: Restatement of theory for cubic and face-centered cubic crystals.

Mechanical Properties. On the Variation of Mechanical Properties of Some Metals and Alloys at Low Temperatures (Sur la variation des propriétés mécaniques de quelques métaux et alliages aux basses températures), Léon Guillet and Jean Cournot. Révue de Métallurgie, vol. 19, no. 4, Apr. 1922, pp. 215–221, 9 figs. Describes experiments with special steels, ferronickel, cobalt, copper alloys, and aluminum alloys, and gives results in tabular form.

MICA

Properties and Uses. Properties and Uses of Micas. Instn. Elec. Engrs. Jl., vol. 60, no. 307, Mar. 1922, pp. 339–342 and (discussion) 342–346. Notes on specifications, identification tests; selection mica and micanite for commutators; commutator segment separators; rings and cones. Report from British Elec. & Allied Industries Research Assn. See also India-Rubber Jl., vol. 63, no. 19, May 13, 1922, p. 16.

MONEL METAL

Arc-Welding, Metallic Deoxidizers. The Use of Metallic Deoxidizers in Arc-Welding with Monel Metal, P. D. Merica and J. G. Schoener. Am. Welding Soc. Jl., vol. 1, no. 5, May 1922, pp. 13–18, 6 figs. New method which has overcome difficulties of welding this metal. Welding properties of monel metal; preparation and composition of coating powder; some tests of arc welding.

MOTOR BOATS

French Navy, Coastal. Coastal Motor Boat for the French Navy. Engineering, vol. 113, no. 2940, May 5, 1922, pp. 548–551, 15 figs. Description of small high-speed torpedo vessels which are adopted as result of usefulness during war.

MOTOR BUSES

Garford and Fageol. New Designs Added to Growing List of Special Bus Chassis. Automotive Industries, vol. 46, no. 19, May 11, 1922, pp. 1003–1005, 4 figs. Underslung springs and worm permit use of lower body platforms, while kickup in frame gives necessary axle clearance. Wider tread gives more body space and greater stability. Unit powerplant used in Fageol stage.

Paris. A New Parisian Omnibus (Un nouvel Omnibus parisien), Jean Texier. Industrie des Tramways, vol. 16, no. 182, Feb. 1922, pp. 37–41, 6 figs. Details of construction of a three-axle motor bus having 48 seats with front and back wheels driven.

MOTOR TRUCKS

Construction, German. The Present Status of German Motor Truck Construction (Der Stand des deutschen Lastkraftwagenbaues), Erwin Aders. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 16 and 17, Apr. 22 and May 6, 1922, pp. 387–391 and 443–447, 31 figs. Apr. 22: Discusses increased employment of motor trucks; improvements in construction, especially of engines, lubrication, atomizers, cooling, etc. May 6. Driving, braking, spring suspensions, etc.

Design. Motor Truck Design from the Truck Buyer's Viewpoint, Cornelius R. Myers. Indus. Management, vol. 63, no. 5, May 1922, pp. 273–281, 11 figs. Important features in buying transportation which might be overlooked in salesman's emphasis on detail.

Logging Methods. Motor Truck Logging Methods, Frederick Malcolm Knapp. Univ. of Wash. Eng. Exper. Station Bul., no. 12, Apr. 1921, pp. 3–29, 13 figs. Useful facts for ordinary truck type not including tractor and caterpillar.

Motors. Thermic Importance of Motors for Trucks (Thermische Vervollkommnung der Kraftwagen-Motoren), Heller. Archiv fur Warmewirtschaft, vol. 3, no. 4, Apr. 1922, pp. 67–70, 17 figs. Method of packing; limitation of heat transmission to walls; experiments with pistons of various alloys; play and wear of pistons; etc.

Producer-Gas-Fueled. Land Transport and the Gas Producer, R. J. Mitchell. Eng. Rev., vol. 35, no. 10, Apr. 1922, pp. 335–337, 1 fig. Description of gas producer developed by D. J. Smith applied to motor truck which shows marked economy over liquid-fueled type.

Straker-Squire. The 5-ton Straker-Squire Chassis, Automobile Engr., vol. 12, no. 163, May 1922, pp. 130–138, 18 figs. One of few entirely new British designs since war which abounds in original features; 58 hp. at 1100 r.p.m.

MOTORSHIPS

Diesel Machinery for Single-Screw. Diesel Machinery for Single-Screw Motor Ships, James Richardson. Engineering, vol. 113, no. 2936, Apr. 7, 1922, pp. 416–419, 8 figs.; also Shipbldg. & Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 471–475, 8 figs. Deals with problems inherent to single-screw Diesel machinery. Paper read before (British) Instn. Nav. Architects.

N

NON-FERROUS METALS

Gas Absorption and Oxidation. Gas Absorption and Oxidation of Non-ferrous Metals, B. Wyoski and J. W. Boeck. Trans. Amer. Inst. Min. & Met. Engrs., issued with Min. & Metallurgy, May 1922, no. 1160-N, 8 pp., 2 figs. Argument that oxidation and gassing of bronzes and red brasses can not take place simultaneously, and conditions effecting each.

O

OIL

Crude. Properties of Some Typical American Crude Oils. Oil Eng. & Finance, vol. 1, no. 19, May 29, 1922, pp. 613–616. Selected analyses from 33 Western oils and 39 from Eastern fields, carried out under auspices of U. S. Bur. Mines.

OIL ENGINES

Airless-Injection. New Airless-Injection System for Oil Engines, E. Lundgren. Motorship, vol. 7, no. 6, June 1922, pp. 444–445, 4 figs. Remarkable results obtained from highly scientific experiments made by Hesselman in Sweden.

Design and Operation. Oil Engine Hints. Power Plant Eng., vol. 26, no. 11, June 1, 1922, pp. 565–569, 5 figs. Proportions, installation of engine, operating suggestions for modern installation.

Foundations. An Erector's Experiences in Building Oil-Engine Foundations, L. H. Morrison. Power, vol. 55, no. 17, Apr. 25, 1922, pp. 651–654, 8 figs. Increasing use of this type of engine makes consideration of details of foundation design important.

OIL FUEL

Heavy Oils. Receiving Heavy Fuel Oils (Réception des combustibles liquides lourds). Bul. Technique du Bureau Veritas, vol. 3, nos. 11 and 12, Nov. and Dec. 1921 and vol. 4, no. 1, Jan. 1922, pp. 272–276, 293–295 and 8–13, 16 figs. Nov.: Calorific power and determination of quantity of sulphur. Dec.: Sampling on board ship with or without convenience of a laboratory. Jan.: Sampling of tanks, tank steamers, etc., and calculation of quantities taken aboard.

Receiving Heavy Liquid Fuels, Fuel Oils and Gas Oils (Reception des combustibles liquides lourds). Bul. Technique du Bureau Veritas, vol. 3, nos. 11 and 12, Nov. and Dec. 1921, pp. 272–276 and 293–295, 9 figs. Nov.: Distillation of oils, and experience with various apparatus. Dec. Testing on board ship with and without apparatus:

OPEN-HEARTH FURNACES

Design. Design of Open-Hearth Furnaces, A. D. Williams. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1075–1076. Consideration of port areas and velocities as affected by pressures; chimney height determined.

Fuel Utilization. Utilizing Fuels in Open Hearths, Herbert F. Miller, Jr. Iron Trade Rev., vol. 70, no. 23, June 8, 1922, pp. 1646–1647 and 1650, 6 figs. Present pressures of both air and gas in gas-fired furnaces are too low and should be increased from ounces to pounds; experiments show that time of heating may be reduced. From paper read before Am. Iron & Steel Inst.

Valve Design. Improving Reversing Valve Design, Wm. C. Bulmer. Iron Trade Rev., vol. 70, no. 22, June 1, 1922, pp. 1560–1561 Types of air or gas valve providing most effective seal and affording unrestricted passage is considered best for open hearths; water-cooled slide with inclined seat is favored.

OSCILLOGRAPHS

Turbo-Generator Investigation. Investigation of Oscillation Phenomena in Turbo-Generators (Untersuchung von Schwingungserscheinungen an Turbo dynamos mit Hilfe des Vibrographen), Jos. Geiger. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 18, May 6, 1922, pp. 437–440, 39 figs. Explains investigation by means of vibrograph; methods of measuring used; successful methods adopted to eliminate vibration.

OXY-ACETYLENE CUTTING

Cutting Machines. Efficiency of Machine Cutting F. J. Maeurer. Welding Engr., vol. 7, no. 5, May 1922, pp. 17–23, 25 figs. Cutting with oxy-acetylene torch can be made to approach very closely maximum theoretical efficiency. Paper read before Am. Welding Soc.

Underwater. Cutting Metals Under Water. Robert G. Skerrett. Compressed Air Mag., vol. 27, no. 5, May 1922, pp. 129–133, 14 figs. Repairing broken 36-in. diam. water main under New York Harbor by means of submarine torch and compressed air.

OXY-ACETYLENE WELDING

Water Main, Submarine. The Repair of The New York-Brooklyn Submarine Water Main. Engineering, vol. 113, no. 2939, April 28, 1922, pp. 509–511, 8 figs. Account of procedure and discussion of apparatus used.

P

PAINTS

Photometric Integrating Spheres, for. Paints for Integrating Spheres, A. H. Taylor. Illuminating Eng. Soc. Trans., vol. 16, no. 9, Dec. 30, 1921, pp. 587–590 and (discussion) pp. 599–605. Requirements of satisfactory paint. Preparation of zinc-oxide paint now being used at Bur. of Standards.

PAPER MANUFACTURE

Power. Power Used in Papermaking, A. G. Darling and H. W. Rogers. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 20–24. Heat and mechanical energy must be balanced. Demands for steam in processes.

Water Wheels. Water wheels in Making Groundwood, Adolph F. Meyer. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 58–66. Suggestions as to selection and regulation of speed of water wheels for grinding machinery. Paper read before Tech. Assn. of Pulp & Paper Industry.

PAPER MILLS

Electric Generation of Steam. Electric Generation of Steam, Horace Drever and Frank Hodson. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 73–75 and 78–81, 3 figs. Recent development in conversion of electric energy into steam by means of electric steam generator; underlying theories and practical application. Paper read before Technical Assn. of Pulp and Paper Industry.

Electricity in, Use of. Electricity in the Paper Mill, R. W. Leeper. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 24–28. Uses of the force from power plant to finished product.

Water-Power Sources, Canada. Mill Waterpower Sources in Canada. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 11–18, 8 figs. Paper prepared by Dominion Water Power Branch of Dept. of Interior, Ottawa, Ont., giving power supply of various mills in Canada.

PATENTS

Ownership, Employer and Employee. Relation of Employer and Employee as Regards Ownership of Patents, Maurice Block. Chem. Age (N. Y.), vol. 30, no. 5, May 1922, pp. 201–202. Discussion of rights of employer and employee in patents on inventions developed by an employee. Legal precedents.

PETROLEUM

Bibliography. Recent Articles on Petroleum and Allied Substances. U. S. Bur. of Mines Reports on Investigations, serial no. 2340, Mar. 1922, 20 pp. Bibliography compiled by E. H. Boroughs.

Federal Specification Revision. Federal Government Revises Petroleum Specifications. Automotive Industries, vol. 46, no. 19, May 11, 1922, pp. 1012-1013, 1 fig. Color test only change of importance in respect to motor gasoline. Points on distillation curve unchanged. Viscosity limits on lubricating oils are altered and some minor changes are made in other items.

PHOSPHOR BRONZE

Properties and Manufacture. Phosphor-Bronze from the Engineering Standpoint, R. T. Rolfe. Metal Industry, vol. 20, nos. 18 and 19, May 5 and 12, 1922, pp. 413-416 and 437-438, 3 figs. May 5: Classification, composition and tests. Manufacture, microstructure and bearing properties of 85-15. May 12: Alloys for gear wheels and characteristics. Manufacture and uses of malleable.

PHOTOELASTICITY

Application to Engineering Problems. Photo-Elasticity and Its Application to Engineering Problems, P. Heymans. Tech. Eng. News, vol. 3, no. 3, June 1922, pp. 80-85, 96 and 100, 27 figs. Application of temporary birefraction properties, shown by transparent bodies when stressed, on general stress determinations.

PIGMENTS

Titanium. Manufacture and Properties of Titanium White (Fabrication et propriétés du blanc de titane), Ch. Coffignier. Chimie & Industrie, vol. 7, no. 4, Apr. 1922, pp. 651-661, 11 figs. Manufacture and properties of white pigments in Norway, America and France; describes Devaux, Paquet and Andreu processes.

PIPE LINES

Capacity-Calculation Chart. A Linear Chart for Calculating Pipe Line Capacities, C. H. M. Burnham. Natural Gas Industry, vol. 16, no. 5, May 1922, p. 163. Graphic method of solving usual pipe line capacity equation.

Superheated Steam. The Most Economic Pipe Diameter for Superheated Steam Lines (Der billigste Rohrdurchmesser für Heissdampf-Kraftleitungen), O. Denecke. Wärme, vol. 45, nos. 8, 9, 10 and 11, Feb. 24, Mar. 3, 10 and 17, 1922, pp. 104-105, 113-115, 125-128 and 136-139, 3 figs. Mathematical paper discussing pipe diameter for least steam loss on saturated-steam lines; most economic diameter for various loads of machines; increase of yearly operating costs by departing from most economic diameter, examples of practical calculations.

PIPES

Economic Size. Economic Size of Pipe for Power Purposes, George E. Lyon. Eng. & Contracting, vol. 57, no. 19, May 10, 1922, pp. 436-437, 1 fig. Formulas and curves from which proper diameters can be found.

PIPES, CAST-IRON

Flexible-Joint. Making 30-Inch Flexible Joint Cast-Iron Pipe, William G. Hammerstrom. Eng. News-Rec., vol. 88, no. 19, May 11, 1922, pp. 780-782, 5 figs. Spherical-shaped bell and spigot on each length machined to give flexibility at every joint; foundry practice.

PISTONS

Dowmetal. A Superior Piston Material. Motor Boating, vol. 29, no. 6, June 1922, pp. 39 and 100, 2 figs. Dowmetal, an alloy composed of high percentage of magnesium and small amounts of other metals, manufactured by Dow Chem. Co., Midland, Mich., for pistons of internal-combustion engines, equal, if not superior, to cast iron or aluminum.

Machining. Tooling Equipments for Pistons. Machy. (Lond.), vol. 20, no. 504, May 25, 1922, pp. 220-224, 13 figs. Use of automatic machines and special equipment for machining pistons at high rate of production.

POWER GENERATION

Rating of Supply Undertakings. The Rating of Electric Power Supply Undertakings, L. Andrews. Elec. Times, vol. 61, no. 1596, May 18, 1922, pp. 477-478, 1 fig. Economic consideration of various factors and necessity of analyzing same.

POWER PLANTS

Auxiliaries. Power Plant Auxiliaries, L. R. Lee. Power Plant Eng., vol. 26, no. 11, June 1, 1922, pp. 553-557, 4 figs. Requirements and types used in modern plants.

Auxiliaries Drive. Under What Conditions are Steam Turbines Preferable to Electrical Units for Driving Auxiliaries? Coal Age, vol. 21, no. 21, May 25, 1922, pp. 875-876, 1 fig. Turbines save conversion costs; independent steam units may release large generator at times of idleness; cheap fuel makes heat balance less imperative.

Calumet Station, Chicago. Calumet Station. Power Plant Eng., vol. 26, no. 10, May 15, 1922, pp. 497-508, 17 figs. Description of Commonwealth Edison Company's new plant which will ultimately produce 180,000 kw.

Hell Gate. New Hell Gate Power Station. Power, vol. 55, no. 18, May 2, 1922, pp. 678-686, 12 figs. Description and table of principal equipment of this plant of United Elec. Light & Power Co.

The Hell Gate Station, Howard W. Leitch. Elec. Jl., vol. 19, no. 5, May 1922, pp. 214-220, 14 figs. Layouts, curves, illustrations and general description.

Maintaining Heat Balance at Hell Gate. Power, vol. 55, no. 20, May 16, 1922, pp. 760-763, 4 figs. Features of units and control.

Switching Equipment for the Hell Gate Station, C. M. Moss and J. B. Macneill. Elec. Jl., vol. 19, no. 5, May 1922, pp. 221-226, 10 figs. Description of unusually good installation at this plant.

Lots Road Station, London. Lots Road Power Station, London "Underground" Railways. Ry. Gaz., vol. 36, no. 19, May 12, 1922, pp. 777-780, 3 figs. This station, opened in Feb. 1905, is largest in British Isles erected for supplying current for railway traction and associated purposes. New plant recently added is described, and main features of original equipment, in so far as it still applies, are set forth.

Producer-Gas. Some Observations on a Producer-Gas Power Plant, H. S. Denny and N. V. S. Knibbs. Instn. Mech. Engrs. Proc., no. 2, 1922, pp. 97-194, 17 figs. Thorough examination of use of coal with view to economy.

Sheboygan, Wis. New Plant of Badger State Tanning Co. Power Plant Eng., vol. 26, no. 11, June 1, 1922, pp. 547-553, 10 figs. Description of new installation of uniflow engines with a.c. individual motor drives.

POWER TRANSMISSION

Drive, Unit and Line. Comparative Advantages of Unit and Line Drive in Industry, H. P. Phillips. Jl. Elec. & West. Industry, vol. 48, no. 11, June 1, 1922, pp. 445-447, 6 figs. Discussion of mechanical installations in some important western industrial plants tending to show that adoption of unit or line drive depends upon type of work to be done.

Electric vs. Mechanical. The Merits of Electrical vs. Mechanical Power Transmission, R. Gillespie Williams. Eng. & Indus. Management, vol. 7, no. 11, Apr. 6, 1922, pp. 319-322, 3 figs. Deals with questions relating to running costs and maintenance, and economical arrangement of electric generator plant.

Fluid Waves. Transmitting Power in Fluid Waves. Sci. Am., vol. 126, no. 5, May 1922, pp. 320 and 362. Setting up wave motions or pulsations in enclosed column of liquid, usually water, which is contained in pipe connecting wave-generating apparatus with point of power application. Discusses generator now on market and applications.

Machinery. A Review of Power-Transmission Machinery. Belting, vol. 20, nos. 4 and 5, Apr. and May 1922, pp. 29-30 and pp. 36 and 38, 10 figs. Apr.: Deals with steel hangers. May: Steel pulleys and one type of steel hanger.

PRESSES

Accident Elimination. Eliminating Cold Trim Press Accidents, G. A. Kuechenmeister. Can. Machy., vol. 27, no. 21, May 25, 1922, pp. 21 and 29, 2 figs. Danger of working on unguarded presses; repeating of press ram not always cause of trouble; unsatisfactory experiments with mechanical tripping devices, electrical guard which has solved problem.

PULVERIZED COAL

Boiler Firing. Commission of Fuel Utilization—3rd Report (Commission d'Utilisation du Combustible). Annales des Mines, vol. 1, no. 2, Feb. 1922, pp. 99-152. Firing with pulverized coal. Actual developments in use of pulverized coal; description of installation using it; detailed description of advantages and drawbacks.

Firing With Pulverized Coal (Ueber Kohlenstaubfeuerungen), Max Birkner. Wärme, vol. 45, no. 16, Apr. 21, 1922, pp. 201-204, 3 figs. Storage of pulverized coal; pulverizing; economic limitation of size of powder; combustion chamber; some recent installations.

Powdered Coal, John Blizard. Colliery Guardian, vol. 123, nos. 3198, 3199 and 3201, Apr. 13, 21 and May 5, 1922, pp. 918-919, 990-991 and 1119-1120, 10 figs. Apr. 13: Functions of powdered-fuel plant; preparation and distribution of fuel. Apr. 21: Various appliances employed in use of pulverized fuel; applications of powdered fuel. May 5: Use of powdered fuel in raising of steam cost and inherent dangers involved. From Bul. Can. Dept. Mines.

Power Plants. First Large Plant Using Pulverized Coal Exclusively. Elec. World, vol. 79, no. 15, Apr. 15, 1922, pp. 720-724, 13 figs. partly on supp. plate. Lakeside generating station of Milwaukee Elec. Ry. & Light Co. designed for initial capacity of 40,000 kva., with ultimate rating of 200,000 kva. Central control and minimum of attendance. See also Power, vol. 55, no. 16, Apr. 18, 1922, pp. 604-610, 16 figs. partly on supp. plate; and Elec. Ry. Jl., vol. 59, no. 15, Apr. 15, 1922, pp. 633-640, 15 figs. partly on supp. plate.

PUMPING PLANTS

Hamilton, Ont. Beach Water Works Pumping Plant at Hamilton, R. De Bruno-Austin. Can. Engr., vol. 42, no. 19, May 9, 1922, pp. 462-468, 8 figs. General description of machinery, with special reference to recent installation of 2 ten-million-gallon pumping units; tests show efficiencies as high as 80 per cent; historical review of earlier equipment.

Maple Ridge, B. C. New Pumping Plant for the Maple Ridge Dyking in B. C., H. M. Burwell. Contract Rec., vol. 63, no. 20, May 17, 1922, pp. 465-467, 4 figs. Old pumps in service for 27 years for reclaiming 9,000 acres of rich land, replaced by two 20,000 g.p.m. electrically-driven centrifugal pumps. Unusual type of valves.

PUMPING STATIONS

Stand-By Service. A 2,500-Kva. Diesel-Engine Plant for Stand-by Service, Homer I. Steffa. Power, vol. 55, no. 21, May 23, 1922, pp. 804-809, 8 figs. Calumet station equipped with four 750-b.hp. two-stroke cycle Diesel-engine generator units, insuring breakdown service for sewage-pumping stations.

PYROMETERS

Optical. Disappearing Filament Pyrometer. Engineering, vol. 113, no. 2938, April 21, 1922, p. 501, 5 figs. Design and construction of optical pyrometer for industrial and laboratory work, made by H. Tinsley & Co.; improvement of this type of pyrometer by placing lamp in one arm of Wheatstone bridge.

R

RAILWAY ELECTRIFICATION

Austria. The Electrification of the Austrian Federal Railways and the Development of Austrian Water Power (Die Einführung der elektrischen Zugförderung auf den österreichischen Staatsbahnen und der Ausbau der österreichischen Wasserkräfte), R. Seifert. Zentralblatt der Bauverwaltung, vol. 42, nos. 21 and 22, Mar. 11 and 18, 1922, pp. 117-120 and 133-134, 4 figs. Discusses plans for electrification of 1788 km. of railway lines, of which 726 km. are double-track.

Chile. Electrification on the Chilean Railway. Ry. & Locomotive Eng., vol. 35, no. 5, May 1922, pp. 111-115, 6 figs. Solution of high cost of fuel, and congested traffic. Descriptions of locomotive equipment.

Gothard Line, Switzerland. Where Electrification Is Both Logical and Picturesque. Ry. Rev., vol. 70, no. 16, Apr. 22, 1922, pp. 559-564, 17 figs. Alpine water power being substituted for imported coal on famous Gothard line in Switzerland.

Industrial Plants. Yard Electrification of Industrial Plant Railways, D. M. Petty. Engrs. & Eng., vol. 1, no. 3, Mar. 1922, pp. 79-84 and 96-97. Underrunning third-rail scheme is best suited for heavy work and low voltages; existing substations used to supply d.c. power; etc.

Mountain Districts. Advantages of Electrical Operation in Mountain Districts, Frank Rusch. Gen. Elec. Rev., vol. 25, no. 6, June 1922, pp. 362-364. Some features of 660 route miles operation of C., M., & St. Paul Ry. Co., on five mountain ranges. (Reprinted from Milwaukee Employees Mag., Mar. 1922.)

Voltages Near Ground. Railway Electrification and Safety Limits of Voltages Near the Ground. Tramway & Ry. World, vol. 51, no. 24, May 18, 1922, pp. 243-244. Discussion of limits of voltage safety for third rail or near ground.

RAILWAY MANAGEMENT

Chinese Government. The Administration of Chinese Government Railways, Ching-Chun Wang. Assn. Chinese & Am. Engrs. Jl., vol. 3, no. 1, Jan. 1922, pp. 3-16, 2 figs. Development; statistical features; central administration; improvements.

RAILWAY MOTOR CARS

Diesel-Electric. Diesel-Electric Motor Cars for Railway Service. Ry. Age, vol. 72, no. 20, May 20, 1922, pp. 1183-1184, 2 figs. Successful operation in Sweden has led to introduction of 250-hp. cars.

Gasoline. Developments in Bus-Type Rail Cars for Local Service. Ry. Rev., vol. 70, no. 18, May 6, 1922, pp. 633-635, 5 figs. Describes rail cars with both Mack and White Company chassis.

Some Recent Developments in Gasoline Motor Rail Cars, W. L. Bean. Ry. Rev., vol. 70, no. 21, May 27, 1922, pp. 741-747, 8 figs. Present equipment admirable in design but limited in capacity; railways need larger cars built on same principle.

The Power Behind the Modern Gasoline Motor Rail Car. Ry. Rev., vol. 70, no. 19, May 13, 1922, pp. 669-673, 6 figs. Features to which consideration must be given in selection of power unit for gasoline rail-car operation. Describes Midwest heavy-duty high-speed engine.

Type Selection. Railcars are Needed—But What Type? Herbert Chase. Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1150-1152, 6 figs. Consideration of factors entering into selection of type.

RAILWAY OPERATION

Amphibious. By Rail and By Water. Sci. Am., vol. 126, no. 6, June 1922, p. 374, 5 figs. Combination train and two barges invented by Belgian engineer for use in Congo.

Parallel Traffic Working. "Parallel" Traffic Working on South Eastern & Chatham Railway. Ry. Gaz., vol. 36, no. 20, May 19, 1922, pp. 805-814, 7 figs. By systematic scheduling of trains on "Parallel" basis in both directions, time-keeping is improved, facilities increased, signaling movements reduced, and engines and rolling-stock utilized to better advantage.

Suburban Passenger Service. The Operation of Heavy Suburban Passenger Services on A Steam Railway, F. V. Russell. Ry. Gaz., vol. 36, no. 21, May 26, 1922, pp. 841-842. Steam and electric traction compared. Suggestions for adoption by steam railways of features in use in electrically-operated ones. From Lecture before Roy. Soc. Arts.

Train Control. Automatic Train Control Systems. Ry. Elec. Engr., vol. 13, no. 4, Apr. 1922, pp. 117-126, 21 figs. Four articles, describing the Regan contact shoe and ramp type, the Simmen speed control system, the Wooding and the Miller systems.

Freight Train Tests of Train Control on the C. I. & W. R. R. Ry. Rev., vol. 70, no. 18, May 6, 1922, pp. 627-628, 1 fig. Particulars of test designed to show action of Shadle system of train control in operation of heavy freight train.

Shadle Automatic Train Signal-Stop. Ry. Elec. Engr., vol. 13, no. 5, May 1922, pp. 149–150, 3 figs. Intermittent ramp contact type incorporating cab signals and speed control which have been developed on C. I. & W.

The American Train Control System. Ry. Elec. Engr., vol. 13, no. 5, May 1922, pp. 156–159, 6 figs. Developed on Maryland and Pennsylvania railroad and brought before Interstate Commerce Commission in 1907. Installed on C. & O.; inspected by Railroad Administration in 1919. Intermittent contact type.

The Sprague System of Automatic Train Control. Ry. Rev., vol. 70, no. 21, May 27, 1922, pp. 747–757, 11 figs. Description of test installation in electric zone of New York Central R.R.

RAILWAY SHOPS

Management. Improvements in Workshop Management (Verbesserungen im Werkstättenbetrieb), Hans A. Martens. Verkehrstechnik, special number, May 1922, pp. 240–247, 1 fig. Discusses methods in use on German state railways and proposes improvements for more efficient control.

Tools and Fixtures. Special Tools and Fixtures in a Southern Railroad Shop, S. Ashton Hand. Am. Mach., vol. 56, no. 17, Apr. 27, 1922, pp. 613–616, 15 figs. Describes equipment of shops of Chesapeake & Ohio Ry., Richmond, Va.

RAILWAY SIGNALING

Alsace-Lorraine. Signaling on the Alsace-Lorraine Railways (Dispositions adoptées pour assurer la sécurité des trains sur le réseau d'Alsace-Lorraine), Georges Levi. Annales des Mines, vol. 1, no. 4, Apr. 1922, pp. 266–315, 10 figs. Describes in detail principles and operation of signaling system in force to assure safety of trains.

Interlocking. New Interlocking on the C. R. R. of N. J., Fred W. Bender. Ry. Signal Engr., vol. 15, no. 5, May 1922, pp. 184–189, 14 figs. Large electro-pneumatic plant at Phillipsburg, N. J., uses new operating mechanisms and lead-covered cables.

Location of Signals. Location of Signals as an Aid to Traffic Working, R. S. Proud. Engineering, vol. 113, no. 2939, April 28, 1922, pp. 533–535, 3 figs. Signals from standpoint of traffic handling rather than safety. Paper read before Instn. Ry. Signal Engrs.

RAILWAY TERMINALS

Electrification. Operation of an Electrified Terminal, L. E. Lynde. Elec. Traction, vol. 28, no. 5, May 1922, pp. 403–404, 2 figs. Conditions at Broad Street Station, Philadelphia, as compared with steam operation on this portion of Penna. system.

RAILWAY TIES

Electric Resistance. Electrical Resistance of Treated and Untreated Crossties, P. R. Hicks. Ry. Signal Engr., vol. 15, no. 5, May 1922, pp. 190–192, 2 figs. Results of measurements made by Forest Prod. Laboratory in coöperation with Chicago, Milwaukee & St. Paul.

RAILWAY TRACK

Machines for Track Work. Special Machines and Combinations for Track Work. Eng. & Contracting, vol. 57, no. 16, Apr. 19, 1922, pp. 368–370, 3 figs. Information on use of mechanical appliances and tools in track work and organization of labor involved, given in appendix to report presented before Am. Ry. Eng. Assn. by Committee on Rules and Organization. (Abstract.)

RAILWAYS

Australia and China. Railway Problems in Australia and China, T. R. Johnson. Inst. of Transport Jl., vol. 3, no. 4, May 1922, pp. 214–222 and (discussion) 222–225. Some facts about rail transportation in these two countries.

REDUCTION GEARS

Double. Double Reduction Gears in the SS. "Melmore Head," J. W. Wilkie. Engineering, vol. 113, no. 2937, Apr. 14, 1922, pp. 469–471, 6 figs. Detailed account of troubles experienced with double-reduction gearing, together with description of methods recently adopted to overcome them. [Paper read at Spring Mtg. of I. N. A.] See also Mar. Engr. & Naval Archt., vol. 45, no. 536, May 1922, p. 190 and Shipbldg. & Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 457–460.

Turbine. Turbine Reduction Gearing and Its Production, J. H. Melloy. Mar. Engr. & Naval Architect, vol. 45, no. 536, May 1922, pp. 184–187, 3 figs. Hobbing process with particular reference to Muir & Melloy patent hobbing machine. Abstract of paper read before Northwestern Branch of I.M.E.

REFRIGERANTS

Hydrocarbon. Some Properties of Hydro-Carbon Refrigerants, H. D. Edwards. A.S.R.E. Jl., vol. 8, no. 6, May 1922, pp. 488–495, 5 figs. Discusses use of butane, propane, ethane, and makes comparison with ammonia.

REFRIGERATING MACHINES

Compression. Effect of Water Cooling Jackets on Compression Refrigerating Machines (Der Einfluss des Kühlwassermantels an Kompressions Kältemaschinen), Walther Fischer. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 244, 1921, 78 pp., 25 figs. Investigation into the advantage of water-cooling jacket on cylinder of compressor for refrigerating machines of various types.

REFRIGERATING PLANTS

Steam vs. Electric Drive. A Few Facts About Steam- and Electric-Driven Refrigerating Plants, G. E. Porce. Power, vol. 55, no. 22, May 30, 1922, pp. 855–856. Comparison of electric motors and other prime movers.

Testing Rules for. Rules for Efficiency Testing of Refrigerating Machines and Plants (Regeln für Leistungsversuche an Kältemaschinen und Kühlanlagen). Zeit. für die gesamte Kälte-Industrie, vol. 29, no. 4, Apr. 1922, pp. 57–68, 6 figs. Gives rules formulated by the German Refrigerating Soc. and also the Standard Committee of the German Industry.

REFRIGERATION

Insulation, Thickness of. The Economic Thickness of Insulation in the Refrigerating Field, P. Nicholls. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 3, Apr. 1922, pp. 343–358, 6 figs. Various items of monetary expense which leakage of heat causes and formulas which include all of the definite expense factors.

Low-Temperature. Recent Developments in Low-Temperature Work (Neuere Entwicklung der Tieftemperaturtechnik), F. Pollitzer. Zeit. für die gesamte Kälte-Industrie, vol. 28, no. 9, Sept. 1921, pp. 125–133, 12 figs. Discusses large increase in expenditure of energy to reach temperatures lower than that of liquid air; describes Borsigwalde oxygen works and their equipment.

RIVERS

Canalization of St. Lawrence. An Examination of the Plan for Canalizing the St. Lawrence River, Wilfred H. Schoff. Engrs. & Eng., vol. 1, no. 3, Mar. 1922, pp. 85–89. Author concludes that as economical investment in combined power and navigation it is not desirable. Better to develop each separately.

Colorado. Controlling the Principal Artery of the Southwest States, C. E. Grunsky. Jl. Elec. & West. Industry, vol. 48, no. 9, May 1, 1922, pp. 348–350, 4 figs. Discusses feasibility of construction of dam that would rise to height of 550 ft., storing 25,000,000 acre-ft. of water which will irrigate thousands of acres of arid land, protect Imperial Valley from disastrous floods and generate approximately 600,000 hp. of electrical energy.

The Colorado River; Its Control and Development. Eng. News-Rec., vol. 88, no. 18, May 4, 1922, pp. 741–744, 2 figs. Hydraulics of river and demand for power, flood control and irrigation subject of federal report. Recommendations include Boulder Canyon dam and all-American canal in Imperial Valley.

ROADS

Truck Overloading. Analysis of Connecticut's Traffic Census Data Yields Facts on Truck Overloading, J. Gordon McKay. Eng. News-Rec., vol. 88, no. 20, May 18, 1922, pp. 826–830, 5 figs. Digest of report made for U. S. Bur. of Public Roads shows every third truck to be loaded beyond capacity of truck and tires.

ROLLING MILLS

Cold-Rolling Strip. New Five-Stand Cold-Rolling Strip Mill. Iron Age, vol. 109, no. 19, May 11, 1922, pp. 1289–1291, 5 figs. Tandem mill of new design has unusual flexibility of control; electric power a feature.

Continuous. Development of Continuous Rolling Mills, John W. Sheperdson. Iron Age, vol. 109, nos. 11, 15 and 17, Mar. 23, Apr. 13 and 27, 1922, pp. 791–794, 993–995 and 1149–1151, 15 figs. Design affected by fundamental conditions, specific problems, and co-relation of units. Merchant mills not well adapted to continuous principle. Selection of cooling-bed length; staggering of mills. Paper read before Engrs'. Soc. West. Pa.

Electrification Progress. Mill Electrification Progresses, Wilfred Sykes. Iron Trade Rev., vol. 70, no. 22, June 1, 1922, pp. 1550–1554, 1 fig. Recent years have witnessed number of large installations of motor drives on rolling mills; operation results are satisfactory; power and motor size not limited; general plant layout discussed. From paper read before Am. Iron & Steel Inst.

Hot Billet Scraper. An Automatic Hot Billet Scraper, R. C. Rohrabacher. Iron Age, vol. 109, no. 17, Apr. 27, 1922, pp. 1126–1128, 6 figs. Mechanical device for removing defects in use in Canadian rolling mill. Advantages and savings.

Strip Mills. New Continuous Ten-Stand Strip Mill. Iron Age, vol. 109, no. 22, June 1, 1922, pp. 1510–1512, 3 figs. Compact unit which was designed for heavy production; interesting details given of electric drive; arrangement at Trumbull Steel Co.

Wrought-Iron Bars, Rolling. Power Required to Roll Wrought Iron Bars, Edwin L. Fletcher. Iron Age, vol. 109, no. 17, Apr. 27, 1922, p. 1144. Results of tests that were made in reducing 3-in. billets to $^1/_2$-in. rounds.

Zinc Sheet. Zinc Sheet Rolling Mills (Das Zinkblechwalzwerk), W. Krämer. Metall., no. 6, Mar. 25, 1922, pp. 67–71, 5 figs. Gives list of mills supplying zinc. Describes operations of the various passes which are similar to that of iron sheets.

ROPE

Flexible Steel. Making and Care of Flexible Steel Ropes, W. Voigtlander. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1065–1066, 1 fig. Operation of stranding machines; securing open ends of rope; effective strength with some wires broken.

Making and Care of Flexible Steel Ropes, W. Voigtlander. Eng. & Indus. Management, vol. 7, no. 15, June 1, 1922, pp. 463–465. Description of three steps in manufacture, lubrication and inspection when in use. Based on paper read before Assn. Iron & Steel Elec. Engrs.

S

SAFETY

Electricity in Factories. Electricity and Safety First in Factories, W. H. Seal. Electrician, vol. 88, no. 2297, May 26, 1922, pp. 618–623, 4 figs. Suggests code of safety rules; precautions desirable in using electrical machinery.

SAWS

Wire, for Slate and Marble. Wire Saws for Slate and Marble Cutting. Quarry, vol. 27, no. 303, May 1922, pp. 181–183, 4 figs. Description of this kind of saw used in England and abroad.

SCRAP

Railroad, Reclaiming of. Reclaiming a Railroad Scrap Pile, Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 769–772, 8 figs. Conversion into useful articles of much material found in scrap piles. How Can. Pacific turns ts scrap pile into source of revenue.

SCREW THREADS

Inspection by Optical Projection. Speeding Up Screw Thread Inspection by Optical Projection, Ralph E. Flanders. Automotive Industries, vol. 46, no. 21, May 25, 1922, pp. 1116–1119, 7 figs. Speed and accuracy attained by Hartness screw-thread comparator. Method applied to test cutters and to locate imperfect edges of gear teeth by tracing outline of median tooth section. Paper presented before Am. Gear Mfrs. Assn.

SCREWS

Machine Bolts and. Designing Machine Screws and Bolts, L. T. Rutledge. Can. Machy., vol. 27, nos. 8 and 10, Feb. 23 and Mar. 9, 1922, pp. 26–27 and 24–25 and 29, 6 figs. Feb. 23: Various thread shapes and their respective uses; screw thread as a power medium; thrust factor depending on shape; safety of bolts; pipe threads. Mar. 9: Screw threads for bolts and nuts. Bending stresses; stripping of threads; failure due to shear; lacking devices; effect of vibration; etc.

Milling. The Milling of Screws, H. H. Jeffcott. Engineering, vol. 113, no. 2936, Apr. 7, 1922, pp. 441–442, 5 figs. Account of problems of interest to manufacturer and metrologist. Paper read before (British) Instn. Mech. Engrs.

SEMI-DIESEL ENGINES

Operation. Semi-Diesel Engines (Les Moteurs Semi-Diesel). Technique Moderne, vol. 14, no. 4, Apr. 1922, pp. 145–150, 31 figs. Construction and operation, fuel injection, regulation and general application.

Water Injection in. The Use of Water Injection in Semi-Diesel Oil Engines, R. B. White. Power, vol. 55, no. 16, Apr. 18, 1922, pp. 617–618. Author claims that while water injection is necessary in low-pressure engines, it is not desirable and may be avoided by higher compressions; and that water does free cylinder of carbon, and its occasional use is recommended, even in dry engines.

SEWER CONSTRUCTION

Pneumatic Diggers. Pneumatic Clay Diggers Speed Sewer Tunnel Work, R. A. Lundell. Compressed Air Mag., vol. 27, no. 6, June 1922, pp. 167–168, 3 figs. Development of air-driven clay diggers eliminating picking or blasting, makes possible record progress in tunnel driving.

SHEARS

Hydroelectric Bloom. Hydro-Electric Bloom Shear. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1078–1079, 4 figs. New method of operation devised for use in mills without steam power.

SHIP PROPULSION

Hydraulic Transmission. The Foettinger Hydraulic Transmission Gear of the Mail Boat "Tirpitz" (Les transformateurs hydrodynamiques "Foettinger" du paquebot "Tirpitz"), Grison. Bul. Technique du Bureau Veritas, vol. 4, no. 1, Jan. 1922, pp. 1–5, 6 figs. Built by Vulcan Shipyards for Hamburg-American Line. Design, operation, and tests of these gears which show efficiency of 90 per cent.

SNOW REMOVAL

Crane Cars. Crane Cars Solve Snow-Removal Problem. Elec. Ry. Jl., vol. 59, no. 20, May 20, 1922, pp. 825–827, 5 figs. Three crane cars designed by Third Ave. Ry., New York City, for general track repair and handling and transportation of miscellaneous materials have been used to increase snow-fighting equipment by addition of wings.

SPRINGS

Automobile. See AUTOMOBILES, Suspension.

Leaf, Modern Manufacture. Modern Methods of Making Leaf Springs, E. F. Lake. Iron Age, vol. 109, no. 20, May 18, 1922, pp. 1343–1346, 6 figs. Mechanical forming machines; tempering furnaces; assembling, testing and inspecting.

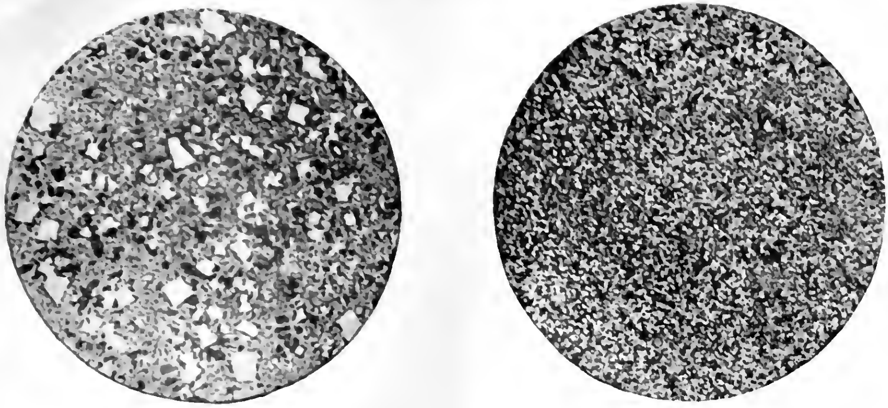
STANDARDS

British, Rail Testing Machines. Falling Weight Testing Machines for Rails. British Eng. Standards Assn., Apr. 1922, no. 103, 1 p.

U. S. Bureau of Standards. What the Bureau of Standards Can Do for You. Factory, vol. 28, no. 5, May 1922, pp. 540–541 and 554, 556 and 558, 3 figs. Indicates scope of service.

STEAM

Consumption, Calculation. Steam Consumption



HIGH GRADE BABBITT CADMAN BEARITE METAL

Microphotographs by Pittsburgh Testing Laboratory.
Magnified 100 diameters. Etched with Nitric Acid.

Effective *versus* Apparent Bearing Surface

The microphotographs above are of bearing metals of identical, and time-proven, composition. That on the left is alloyed in the ordinary way, while that on the right is alloyed to bring out its full bearing properties.

The metals are the same. Which would you buy?

In the metal on the left, the load is carried on the crystals. The matrix simply serves to hold the crystals in place. This is a scientific fact.

In the metal on the right, the crystals are broken up into a uniform network which embraces the full bearing surface. The apparent bearing surface is the same, but the effective bearing surface of Cadman BEARITE is four times that of the metal on the left. The rate of wear of the metal on the left is four times that of BEARITE.

The crystals in the ordinary babbitt are readily removed under the abrasive action of the shaft. The places from which crystals have been removed, even under the delicate process of polishing, can readily be seen in the microphotograph. In Cadman BEARITE, there are no crystals to be removed.

The uniform depressions in the surface of Cadman BEARITE form oil pockets. BEARITE can readily be shown to hold an oil film under conditions which would destroy any other metal.

With the usual alloying process, the metals are just "put together." In the Cadman process, they are scientifically alloyed to bring out every valuable bearing property.

The metals are the same. The cost is the same. Yet one has four times the value of the other. Which are you buying?

Engineering Bulletin M1 is a digest of sixty years' experience in the manufacture of fine bearing metals. It covers the subject of bearing metals in detail.

(Clip the coupon or simply enclose your card in an envelope)

A.W. Cadman Manufacturing Co. Pittsburgh Pa.

Master Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletin M-1, samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:...**Position:**.....................

Company Name:...

Address:..

Accounted For by Indicator Diagram. Power, vol. 55, no. 24, June 13, 1922, pp. 935–937, 7 figs. Development of equations for water rate and application to indicator diagram giving steam that would be used if no condensation occurred.

Production and Use. Production and Use of Steam (Production et utilisation de la vapeur), Victor Kammerer. Bul. de la Société Industrielle de Mulhouse, vol. 87, no. 9, Nov. 1921, pp. 440–464. Discusses fuel, efficiency and losses, automatic stokers, etc.

Saturated. The Behavior of Saturated Steam (Ueber das Verhalten gesattigter Dämpfe), R. Plank. Zeit. fur technische Physik, vol. 3, nos. 1 and 2, 1922, pp. 1–7 and 69–78, 5 figs. Theoretical principles and facts based on experience; empirical equations for heat of evaporation and for pressure curve; tables of dry saturated steam, dry saturated CO_2 vapors, heat of vaporization of ethyl ether.

STEAM ACCUMULATORS

Ruths. The Ruths Steam Accumulator (Der Ruths-Dampfspeicher), R. G. Constam-Gull. Schweizerische Bauzeitung, vol. 79, no. 16, Apr. 22, 1922, pp. 203–207, 13 figs. Built by Vaporackkumulator Co. in Stockholm. Acts as a pressure equalizer and when in operation is filled 95 per cent with superheater water. See also Wärme, vol. 45, nos. 14 and 15, Apr. 7 and 14, 1922, pp. 170–173 and 193–195, 14 figs.

STEAM ENGINES

Extraction. Possibilities of the Extraction Engine. Iron & Coal Trades Rev., vol. 104, no. 2825, Apr. 21, 1922, pp. 567–568, 2 figs. Describes a steam-extraction engine built by John Musgrave & Sons, Ltd., Bolton, Eng., of 650 i.hp. at 160 r.p.m. for maximum extracted steam quantity of about 11,000 lb. per hr. at from 10 to 15 lb. receiver pressure; drives line of shafting by ropes, and is direct-coupled to a 200-kw. d.c. generator.

STEAM POWER PLANTS

Battle Creek. Battle Creek Steam Plant of Consumers Power Company, W. W. Tefft. Power, vol. 55, no. 23, June 6, 1922, pp. 880–885, 6 figs. Plant capacity of 27,500 kw; modern boiler installation with large boilers to operate at high capacity; combined evaporative efficiency of boilers, water backs, superheaters and economizers of 85 per cent on test, and average under load for January of 80 per cent; other outstanding features.

STEAM TURBINES

Reliability and Design. Steam Turbine Reliability and Design. Engineer, vol. 133, no. 3462, May 5, 1922, pp. 486–487, 1 fig. Particular considerations are reliability, economy and first cost.

Starting Up. Putting Steam Turbines in Service. Power, vol. 55, no. 20, May 16, 1922, pp. 756–759, 4 figs. Increasing size of units makes procedure of starting more serious. Features to look out for.

STEEL

Chromium. See CHROMIUM STEEL.

Fracture Test. Fracture Test on Steel to Determine Its Quality, W. J. Priestley. Am. Soc. for Steel Treating Trans., vol. 2, no. 7, Apr. 1922, pp. 620–622, 2 figs. Saw disk about 1¼ in. thick from end of forging or bloom; quench slightly above critical temperature, draw between 900 and 1100 deg. fahr., and break in two. Fracture parallel to direction of forging or rolling will disclose texture of metal. Flake, slag, blowholes and pipe are easily detected.

Rivet, Effect of Sulphur on. Effect of Sulphur on Rivet Steel, E. E. Thum. Chem. & Met. Eng., vol. 26, no. 22, May 31, 1922, pp. 1019–1024, 15 figs. Maximum sulphur now allowed (0.045 per cent) is at least 0.01 per cent below quantity where sulphur will damage strength of well-made rivet steel as far as its performance can be predicted by standard tests.

Stainless. Stainless Steel and Rustless Iron, Herbert Whitaker. Ironmonger, vol. 175, no. 2530, May 13, 1922, p. 106. Rustless iron, rustproofing cast iron and steel, formation of magnetic oxide.

STEEL, HEAT TREATMENT OF

Abrasive Qualities, Effect on. The Abrasive Qualities of Plain Carbon and Alloys Steels, A. M. Cox. Am. Soc. for Steel Treating Trans., vol. 2, no. 8, May 1922, pp. 680–690, 12 figs. Results of tests on effect of heat treatment on abrasive qualities of plain carbon and alloy steels, after having been subjected to various heat treatments.

Annealing. A New Annealing Process for Sub-Pearlite Steels (Ein neues Gluhverfahren fur unterperlitische Stähle), Bengt Kjerrman. Stahl u. Eisen, vol. 42, no. 18, May 4, 1922, pp. 697–700, 3 figs. Annealing of steel to increase its workability by means of cutting tools.

Chrome Steel for Ball Bearings. Heat Treatment of Chrome Steel for Ball Bearings, Haakon Styri. Am. Soc. for Steel Treating Trans., vol. 2, no. 8, May 1922, pp. 718–729, 34 figs. Metallography and important features of process.

Heating and Cooling. Importance of the Proper Heating and Cooling of Steel, John A. Succop. Am. Soc. for Steel Treating Trans., vol. 2, no. 8, May 1922, pp. 673–679, 4 figs. Vital points in this process including temperature, time, surface and mass.

On the Stepped A1 Transformation in Carbon Steel During A Rapid Cooling, K. Honda and T. Kikuta. Iron & Steel Inst., advance paper, no. 8, meeting, May 1922, 13 pp., 13 figs. Experiment and discussion of effect of rapid cooling on A1 transformation point.

STEEL, HIGH-SPEED

Physical Tests. Physical Tests on High Speed Steels, A. H. d'Arcambal. Am. Soc. for Steel Treating Trans., vol. 2, no. 7, Apr. 1922, pp. 586–595 and (discussion) 595–601, 33 figs. Results of series of tensile and transverse tests on two classes of high-speed steel, namely, the 18-per cent tungsten, 1-per cent vanadium type and the 14-per cent tungsten, 2-per cent vanadium grade.

STEEL MANUFACTURE

Acid, Analysis. Analysis Aids Acid Steelmaking, A. C. Jones. Iron Trade Rev., vol. 70, no. 24, June 15, 1922, pp. 1720–1722. Operating schedule and discussion of elements entering into electric furnace process; desirability of accurate control; melter's ability.

Acid Open-Hearth Process. Fine Steels from the Acid Open Hearth, W. P. Barba and Henry M. Howe. Chem. & Met. Eng., vol. 26, no. 20, May 17, 1922, pp. 929–931, 1 fig. Discussion of underlying principles and necessary furnace practice for production of high-grade nickel steel for gun tubes and shafting. Comparison of pig, scrap, and ore processes used in America with all-scrap practice used in Europe. Digest of paper presented before Am. Inst. Min. & Met. Engrs.

British Siemens Furnace Practice. British Siemens Furnace Practice, F. Clements. Iron & Steel Inst., advance paper, meeting May 1922, 19 pp., 14 figs. on supp. plates. Results of tests carried out at Park Gate together with many charts showing characteristics of operation. See also Engineering, vol. 113, no. 2941, May 12, 1922, pp. 579–582 and Iron & Coal Trades Rev., vol. 104, no. 2827, May 5, 1922, pp. 640–659.

STEEL WORKS

Alabama City. Description of the Alabama City Works of the Gulf States Steel Company. Blast Furnace & Steel Plant, vol. 10, no. 5, May 1922, pp. 254–258, 2 figs. This company owns plants and properties which constitute an integrated steel operation from raw materials and fuel to finished product consisting of wire, nails, fencing and bars.

Electric, Adaptable. An Adaptable Electric Steel Company, Sidney G. Koon. Iron Age, vol. 109, no. 18, May 4, 1922, pp. 1196–1202, 10 figs. Two forging plants of different characteristics afford opportunity for handling in each, work to which it is best fitted.

Park Gate Co. Ltd., Rotherham, England. British Siemens Furnace Practice, Fred Clements. Iron & Coal Trades Rev., vol. 104, no. 2827, May 5, 1922, pp. 640–659, 27 figs. Detailed description of entire operation, with tables and graphs on temperatures, and fuel and air consumption, chemical balance sheet of furnace charts, heat balance sheet of furnace charts; outline of furnaces. Paper read before Iron & Steel Inst. See also Engineering, vol. 113, no. 2941, May 12, 1922, pp. 579–582.

STEREOAUTOGRAPHS

Pulfrich. Principles and Use of Stereoautography (Grundlagen und Anwendung der Rambildmessung), K. Lehmann. Gluckauf, vol. 58, no. 17, Apr. 29, 1922, pp. 489–495, 8 figs. Describes stereocomparator, phototheodolite, and the stereoautograph, and their use, especially in connection with aeronautics, on system of Prof. Pulfrich.

STOKERS

Developments. Topical Discussion: Stokers and Their Recent Developments. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 4, Apr. 1922, pp. 163–211. Various notable features brought out by men prominent in industry.

Forced-Draft. Some Notes on the Construction and Operation of Coxe Stokers, John van Brunt. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 3, Apr. 1922, pp. 298–308 and (discussion) 308–310, 8 figs. History of development, details of present type, and notes on operation.

Marine Boilers. Water-Tube Boiler with Underfeed Stoker for Shipboard. Engineering, vol. 113, no. 2941, May 12, 1922, pp. 581–586, 7 figs. Introduction of water-tube boilers in place of Scotch type makes mechanical stoker possible. Results obtained from installations.

STREET RAILWAYS

Cars, Light-Weight Interurban. Light Weight Interurban Cars, C. T. Dehore. Gen. Elec. Rev., vol. 25, no. 6, June 1922, pp. 352–359, 10 figs. Results from use of light-weight cars by number of different companies.

Edinburgh, England. Edinburgh Tramways Inquiry. Tramway & Ry. World, vol. 51, no. 18, Apr. 13, 1922, pp. 188–190, 2 figs. Gives evidence taken in favor of overhead equipment proposed by municipality and objections raised against it.

Standardization. Standardization Work of the German Society of Street Railways, Etc. (Die Normungsarbeiten des Vereins Deutscher Strassenbahnen, Kleinbahnen und Privateisenbahnen E. V.). Verkehrstechnik, special number, May 1922, pp. 256–274, 32 figs. Standards in effect Apr. 1, 1922, as to rails, poles and track construction, and rolling stock.

STRUCTURAL STEEL

Testing. The Blow Bending Strength and Blow Hardness of Structural Steel (Schlagbiegefestigkeit und Schlaghärte legierter Konstruktionsstähle), W. Muller. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 217, 1922, 38 pp., 74 figs. partly on supp. plates. Describes test steel and method of carrying out experiments; results of breaking tests, bending tests, hardness tests; connection between mechanical properties and alloying of steels.

SUPERHEATED STEAM

Specific Heat. Specific Heat of Superheated Steam for Pressures of 20 to 30 Atmos. and Saturation Temperature of 350 Deg. Cent. (Die spezifische Wärme des uberhitzten Wasserdampfes für Drücke von 20 bis 30 at und von Sättigungstemperatur bis 350° C), Osc. Knoblauch and Erwin Raisch. Zeit. des Vereines deutscher Ingenieure. vol. 66, no. 17, Apr. 29, 1922, pp. 418–423, 9 figs. Describes experiments carried out in laboratory of Munich Technical High School.

Temperature Measurement. Measurement of Superheat, B. O. Snyder. Power Plant Eng., vol. 26, no. 10, May 15, 1922, pp. 515–516, 2 figs. Types of thermometers used; precautions in taking readings; making corrections.

SUPERHEATERS

Design. Advantages and Calculation of Size of Superheaters As Well As Flue Gas and Waste Steam Preheaters (Vorteile und Grössenberechnung von Dampfüberhitzer sowie Rauchgas- und Abdampfvorwärmer). Wärme- und Kälte-Technik, vol. 24, no. 9, May 1, 1922, pp. 101–102. Mainly deals with superheaters.

T

TAPERS

Standardization. Shall We Standardize Tapers? Am. Mach., vol. 56, nos. 15, 16 and 17, Apr. 13, 20 and 27, 1922, pp. 551–552, 595–597 and 627–629. Opinions of many firms making and using tapered members. Nearly all want a standard.

TEMPERATURE MEASUREMENT

Accuracy. Accuracy in Temperature Measurements, Horace C. Knerr. Forging & Heat Treating, vol. 8, no. 5, May 1922, pp. 235–237. Accuracy sseential because of variations in steel; potentiometer pyrometers recommended; cold junction compensation; remarks on thermocouples with reference to standardization.

TESTING MACHINES

Penetrometer. Apparatus for Comparing the Hardness of Pitches and Bitumens. Engineer, vol. 133, no. 3456, Mar. 24, 1922, pp. 338–339, 2 figs. Describes the Hall-Marriott automatic penetrometer, designed to exclude human element in determination of consistency of plastic substances used in road construction.

TEXTILE MACHINERY

Maintenance. Maintenance of Textile Machinery, Edwin H. Marble. Mech. Eng., vol. 44, no. 5, May 1922, pp. 311–312. Purpose of ball bearings and importance of proper lubrication. Common abuses and suggested corrections.

Revolving Flat Cards. Modern Shop Practice in the Building of Revolving Flat Cards, F. E. Banfield, Jr. Mech. Eng., vol. 44, no. 5, May 1922, pp. 301–304, 310, 14 figs. Details of special machines developed for work. Production cost per unit lowered by efficient shop arrangement, careful machine designing and standardization.

TIRES, RUBBER

Cord. The Superiority of Cord Tyres, C. M. Gautier. India-Rubber Jl., vol. 63, no. 18, May 6, 1922, pp. 7–8, 4 figs. Superiority of this type shown by experiments with appliances which subject tires to conditions actually met in service.

TINNING

Hot Tinning. Hot Tinning, S. R. Gerber. Metal Industry (Lond.), vol. 20, nos. 16 and 17, Apr. 21 and 28, 1922, pp. 369–371 and 396, 2 figs. Description of reorganization of department for tinning steel cans.

TOOLS

Calculation of Circular. The Calculation of Circular Form-Tools: An Empirical Formula, Mech. World, vol. 71, no. 1847, May 26, 1922, pp. 375–376, 4 figs. Development of simplified empirical formula for circular form tools.

Ring. The Economical Design of Ring Tools, H. Baker. Machy. (Lond.), vol. 20, no. 504, May 25, 1922, pp. 236–238, 2 figs. Formulas for figuring labor costs in consideration of circular form tool.

W

WAGES

Payment Plans. Wage-Payment Plans—A Discussion, Harrington Emerson. Management Eng., vol. 2, no. 6, June 1922, pp. 370–372, 1 fig. Exposition of six plans of payment with some detail of author's plan.

WASTE HEAT

Utilization. The Utilization of Waste Heat From Electrical Generating Stations, F. H. Whysall. Practical Engr., vol. 65, no. 1823, Feb. 2, 1922, pp. 69–70. Possibility of locating industrial plants about generating stations to use waste heat, and difficulties arising. Paper read at joint meeting of Instn. Elec. Engrs. and Instn. Heat. & Vent. Engrs.

WASTE UTILIZATION

Metal Waste. Using Wastes of the Metal Industry (Nutzbarmachung von Abfällen in der Metallindustrie), Karl Micksch. Bergbau, vol. 35, nos. 12 and 13, Mar. 23 and 30, 1922, pp. 416–419 and 447–449. Discusses remelting of metal scrap of various kinds, also sheet metal for detinning.

MECHANICAL ENGINEERING

Volume 44 September, 1922 No. 9

The Oil Supply of the World

Estimates of the Oil Resources of the Various Regions of the Earth The Economic Future as to Oil in the United States—Measures Necessary to be Taken in Order to Increase and Conserve the Domestic Supply

By DAVID WHITE,[1] WASHINGTON, D. C.

THE question is asked, Why is the United States, whose market is now suffering from a slight excess of oil supply, especially concerned about how much oil there is in our own country and the world? Are we trying to corner the world's oil? Do we fear harmful competition from countries more richly supplied? Are we running short of oil, or is there oil famine in other parts of the world that threatens to draw too heavily on our supplies in competition with our own people, with consequent raise of oil prices to levels harmful to the consumers of this country? The concern of the public in the economic problem of oil supplies arises from the following outstanding features of the situation, which give the question an incisive significance to every American user of oil.

To date the United States has furnished nearly two-thirds of all the oil yet taken from the ground in the world—5.5 billions of barrels out of a total of 8.5 billions. Our American fields are now pouring out 62 per cent of the world's annual supply, while our country is using over 75 per cent of that total supply. In other words, the United States requires over 115 million barrels more than it produces; for, whereas our output now approximates 470 millions yearly, our requirements, even during the business stagnation of 1921, called for 525 millions. Our autovehicle program, already passing 10 million cars, is still growing; our merchant ships must burn oil to compete with those of other nations; there are bound to be more tractors and trucks, pumps, small machinery and miscellaneous equipment; and air service is destined to become an everyday necessity. Everywhere, except perhaps in the Navy, the demand for even more oil is in evident prospect. Nothing can check the increase more than momentarily, except high prices due to scarcity of oil or high costs of production or importation—that is, the greater expense of obtaining the oil.

Where will the oil to satisfy these requirements come from year after year, and how long can we keep up the pace? These are plain, common-sense business questions, predicted on our present oil requirements as an established fact and on the suggested possibility that our prodigal spending of our petroleum heritage may cause its too rapid depletion if not its early exhaustion in the midst of our spendthrift career, and at some untoward moment send us as beggars to foreign countries for the precious fluid necessary not only to satisfy our extravagant habits, but even to sustain our industrial prosperity, our standards of living, and our civilization.

Obviously there is only one first thing to be done, and that is for the nation to proceed in the nation's business just as the business man proceeds under similar conditions in his private business, namely, to take account of stock, to find out how much oil there is left in the United States and then to learn as nearly as possible how much oil there is in the rest of the world and where the principal deposits or reserves are located, due consideration being given to probable availability and conditions of production of these reserves.

No apology, therefore, is needed for the searching appraisal and careful estimate recently made of the oil reserves remaining in the ground recoverable by present methods in the United States, nor for its publication for the information and advice of the industry and the country at large. The justification of the formulation of estimates of the oil reserves in other countries, based upon long and painstaking studies of the available data relating to the oil reserves and relative oil possibilities of those other regions of the world, is evident. Such information is indispensably requisite for understanding the present economic situation.

Known Oil Resources of the World

The oil reserves to be found in the regions of the earth where oil has already been proved to exist in commercial amounts were in 1920 estimated by Eugene Stebinger and the author at 43 billions of barrels, as listed in Table 1. This calculation is based upon a review of the available data as to the regional geology the structure, the character and composition, thickness, relations, and alteration of the sedimentary deposits of the different basins, the information as to local and minor folding, and as to surface indications of oil, and finally the records as to developmental tests or actual production. The consideration of the geology of other regions in which oil has not yet been proved to be present in commercial amounts led to the formulation of an additional estimate of 17 million barrels for these regions, placing the total estimate for the world's oil reserves in the ground and recoverable by present methods at 60 billions of barrels. As stated at time of publication, these estimates are necessarily highly speculative and, in spite of the care and study given to their preparation, are subject to great range of error, especially with reference to non-producing countries and to those concerning which the geologic information is meager. They are avowedly conservative. From data subsequently reviewed and on consideration of further information in hand, the author is disposed to regard the estimates for eastern Siberia, Sakhalin, India, Assyria, and Arabia as much too low, with the probability that the oil content of South America will exceed 13 billions of barrels. He accordingly believes that an estimate of 70 billion barrels for the world's total resources is conservative.

TABLE 1 OIL RESOURCES OF REGIONS OF THE WORLD KNOWN TO CONTAIN COMMERCIAL DEPOSITS, AS ESTIMATED BY EUGENE STEBINGER AND DAVID WHITE

Country or region	Millions of barrels
United States and Alaska	7,000
Canada	995
Mexico	4,525
Northern South America, including Peru	5,730
Southern South America, including Bolivia	3,550
Algeria and Egypt	925
Persia and Mesopotamia	5,820
S. E. Russia, S. W. Siberia and the region of the Caucasus	5,830
Roumania, Galicia and western Europe	1,135
Northern Russia and Sakhalin	925
Japan and Formosa	1,235
China	1,375
India	995
East Indies	3,015
Total	43,055

The most important oil regions outside of the United States are believed to be located in Mexico, Venezuela, Colombia, Bolivia, Argentina, Russia, Mesopotamia (together with western Persia), Assyria and Arabia, the East Indies, China and Eastern Siberia (including northern Sakhalin), the Japanese Empire, India, and probably northern Africa. A forecast as to the proportions of light and heavy oils in these great regions would be extra hazardous, but a review of the results of exploration, combined with the consideration of the regional geology, the character of the formations and the stages of alteration, tends to confirm the very natural assumption that the

---

[1] Chief Geologist, U. S. Geological Survey.

Presented at the Regional Meeting of the Local Sections of The American Society of Mechanical Engineers, Kansas City, Mo., March 6 and 7, 1922. Slightly abridged.

production of all of these regions will include moderately light, and in some regions very light, oils as well as, in nearly all cases, fuel oils.

A review of the map compiled by Mr. Stebinger and used in numerous discussions, including the author's paper in the Annals of the American Academy of Political and Social Science for May, 1920, indicates a concentration of the world's oil resources in the northern subtemperate and tropical regions of the earth. Many of the great reserves are distributed along the north Pacific border, the region of the Indian Ocean, and the western Atlantic. Most of them are easily tributary to the principal routes of maritime world trade. It is likely that further investigation will show considerable reserves not only in North Africa, but along the west African coast and in Brazil—in other words, on the borders of the south Atlantic.

Concerning the restrictions by which the nationals of the United States are excluded from free participation in the development of the oil deposits of a large part of the world, and in the Eastern Hemisphere especially, to which the author has given some attention, authentic information will be found in two statements prepared by the Department of State.[1] Most American readers are aware of the efforts of our Government to secure entry for American oil companies in Mesopotamia and again in Djambi, which represents the Dutch East Indies. A satisfactory compilation of concessionary as well as political control of the oil resources outside of North America is at present nearly impossible, but it appears practically certain that two-thirds of the world's oil reserves outside of the United States are not open to development by American companies. In some countries the "open door" is not so open as it appears to be. Some of these reserves may in time of peace be available, if needed, to our citizens at a price, but priority of right, if not permanent reservation, will be given to the navies and militaries of the different countries. Undoubtedly whenever our citizens become dependent for oil on foreign reserves in the hands of rival nationals, they will restore with ample interest all the profits enjoyed through many years by the American exporter. Any protection that we may then need should be assured in advance.

Oil Resources of the United States That Are Recoverable by Present Methods of Exploitation

Having considered the wealth of oil in foreign countries which, according to the very conservative calculations given above, is sufficient to meet the present rate of consumption requirements of the aggregate countries outside of the United States for 215 years, we come to the important question as to the sufficiency of the oil deposits of our own country to meet the whole or a considerable part of our own requirements for the future. In other words, what is the economic future as to oil in the United States? Are our supplies ample and shall we be independent, continuing our role as the world's great producer and distributor of petroleum and its products, or are our reserves so rapidly becoming exhausted that we are in the way to become a mendicant for oil among the nations which we have served with such prodigal generosity?

To answer this question, an appraisal of the domestic oil resources in the ground recoverable by present methods of exploitation has just been completed. Taking advantage of the great expansion of oil-field exploration in the United States in the last few years, the results of widespread wildcatting in regions of merely possible as well as probable territory, the proving of entire oil fields as well as pools, the training of hundreds of geologists and engineers specialized in the problems of the geologic occurrence of petroleum, and desiring to apply the best methods as well as the experience developed through oil-field examination and estimation in appraisal or depletion, in accordance with the requirements of existing tax laws, the United States Geological Survey, a year ago, invited the American Association of Petroleum Geologists to appoint from its membership representatives to serve with the oil geologists of the Survey in a joint committee for the estimation of the oil resources of the United States. With the joint committee thus promptly formed, there worked in heartiest coöperation, through sub-committees covering different areas or states, or in direct collaboration, a large number of state geologists, consulting specialists and company geologists especially familiar with the stratigraphy, structure, and mode of occurrence of oil in the different fields. After nine months of compilation, study and discussion, the estimates were reviewed and revised in joint conference, and in January of this year were made public by the Director of the Geological Survey as given in Table 2.

TABLE 2 ESTIMATED OIL RESERVES OF THE UNITED STATES BY STATES OR REGIONS

	Millions of Barrels
New York	100
Pennsylvania	260
West Virginia	200
Ohio	190
Indiana and Michigan	70
Illinois	440
Kentucky, Tennessee, northern Alabama, and northeastern Mississippi	175
Missouri, Iowa, North Dakota, Wisconsin, and Minnesota	40
Kansas	425
Oklahoma	1,340
Northern Louisiana and Arkansas	525
Texas, except Gulf coast	670
Gulf coast, Texas and Louisiana	2,100
Colorado, New Mexico and Arizona	50
Wyoming	525
Montana, Nebraska and South Dakota	100
Utah, Nevada, Oregon, Washington, and Idaho	80
California	1,850
Eastern Gulf Coastal Plain and Atlantic Coast States	10
Total	9,150

These estimates are, naturally, most accurate in those parts relating to proved territory, for which data invaluable for such calculations are now available. In that part relating to probable territory they represent the balanced judgment of a group of chosen specialists including geologists particularly familiar with the regions and their history. The greatest errors may fall in those portions of the total which relate to merely "possible" territory, especially in regions and states in which oil has never yet been proved to be present in commercial amounts. As stated by the author in a discussion of the subject at the New York meeting of the American Institute of Mining and Metallurgical Engineers, in February, the errors of excess in the estimates for disappointing regions are likely, on the whole, to be balanced by the deficiencies in others.

It may be of interest to engineers, who represent the great oil-consuming industries, to note that of the 9 billion barrels which, as of March 15, 1922, should remain in the ground recoverable by present methods, rather more than 4 billion barrels belong to the heavy group containing the fuel oils. Of the class containing the lighter oils about 725 million barrels are believed to remain in the Appalachian states, and 40 million barrels in the Lima-Indiana region. The fuel oils are largely to be found in the Pacific Coast, the Rocky Mountain and the Gulf states.

Economic Situation of Oil as It Affects the United States

In the United States we have at the present moment produced a total of $5\frac{1}{2}$ billion barrels of oil. We have therefore used up more than one-third of our estimated original heritage of oil. In 1921, a year of stagnation of American oil production, we drew out nearly 470 million—practically half a billion—barrels of oil from our reserves, which are now calculated at 9 billion barrels. Contrasted with our more than 5 per cent rate of annual depletion, the rest of the world withdrew in 1921 not much over 280 million from its store of over 60 billion barrels, or less than half of one per cent of its reserves recoverable by present methods. In other words, the reserves of the rest of the world would stand the present rate of drain for over two centuries. From the standpoint of world distribution of oil and the relations of our reserves to those of the rest of the world, an error of 2 or 3 billion barrels—4 to 6 years' supply—in the committee's estimates of the oil reserves of the United States is comparatively insignificant.

The coöperative committee expressly affirms—and it is well known in the profession—that not all the oil pools in the United States will have been discovered a generation hence. On the other hand, the committee takes great care to point out that while our reserves would not meet our present rate of consumption demands for 20 years, if they could be taken out of the ground fast and cheaply enough to supply our market (a conditioning clause that has gen-

---

[1] Restrictions on American Petroleum Prospectors in Certain Foreign Countries. Message from the President of the United States, May 17, 1920. Senate Document 272, 66th Congress, 2d session.

Restrictions on American Petroleum Prospectors in Certain Foreign Countries. Message from the President of the United States, May 16, 1921. Senate Document 11, 67th Congress, 1st session.

Oil Prospecting in Foreign Countries. Message from the President of the United States, June 13, 1921. Senate Document 39, 67th Congress, 1st session.

erally been lost sight of by the press and the public), this country will be producing oil for as long as 75 years to come.

Since oil cannot so rapidly be located and taken from the ground, it follows with certainty that, according to the laws of oil production, the annual oil output of the United States must at an early date pass its peak and enter upon a long-drawn-out period of general though fluctuating decline to ultimate exhaustion, except so far as fields in great numbers may be rejuvenated by better methods of mining. Opinions differ as to how soon the production peak will be passed; but most geologists believe that within a few years, perhaps less than five, we shall in the normal course enter on a period of waning fields in increasing number, with discoveries more infrequent and in general more costly. The date of passage of the peak depends largely on the demand for oil and the reflected oil prices. If supplies from foreign sources continue adequate and cheap for a long time the passage of the peak may be insensible though early; but should they be seriously curtailed or largely cut off for a considerable period in the near future, we probably shall then see our operators driven by high prices to the greatest maximum, in which an overoptimistic industry will eventually have found it has passed the peak.

A large portion of the public does not yet fully recognize that the United States is already dependent upon foreign oil to meet its still growing requirements. Our oil importations which were 18 million barrels in 1913, grew to 38 million in 1918, 53 million in 1919, 106 million in 1920, and 125 million in 1921. A small part only (9 million barrels) of this amount is offset by exportation of crude petroleum from the United States. In short, in a period of industrial depression we have imported one-fourth as much as we produced. Nearly all of this oil comes from Mexico, and that is why Americans are so profoundly interested in Mexican oil.

The present production in Mexico, amounting to about 195 million barrels in 1921, is mostly drawn from a relatively small number of wells located along a single axis of folding in which a thick limestone, the Tamosopo, is caverned by solution and, in the structurally high points, gorged with gas and oil under most tremendous pressure of salt water. No wells of such enormous production are known in any other part of the world. It is common knowledge that most of these wells have gone or are now going to salt water, and on the basis of this fact as differentially interpreted in the light of other geologic conditions in the field, it is believed by many oil geologists, including some of high repute, that the greater part of Mexico's present phenomenal production is on the verge of approximate extinction. It is practically certain that, while some new discoveries of Tamosopo oil may come to the aid of the rapidly failing pools, sooner or later the production of oil from the world-record-breaking Tamosopo limestone gushers will wane, and the remaining portion of Mexico's 4 to 5 billion barrels of oil reserves, as estimated, must be won by the sweat of the oil operator's brow from wells of the ordinary type. The magnitude of the task of developing enough oil fields of the "common or garden variety" in Mexico to take over the load of an annual production of 195 million barrels which was produced from less than 300 wells in 1921, may be inferred from the fact that in 1908, when for the first time the production of oil in the United States amounted to so much as 175 million barrels, over 140,000 wells contributed to the output. This number is, of course, subject to sweeping and radical discount for rapidity of development and freshness of production. It would take over 10 Haynesvilles or a group of 4 Mexias or 14 Salt Creeks, all running full blast, simultaneously, and all continuously maintaining their January rates of production, which, of course, is impossible. It is difficult to estimate the oil price stimulus necessary to develop a production of 200 million barrels of oil in Mexico from wells of the ordinary type under existing transportation, climatic, and industrial conditions within five years. The prices requisite would certainly be most encouraging for the production of oil from shale in this country.

The collapse, or better, the great slump, in Mexican production, which seems sooner or later inevitable, can hardly fail to react on our own oil-field production, probably driving it to the limit; and it is likely that in the early period of this strain the annual output of petroleum in the United States will pass its peak. Beyond this point our need for more foreign oil is likely to spring up from our decreasing domestic production more than from further growth of our consumption requirements. In this period relief must come from other foreign oil fields and from the production, by distillation, of shale oil, on whose adequacy and on whose yet undetermined cost we may be obliged to rely for protection against transoceanic importations at transoceanic prices beyond our control. Too great an advance in price will, of course, check our use of oil and bring it within the bounds of practicably available supplies from all sources, at prices then viewed as practicable. The oil we cannot afford to buy we will do without.

The extent to which failure of Mexican production may be disastrous to this country depends on the completeness of the slump. It depends also, especially in the early stages, on the extent to which the American oil companies have developed or can rapidly develop considerable available production in other foreign regions on the one hand, and, on the other hand, on the extent to which, as the results of scientific research and energetic commercial application, better methods of oil mining are developed and proportions of the oil not recoverable by present methods of extraction are then taken for the ground. As is well known, in most fields and sands the larger portion of the oil remains locked up in the pores of the reservoir sands, even when the fields are "played out" and abandoned. It is believed by engineers who have given most study and experimentation to the subject that an additional recovery of 40 to 80 per cent over that obtained by present methods will ultimately be possible in many of the fields.

Economic Deductions

Around the constructive economic deductions to be drawn from a review even so superficial and elementary as this summary of the high points of the situation as to oil resources, it is to be seen that—

1 The need of foreign oil reserves available for continued use in the United States is obvious.

2 Waste in producing, in transporting, and in using oil should be prevented or curtailed as far as is economically practicable.

3 Increased concentration of thought and experimentation on the more efficient use of the oil now available and on the production of commodities of greater efficiency are economically urgent. On every occasion consideration should be given to the general abandonment of oil to generate steam, in favor of the three-times-as-efficient Diesel motor or some other still more effective substitute.

4 More intense and more widespread researches in the production of liquid hydrocarbons through processes—so-called low-temperature carbonization—aimed at the more efficient use and the wider adaption of our bituminous and lower-rank coals are important.

5 The development on a commercial scale of an oil-shale industry deserves earnest and wise consideration. Naturally there will be waste and loss of this shale through mining first the richest beds, just as takes place in our coal fields. As has been pointed out by Requa and others, the production of oil from oil shales is a matter of mining and retorting ton by ton and predicates the gradual building up of an industry which, to replace one-third of our present petroleum output, would require men, cities, mining plants, machinery, transportation, water, etc., roughly equal to one-third of our bituminous-coal-mining industry. It is a gigantic task requiring years and enormous capital. Above all it requires planning through research, through experimentation, and through patient trial on a commercial scale, with the closest attention by engineers of all kinds to costs as well as products, with the object of placing the industry on a successful basis as a going concern as soon as prices of crude petroleum and conditions as to prospective supplies permit. Studies should be made to show what prices for crudes of different grades will justify the systematic development, in different regions, of oil-shale production. Shale oil, by which is meant artificial petroleum obtained by distillation of oil shale, may be looked forward to as a stabilizer of domestic prices as well as an economic backstop in oil. Eventually, and especially as foreign supplies available to the United States becomes scarcer or too costly, it should guarantee our ultimate independence in oil, and, to this extent, our industrial and social prosperity as well.

6 The recovery of a much larger portion of the oil in the reservoir rocks than is obtained by present methods is an imperative necessity, demanding the faithful, the intelligent, and the immediate consideration of the states and of the Government, as well as of the oil industry.

Mechanical Refrigeration of Railroad Cars

The Technical, Economic and Operating Aspects of Various Attempts to Employ Mechanical Refrigeration in Railroad Refrigerator Cars, Together with Details of a Proposed Dense-Air System for That Purpose

By W. M. Baxter,[1] Chicago, Ill.

THE subject of mechanical refrigeration as applied to railroad equipment is fraught with tremendous difficulties. First, the physical achievement of a successful mechanical process which will meet the multifarious demands of modern railroad transportation has not yet become a fact. Second, the economics of the problem are such as to lead the author to believe that it will be some time before a practical refrigerating machine can be applied to individual refrigerator cars. Third, from a railroad operating viewpoint any mechanically refrigerated railroad equipment must be held in specified traffic. This is a serious drawback because of the lack of universality of its use, and especially in its acceptance in interchange.

Again, being mechanical, such equipment must have the attention of attendants who must be specifically and practically trained in its maintenance and operation, and even with the most practical achievements along these lines it would be a long time before such a piece of railroad equipment would be heralded by the American railroads.

Fig. 1 Arrangement of Machinery of Absorption-Refrigerating System at End of Car

Refrigerating Machines

Refrigerating machines, or heat pumps, are machines which will carry heat from a cold to a hotter body. (This statement is not at variance with our knowledge that heat does not flow of itself from a cold body to a hotter body.) This, as the second law of thermodynamics asserts, cannot be done by a self-acting process, but it can be achieved by the expenditure of mechanical work. Any heat engine will serve as a heat pump or refrigerating machine if it is forced to operate in such a way as to trace its indicator diagram backward so that the area of the diagram represents work *spent on*, instead of *done by*, the working substance. Heat is then taken in from the cold body and is rejected to the hot body.

The standard systems of mechanical refrigeration are:

1 *The Dense-Air System*, so called because the air which is the refrigerating system is never allowed to fall to atmospheric pressure. This is done in order to reduce the size of the cylinders and pipes through which a given weight of air may be circulated. This process does not depend upon the liquefaction of the air, as it is not liquefied but simply compressed and expanded adiabatically.

2 *The Compression System*, using ammonia, carbon dioxide, sulphur dioxide, ethyl chloride, methyl chloride, etc., so called to distinguish it from the third system because a compressor is used to raise the pressure of the vapor and deliver it to the condenser and there liquefy it, after removing it from the evaporator or expander.

3 *The Absorption System*, using ammonia and so designated because a weak water solution removes the vapor from the expander or evaporator by absorption. The richer aqua ammonia so formed is pumped into a high-pressure chamber (called a generator) in communication with the condenser where the ammonia is discharged from the liquid solution, or rich liquor as it is called, to the condenser by heating the generator, to which the solution is delivered by the only moving part in the process, namely, a slow-moving pump.

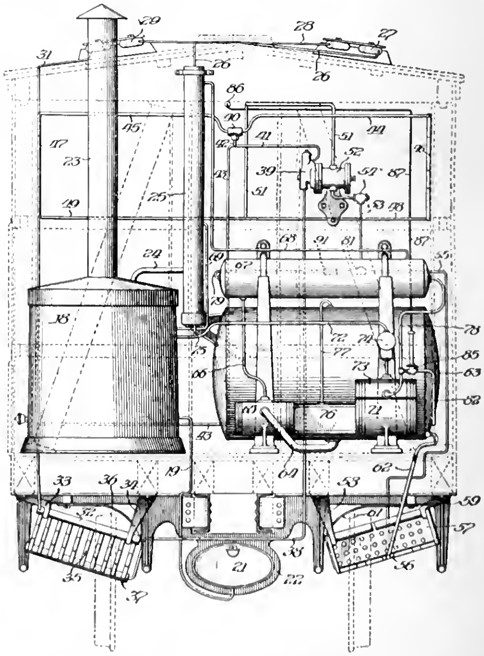


Fig. 2 Later Modifications of Car-Refrigerating System Shown in Fig. 1

The coefficient of performance of refrigerating machines is expressed by the ratio:

$$\frac{\text{Heat extracted from the cold body}}{\text{Work expended}}$$

This ratio may be employed in estimating the merits of a refrigerat-

---

[1] President, Baxter-Stewart Refrigerator Transport Co.; Vice-President, Ideal Truck Equipment Co.

Abridgment of paper presented at a joint meeting of the Metropolitan Section of the A.S.M.E., and the American Society of Refrigerating Engineers, New York, May 16, 1922. All papers are subject to revision.

ing machine from the thermodynamic point of view. When the limits of temperature T_1 and T_2 are assigned, it is very easy to show that no refrigerating machine can have a higher coefficient of performance than one which is reversible according to the Carnot cycle; for let a refrigerating machine A be driven by another, B, which is reversible and is used as a heat engine in driving A, then, if A had a higher coefficient of performance than B, it would take from the cold body more heat than B (working reversed) rejects to the cold body, and hence the double machine, also purely self-acting, would go on extracting heat from the cold body in violation of the second law. Reversability, then, is the test of perfection in a refrigerating machine, just as it is in a heat engine.

When a reversible refrigerating machine takes in all its heat, namely, Q_2 at T_2, and rejects all, namely Q_1 at T_1, then, representing the heat equivalent of the work done by $W = Q_1 - Q_2$, the coefficient of performance is as already defined:

$$\frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$$

hence—and the inference is highly important in practice—the smaller the range of temperature, the better the performance. To cool a large mass of any substance a few degrees will require a much smaller expenditure of energy than to cool, say, one-fifth of the mass through five times as many degrees, although the amount of heat extracted is the same in both cases. If it is desired to cool a large quantity of water or air, for example, it is better to do it by the direct action of a refrigerating machine working through the desired range of temperature than to cool a portion through a wider range and then let it mix with the rest. This is only another instance of a general principle that any mixture or contact of substances at different temperatures is thermodynamically wasteful, because the interchange of heat between them is irreversible.

The foregoing explains why it is mechanically more efficient to produce refrigeration on a large-quantity basis than on a small. In consequence, the amount of energy and machinery in proportion to the refrigerating effect had from a small machine on a refrigerating car is thermally out of proportion to the work done.

European Attempts at the Mechanical Refrigeration of Railroad Cars

The year 1912 marks approximately the beginning of serious attempts at mechanical refrigeration of railroad cars. The first effort that achieved any degree of success was that attempted by the chief of motive power and rolling stock of the Moscow-Kazan Railroad of Russia. Here a semi-absorption process was employed, consisting of refrigerating or expander coils located in the roof of the car and a connection on the outside leading from a drum of anhydrous ammonia, with a suitable expansion valve interposed. The other end of the refrigerating coil was conducted to a crude absorber located underneath the car. This absorber was in reality nothing more than a water tank having an aspirator tube placed therein. To start the process in operation it was only necessary to open the expansion valve and expand the gas in the refrigerating coil; the affinity of the water for the gas in the absorber maintained the back pressure and created the low-pressure side of the machine. It was the intention of the railroad to take the aqua ammonia thus formed in the absorber to a stationary regenerating plant and there distill off and reliquefy the anhydrous ammonia and charge it into suitable receptacles or drums which would be kept on hand and reapplied to equipment passing these points, which latter would virtually perform the same function as re-icing stations. This process failed because it was considerably cheaper to use natural ice for cooling purposes.

While attached to the American Army of Occupation as a major of engineers, the author was on one occasion sent to Poland where he saw in Warsaw an interesting car built in 1912 at Cologne, Germany, for the Russian Government Railways from the designs of M. Humboldt. In the central compartment of this car was a 10-hp. oil engine which drove an ammonia compressor of 4 tons refrigerating capacity. The condensing coils were placed under a sunshade roof on top of the car. No water was used for condensation, the day temperature of the atmosphere being depended upon to wipe off the heat of compression and thus liquefy the ammonia. The liquefied ammonia was passed to various expansion valves, one being located in each of the four refrigerating rooms into which the car was divided—two at each end of the engine compartment. By manually controlling these expansion valves different temperatures could be maintained in each of the various rooms if desired. According to a German railroad official in Warsaw, the cost of operating this car was about 80 per cent more than it would have been had natural ice been employed.

At Mayence on the Rhine, the headquarters of the French Army of Occupation, the author observed a rather new departure in car refrigeration, consisting of three insulated cars placed ahead of a central car provided with a refrigerating plant which was followed by two insulated cars. These cars were built and tried out in 1913. The traffic handled was butter and the service was from Kurgan on the Siberian border to Riga on the Baltic, a distance of about 1500 miles. The temperature maintained in the cars was about 35 deg. fahr. Brine was pumped through piping and coils from the central plant which consisted of a complete refrigerating unit designed by the Linde Company, of Wiesbaden, Germany, one end of the car being partitioned off to serve as a sleeping room for two attendants. The machinery consisted of two double-acting ammonia compressors direct-connected to Diesel engines, ammonia condensers, a brine cooler, and two pumps for brine and for cooling-water circulation, respectively. A fan ventilator in connection with the condenser was set in operation when the train was standing, as otherwise the air passing through the louvres in the upper side walls of the car was not sufficient. A reservoir of cooling water was located beneath the car, as also were water-cooling radiators for the motors.

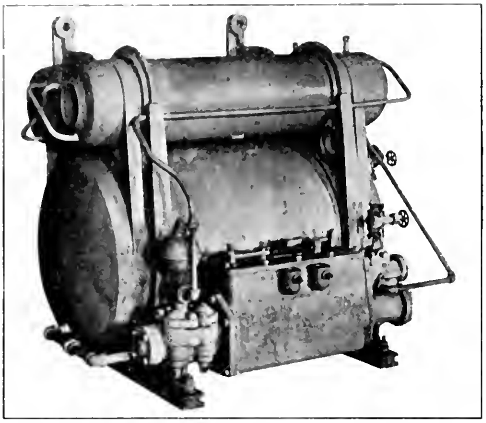


Fig. 3 Secondary Absorber and Temperature Exchanger of Fig. 2

The Author's Earlier System of Mechanical Car Refrigeration

In 1913, when connected with the Canadian Pacific Railroad at Montreal as assistant to the general manager, the author began the study of mechanical refrigeration for railroad cars and built an absorption-system car, which was followed by two more cars constructed by him in the United States. The condenser and absorber were located underneath the car and the source of energy was a slow-burning charcoal fire.

Fig. 1 shows the arrangement of the machinery. The tank on the right is the secondary absorber, while on the left is placed the generator enclosed within an asbestos-insulated jacket. Resting on the generator is seen a portion of the charcoal magazine, which occupies the entire space across the upper end of the car and holds 1500 lb. of charcoal, or enough for twelve days' continuous operation. In the center on the floor is seen the specially constructed ammonia gas-driven circulating pump of the author's design. Above it is located the float regulator which controls the level of the liquor in the generator.

Fig. 2 shows the modifications later made in National Refrigerator Co. Car No. 1003. It was found necessary to add an analyzer and increase the temperature-exchanger capacity. Charcoal was

also abandoned as a fuel in favor of petroleum. The analyzer is shown at 26, while 63 is the secondary absorber, 57 the primary absorber, 67 the temperature exchanger, 35 the condenser, 18 the generator, and 25 the petroleum tank. Fig. 3 shows photographically the secondary absorber and temperature exchanger of Fig. 2.

The construction of the generator is shown in Fig. 5. This consisted of a conical coil of pipe surrounding a kettle hung by means of a trunnion and provided with one central large flue. The rich liquor was pumped into the conical coil first, and as the ammonia gas was distilled off it passed up through three take-offs from various points in the coil to a dome. The other end of the coil was led into the top of the kettle of the generator and there further fractional distillation carried on, the gas passing off through the dome to the analyzer and the condenser. A pipe led out from the generator kettle at the height it was desired to hold the weak-liquor level. This ran to the valve-controlling mechanism of the pump and thence to the power end of the pump, which was driven by the weak liquor and some additional gas.

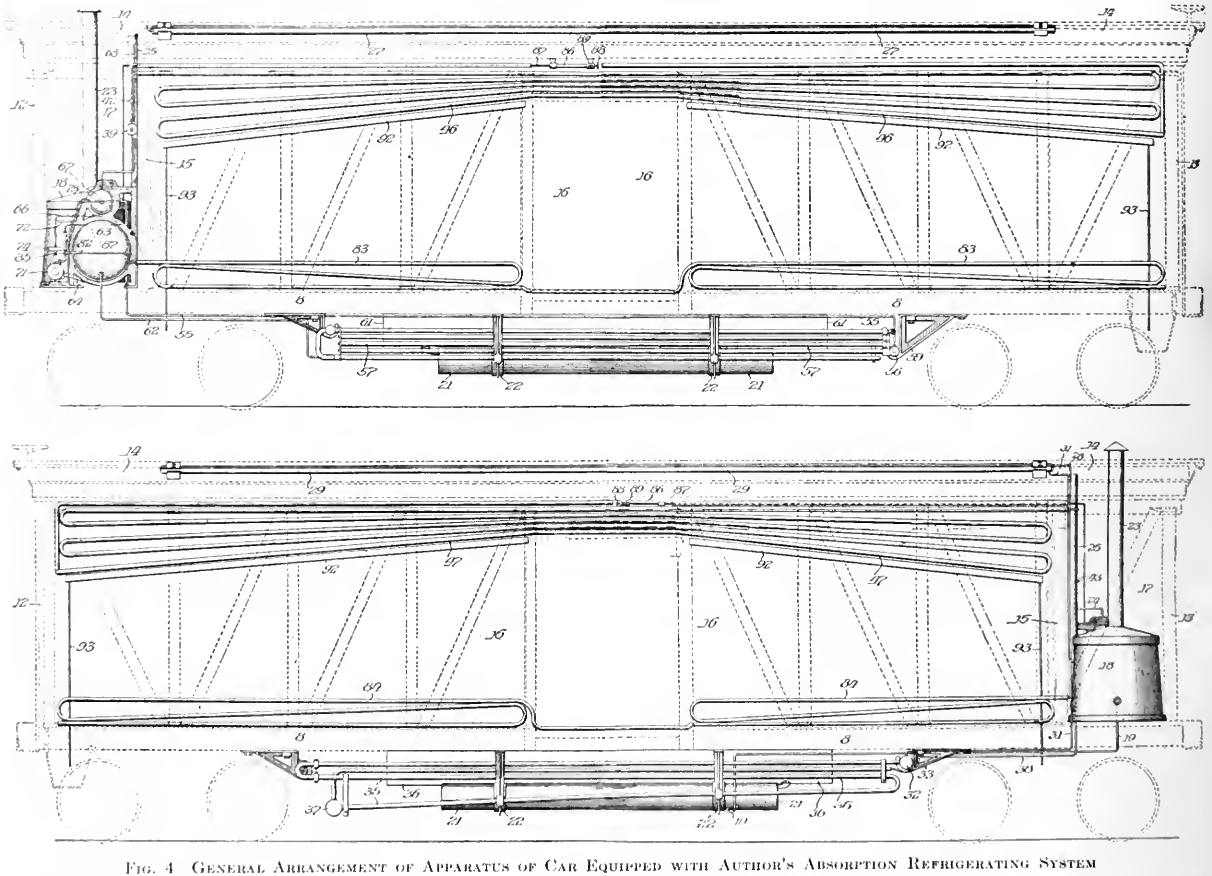


Fig. 4 General Arrangement of Apparatus of Car Equipped with Author's Absorption Refrigerating System

(Upper figure shows absorber underneath car; lower figure, of opposite side of car, shows condenser underneath car. Refrigerating coils are shown on upper side walls and heater coils at lower; superheat-dissipating coils on roof of car, operating mechanism at end.)

Fig. 4 shows the general placement of the various elements of the apparatus. Underneath the car in the upper view is seen the absorber, while in the lower view—of the opposite side of the car—is seen the condenser. Within the car itself on the upper side walls are located the refrigerating coils, while the heater coils are positioned along both sides the lower sides of the side walls. On the roof of the car are placed the superheat-dissipating coils, and in one end of the car is located the operating mechanism.

This car operated successfully on one occasion for nine consecutive days without attention, standing still. The temperature was very evenly maintained at between 32 and 34 deg. fahr. and as low as 26 deg. was reached with an outside temperature of 80 deg. The car was empty.

Fig. 6 shows a diagrammatic plan of the process. Functioning as a refrigerator the operation is as follows: The charcoal magazine is first filled with crushed charcoal; the generator *B* is then filled with a rich charge of aqua ammonia and the secondary absorber to about one-third of its capacity. The fire being lighted, fractional distillation takes place and the gas thus expelled passes to the analyzer through pipe *F*, where a certain amount of dehydration takes place. The gas passes on to the condenser *G* and is liquefied in the header which connects to the automatic expansion valve *H*, the latter not opening until 15 lb. gage pressure has been reached. This retains enough pressure to start the pump automatically. The liquefied ammonia passes through the expansion valve and is expanded in the refrigerating coils *I*, *I*, passing from there to the absorber *J*. The weak liquor leaves the generator through the pipe *K* which projects into the kettle of the generator sufficiently high to obtain the minimum level of liquid desired. This hot weak liquor is conducted to the temperature exchanger *L*, where it meets the cold rich liquor coming from the absorber *J* and which is being pumped by the pump *C*. It gives up its heat to this rich hot liquor and is cooled by the countercurrent of cold strong liquor. It is then sprayed into the primary absorber *N* by means of a nozzle *M* and is further cooled by radiation by the coils *O*, *O*. It is thence conducted to the top of the absorber *J* and sprayed into this chamber. The pump is gas-and-weak-liquor driven and is controlled by the float regulator *Q*. The exhaust from the pump is conducted to a secondary counter-current temperature exchanger where most of its heat is absorbed by the cold rich liquor on its way to the primary temperature exchanger *L*, which liquor is finally conducted into the absorber tube *N* and thence taken up. The operation is continuous and automatic.

To convert the machine into a heater, the thermostat located

in the ceiling of the car functions the thermostatic valve. This opens a direct connection between the hot liquor of the generator and the heating coils *S*. After throwing off the heat imparted to the liquor by the fire, the fluid is conducted directly into the refrigerating coils, where additional heat of absorption by chemical action is further generated, assisting in warming the car, and the liquor passes on to the absorber in the usual way. The working of the machine is unaltered in all of its other operating functions. When the car has risen sufficiently in temperature the thermostat closes the thermostatic valve and the machine is again a refrigerator.

While this car from a construction point of view was a success in that it stood rough usage, met all the requirements of the Master Car Builders' Association, was cheap to build and economical in operation, nevertheless it was difficult to keep the pipe joints tight and leakproof. The real cause of failure, however, was due to boil-overs or foaming as soon as the car was switched or put in motion. The author devoted much time to this feature but was never able to prevent it. Of course, as soon as this occurred the car became inoperative, as liquor passed to the condenser and no anhydrous ammonia remained to expand in the refrigerating coils.

The Dense-Air System of Car Refrigeration

In 1917 the author abandoned all ammonia processes and attempted to achieve the result by means of the dense-air process. In this he has been quite successful. Fig. 7 shows a large refrigerated motor truck equipped with a one-ton dense-air refrigerating machine and having a capacity of 30,000 lb. of dressed beef at a load. The temperature maintained is 36 deg. on a 90-deg. day. A fleet of these trucks have been in continuous service for four years in the stockyards district of Chicago, handling traffic in a radius of 24 miles.

Fig. 5 Construction of Generator of Fig. 2

Fig. 8 shows diagrammatically the process as used on two of these trucks. The plant has a refrigerating capacity of 1000 lb. Its source of energy is a gasoline engine and the refrigerating medium is the air. With this combination the only operating supplies necessary are gasoline and oil. The refrigerating mechanism is located in a space occupying 2 ft. of the length of the body on the front end, leaving a receiving chamber for perishable goods 23 ft. 6 in. long, 7 ft. 4 in. wide, and 6 ft. 2 in. high. The refrigerating coils are located in the roof of the car and are fastened to the steel-plate and angle-iron carlines, which makes it possible to swing carcasses from the coils by meat hooks. The refrigerating machine is adjusted thermostatically to maintain the temperature of 36 deg. fahr. It can also be adjusted to reasonably lower room temperatures if desired, it being possible to carry the expanded air temperature of the refrigerating medium to 30 deg. below zero.

The Refrigerating Machine. The dense-air process is based upon the fact that a perfect gas under pressure, expanding adiabatically and performing external work will suffer a drop in temperature proportional to the mechanical energy produced. Its fundamental advantages lie in these characteristics: There is an unlimited supply of the agent everywhere, as air is the medium; it is readily dried by the use of deliquescent salts, it is innoxious, non-poisonous, and its explosive force lies only in its expansibility under pressure; a leak may be readily sealed and the air, once dried, becomes a perfect medium of refrigeration at temperatures much lower than is possible with any agent except CO_2.

The refrigerating unit consists of a compressor employing two cylinders (5 in. bore by 5 in. stroke), and an integral expander consisting of two cylinder ($4^3/_8$ in. bore by 5 in. stroke), both sets of cylinders operating from the same crankshaft. The unique feature of this design lies in the valve mechanism and means for controlling the expander unit. The exhaust valve is a rotary valve functioning both cylinders. The inlet valves are controlled and timed by a compound rotary cam whose length is adjustable by thermostatic control, thus making it possible to alter and control by thermostat the ratio of expansion, and therefore the resultant temperature. Castor oil is used as a lubricant in both the compressor and expander sides and the oiling system is in itself a closed cycle. The expander mechanism is oiled from the oil separator in the exhaust from the compressor and fed under pressure of the high side to the cams, valve mechanism and pistons of the expander. The compressor pistons are lubricated by splash from the crankcase and an oil separator in the low side returns the oil to the crankcase.

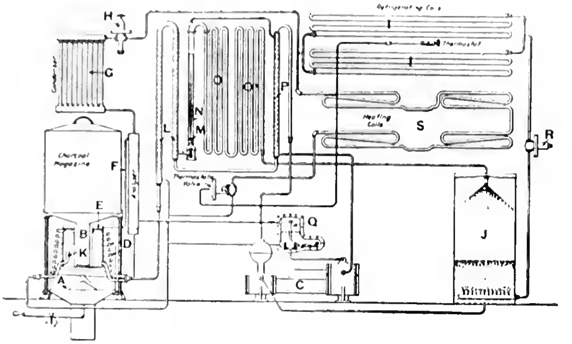


Fig. 6 Diagrammatic Plan of Car-Refrigerating System Shown in Figs. 2–5

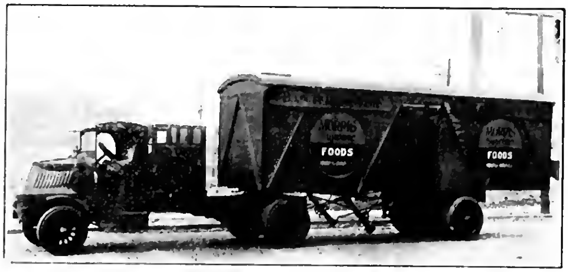


Fig. 7 Large Refrigerated Motor Truck Equipped with a One-Ton Dense-Air Refrigerating Machine

In operation the machine require $1^3/_4$ hp. which is furnished by an air-cooled engine of the Henderson motorcycle type. The engine also drives an exhaust fan of approximately 4000 cu. ft. capacity which produces a rapid flow of air across the compressed-air cooler, the compressor cylinders and gasoline engine cylinders. Proper ducts are provided to connect the various members to be cooled.

The Thermodynamic Cycle. In order to illustrate the system

and to set forth the simplicity of the refrigerating process and the incidental mechanism, attention is again called to Fig. 8 in which *A* is the refrigerating unit, *B* the gasoline engine which supplies the power, *C* the compressed-air cooler and *D* the refrigerating coils.

The device is primed by the use of the hand pump *E* connected with the drier *F*, operation of the hand pump being continued until the gage indicates the density required, as the capacity of the machine depends upon the densities of the two sides, regardless of the ration of expansion. Priming, therefore, is necessary to increase the relative capacity of the device.

In operation the compressor cylinders *G* take air through their pistons from the crankcase and discharge into the cooler *C* first through the oil separator *H*, thence through the drier *F* which removes the entrained moisture, converting the hydrous content into a fixed brine and allowing the anhydrous air to pass on to the cooler *C* where the thermal coefficient of the mechanical energy performed and the specific heat due to change in volume are removed, the cooler serving to bring the temperature of the compressed air down to a point approximately 27 deg. higher than the weather temperature of the day.

The compressed air which has been cooled now passes through the secondary drier *J* to the expander, the secondary drier serving as a precautionary device to remove any moisture which may have passed the drier *F* because of high temperature at that point. In the expander *K* the air is expanded adiabatically at the ratio of expansion determined by the position of the control piston in the cylinder *L*, which is in turn controlled by the thermostat *M*. The expanded air, of extremely low temperature, is carried to the oil separator *N* in which any oil is removed before it may enter the refrigerating coils *D*, as oil in the coils produces a decided loss in efficiency. The oil extracted in the separator *N* is returned to the return pipe from the refrigerating coils *D* by a crossover *O*, both oil and air being finally returned to the crankcase from which the compressor cylinders take their supply.

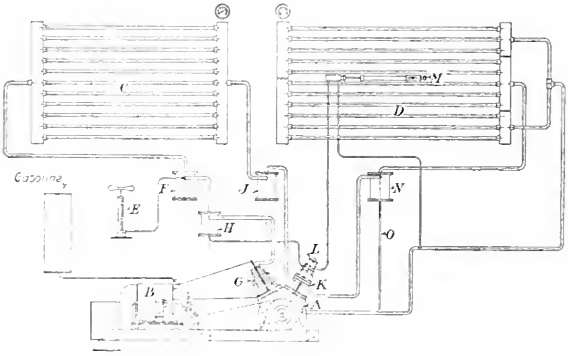


Fig. 8 Diagram Showing Process Employed on Motor Truck of Fig. 7

The thermostatic control of the ratio of expansion is accomplished by means of a piston whose position determines the length of the cam face, which in turn determines the proportionate time of opening and closing the inlet valves, and therefore the ratio of expansion. The position of the control piston is determined thermostatically by a leak-off connected with the thermostat, by which high-pressure air is allowed to escape to the low-pressure side and move the piston proportionately to its rate of escape.

In a device having extremes of temperature such as the one under consideration it is highly important that lubrication be effective and automatic. Castor oil is used because of the fact that its viscosity is not greatly affected by either the high temperature of the compressor or the extremely low temperature of the expander. The compressor cylinders take their air from the crankcase and lubrication of the compressor cylinders is effected by the splash of the crank. It follows that a comparatively large amount of oil is carried with the air into the compressor cylinders, where not only the cylinders but the valves and valve mechanism are amply lubricated. This oil is separated from the compressed air by the separator *H*, and being under the pressure of the high side is fed through a tube to the cam pocket and valve head of the expander mechanism. This constitutes a crossover for the oil. Some portion escapes around the pistons into the crankcase. The remainder is carried with the expanded air to the separator *N* where it is removed centrifugally and by-passed and returned through the tube *O*.

The Ethyl Chloride System

In addition to the systems described there is another, of the compression type, using ethyl chloride as the medium. Ethyl chloride boils at 54.5 deg. fahr. and liquefies at the low pressure of 15 lb., with condenser water at 65 deg. fahr. Its critical temperature is 365 deg. fahr., which is sufficiently high to preclude the danger of generating permanent gases. Being a neutral gas, it is possible to use thin seamless drawn copper tubes, and the joints may be soldered if desired.

As the boiling point of ethyl chloride is so low, a partial vacuum is necessary on the low side of the machine to produce the required temperature in the car. The medium is handled by a valveless rotary compressor.

The machinery is located in the end of the car and the method of operation is as follows: The medium is evaporated in the refrigerator pipes in the refrigerating compartment. The gas is then drawn to the compressor and forced into the condenser where it is liquefied. The condenser consists of a series of copper tubes placed vertically in the compartment with the compressor. The heat of compression is removed by means of a small spray of water fed to the top of the condenser, and this water is cooled by a fan so arranged that the current of air is distributed equally over the entire surface of the condenser. The power to drive this mechanism is taken from the axle of the car by means of a belt and countershaft below the compressor. Between the countershaft and the truck axle are interposed two idler pulleys upon a common guide, these pulleys being held together by springs and placed upon a guide in order that they may operate in either direction. The arrangement is such that in whichever direction the car is running the machine automatically takes up its refrigerating work. The water for cooling the condenser is carried in a tank underneath the car, from which it is pumped by a small rotary pump attached to the main shaft of the compressor. An oil engine is provided for the purpose of continuing the operation of refrigeration when the car is standing still, thus making it possible to set the car out of the train when necessary. The water for cooling the cylinder of the engine is carried in a small tank on the roof of the car.

Conclusion

As stated at the beginning of the paper and for the reasons there mentioned, it will be some time before mechanical refrigeration will be adopted on American railway cars. However, the author believes that it can be accomplished by equipping refrigerator cars with a thermosiphon system and providing a tank in the roof of the car with two compartments, one for receiving ice from regular icing stations and the other for holding a weak brine solution into which is submerged a refrigerating coil; the source of energy for cooling this brine to come from a central refrigerating-plant car carried in the train and having a capacity sufficient to refrigerate ten cars. The brine cooled in this central car would be pumped under a pressure of two or three pounds to the refrigerating coils in the various refrigerator cars, and even remove the latent heat of the brine in the tanks, if necessary, thus freezing it, thereby storing refrigerating work to be used if the car should be set out; or if the car is to be used in traffic where it is not operated from the central-plant car, then, as previously mentioned, it may be iced in the usual way, and by means of the thermosiphon system a rapid automatic circulation of the secondary refrigerating coils will take place whether the car is standing or in motion. It should be possible to store enough latent-heat energy to operate one of these cars at least 72 hours without re-icing or reconnection to the central-plant car.

This central-plant car should have installed within it a dense-air refrigerating machine of 30 tons refrigerating capacity for a ten-car unit. This machine may be driven by any of the standard forms of gas or oil engines, preferably of the Diesel type, and the entire operation can be so designed that no water need be provided to carry away the heat of compression.

The Helicopter and the Variable Pitch Propeller

Notes on Some of the Problems That Are Involved and the Present Situation of Development, Particularly in the United States

THE helicopter differs from the aeroplane in that it obtains its lift directly from the propellers and not through a component of resistance of the air acting on planes inclined at an angle to the direction of the motion of the machine.

The helicopter idea is at least as old as, if not older than, that of the aeroplane, and toy helicopters flew long before Langley and the Wright brothers. The fact that the aeroplane reached practical developments long before the helicopter is, however, due to the much greater difficulty of the solution of the latter problem.

The immediate advantage of the helicopter over the aeroplane is uncertain, depending in the end on its development. Its most important apparent advantage is its ability to rise vertically from a standing start and to hover over a given spot. On the other hand, at least as far as the helicopter has been developed to date, it would appear that its ability to maintain itself in the air is entirely dependent on the engine, and should the latter stop, the helicopter would come down like a stone. Commander J. C. Hunsaker, Aircraft Division, U. S. Navy, was asked whether he considered the present aircraft engine sufficiently reliable for the hazardous service of helicopter flying and he emphatically stated that he did not. We shall see later the ways by which it is attempted to increase the safety of the helicopter in this respect.

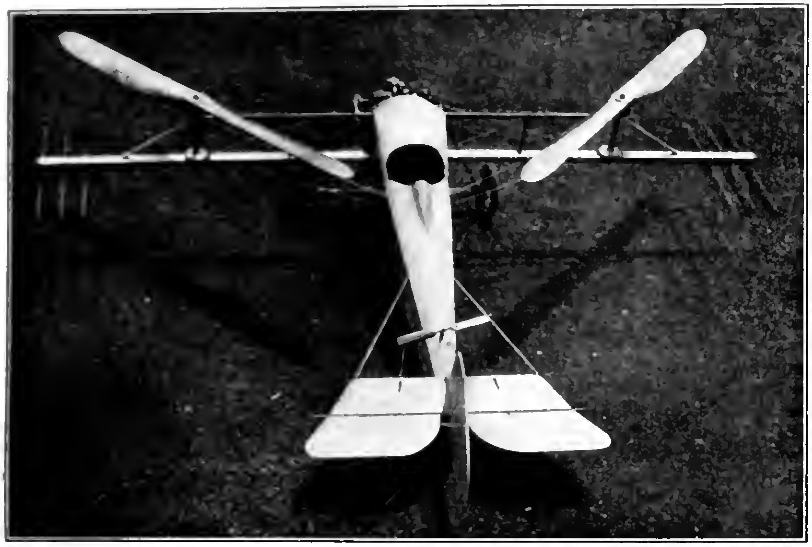


Fig. 1 The Berliner Helicopter

The Four Helicopter Problems

The riddle of the helicopter may be considered as comprising four different problems. The first is that of getting off the ground. This is the simplest and easiest part. With modern large propellers a lift of 15 lb. per horsepower can be easily obtained and as aircraft engines weigh around 2 lb. per horsepower, there is ample margin for the weight of the structure, pilot and supplies for a flight of considerable duration.

The question of getting safely back to the ground in case of engine failure is much more difficult. An aeroplane volplanes; the conventional helicopter would drop like a stone. Several unworkable devices have been suggested, such as the use of parachutes, balloons, etc. The most promising suggestions to date appear to be the use of propellers with extremely wide blades (Damblanc, Fig. 2), the angles of which may be changed so that the propeller would spin like a windmill driven by the air pressure during the descent. With propellers of proper size and design the velocity of descent might be considerably retarded, but would still remain too high to be either safe or comfortable. Another proposal (Leinweber Brothers) involves the use of planes somewhat like those in an aeroplane built up of movable shutters affording large openings during the ascent but acting practically like aeroplane planes during the descent. Whether such a construction will prove practical with the increased weight and mechanical complications, only time will show.

The next problem is that of keeping the helicopter right side up. In the Petroczy-Karman helicopter stability is insured by tethering the helicopter to the ground by cables. This, of course, can be done only with captive helicopters. In the Leinweber helicopter the control of position is secured by varying the angle of the propeller shafts (Fig. 3) with the axis of the machine. Proper balance can undoubtedly be secured in this way, providing the methods of control are sensitive enough.

In the Berliner helicopter (Fig. 1) control is secured by the use of three movable fins under each of the propellers, movable about in the stream of air projected by the propeller. The longitudinal control is secured by the little variable pitch propeller shown in the rear of the fuselage of the machine. In the Damblanc helicopter, control is secured by varying the angle of any of the blades of either propeller independently of the rest. In this way more lift can be secured from one side of the helicopter than from the other. Here again the balance will depend on the sensitiveness of the controls and also on the natural tendency of the machine towards positive or negative stability.

If the above three problems were properly solved the helicopter would be capable of rising, hovering, and coming down. To make it a transportation device it must also become capable of horizontal travel in any desired direction. This can be obtained either by tilting the whole helicopter so that the propellers pull it both forward and upward (which is accomplished in the Berliner helicopter by the use of the little variable pitch propeller), or by the use of an auxiliary propeller for horizontal drive, or, finally, by varying the pitch of the propellers as suggested by the Leinweber Brothers.

Some Foreign Helicopters

As regards helicopters of which the development has advanced far enough to give a fair idea of their construction, it should be stated at the outset that the information available is somewhat sketchy. The designers of some of the helicopters, for example, Brennan, in England, have absolutely refused to give any information to the public. Others have permitted inspection of their machines and given information but with material reservations.

Helicopters attracted some attention of Austrian army authorities as a means of replacing captive balloons for observation purposes. Helicopters, if properly developed, might prove to be quite valuable for this purpose, since in the first place they offer a much poorer target to enemy fire, and second, have fewer vital points to be hit and are not inflammable. Because of this, during the recent war, Lieutenant Petroczy and Professor Karman were authorized to build captive helicopters, one of which was equipped with electric power and the other with two LeRhone motors. The total weight of the captive helicopter and fuel for one hour,

but not including the observer, is about 1300 kg. (2860 lb.) After about 15 successive flight tests lasting up to an hour, at wind velocities up to 8 m. (26.3 ft.) per sec., the machine had a breakdown in landing. Observations proved that in addition to the fundamental demand for ample excess of thrust, the position of the center of gravity in its relation to the plane of rotation of the propeller is of great importance.

In the Karman helicopter the propellers are superimposed.

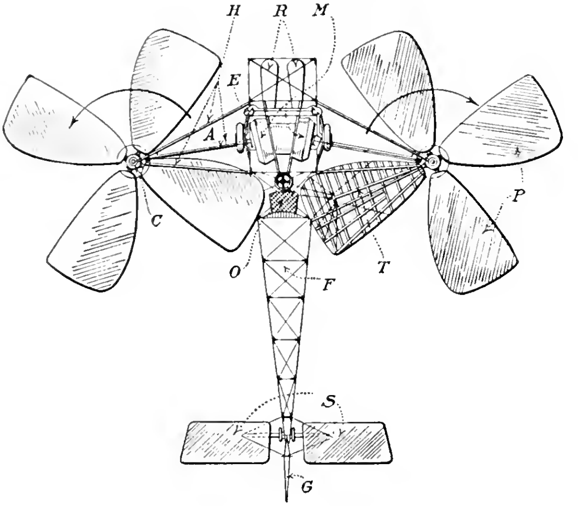


Fig. 2 The Damblanc Helicopter

In the Damblanc helicopter (France) (Fig. 2) there are two rotating wings, each formed of four blades having an area of about 5 sq. m. (53.8 ft.) In addition to this there are two stabilizing planes situated to the rear of the fuselage and controlled by a metallic cable. There is an interesting warping gear for the blades comprising articulated elbow levers acting on the blades of the wings by means of metal cables operated from a control stick. The total area of rotating wings is 40 sq. m. (131 sq. ft.) and the speed of rotation 160 r.p.m.; the weight per square meter of lifting service is 30 kg. (6.2 lb. per sq. ft.) So far as information is available only laboratory tests on this machine have been made.

In the Oemichen-Peugot machine (France) sustentation is partially derived from a hydrogen-filled balloon of fair size. It has two lifting screws driven by belts and disposed symmetrically on the upper part. The screws are each formed with two blades of a special profile, very large towards the root and very thin towards the tips. Their diameter is 21 ft. The machine is driven by a motor developing 25 hp. and weighs 740 lb. The balloon supplies a net lift of 156 lb., while the propellers have to deliver a lift of 495 lb. which is quite a good deal for a motor of 25 hp.

American Helicopter Designs

A good deal of valuable work, both development and research, is being carried on on this problem in the United States. The National Advisory Committee for Aeronautics just completed an extensive investigation of some features bearing on the helicopter problem.

Of the machines actually constructed in this country may be mentioned the helicopters built by Emil Berliner and his son Henry, in Washington, D.C., the Leinweber Brothers in Chicago, Ill., and the late Peter Cooper Hewitt, in association with Prof. F. B. Crocker. Of these the Berliner machine has two main propellers 14 ft. 10 in. in diameter running at 540 r.p.m. and an auxiliary control variable pitch propeller 3 ft. in diameter, running at 1700 to 1800 r.p.m. The machine is driven by a 110 hp. LeRhone motor and weighs complete with pilot and fuel from 1350 to 1400 lb. Henry Berliner stated that all the flights undertaken hitherto have been made at comparatively low altitudes, around 6 ft. and not to exceed 20 ft., this being done mainly in order to avoid unnecessary danger during the experimental period. He also stated that flights were made in a horizontal direction to the extent of several hundred yards.

The Leinweber Brothers machine has so far flown only in the vertical direction, being used for experimental purposes, merely as a captive helicopter. Its main features of construction appear fairly well from the photograph (Fig. 3).

It has a length 25 ft., width from propeller tip to tip 22 ft., weight 1500 lb.; uses two Gnome engines of 100 hp. each, two 10-ft. propellers and also four three-bladed propellers size 2–9 ft. 6″ on top and 2–6 ft. propellers at the bottom. In addition to that, however, the designers have developed a system of control for the propellers operating essentially in the following manner:

The active members of the control consist of two weights freely suspended as pendulums each operating a four-way valve controlling a compressed-air motor, which, in its turn, regulates the position of the shafts carrying the propeller blades. The device is somewhat similar to numerous devices used in aeroplane stabilizers where, however, their operation is apt to be considerably disturbed by centrifugal force arising when an aeroplane makes a sharp turn. When this fact was mentioned to William Leinweber he agreed with the possibility of it, but stated that the helicopter would not be supposed to take as sharp turns as an aeroplane.

An American design which attracted a good deal of attention towards the end of the war was the Hewitt-Crocker helicopter, jointly developed by the late Peter Cooper Hewitt and Prof. Francis Bacon Crocker. In this machine there are two propellers, an upper propeller revolving in a normally horizontal plane and another propeller revolving in a parallel plane 7 ft. below, each propeller being 51 ft. in diameter. The motor speed is 1400 r.p.m. and the propeller speed 100 r.p.m. which means a speed reduction of 14 to 1, this being obtained by a gear train consisting of a gear 30 in. in diameter and a pinion 2 in. in diameter. The gears are designed so as to avoid their springing out of mesh. The propeller blades of the Hewitt-Crocker helicopters have the form of aeroplane wings, not only in cross section but also in aspect ratio and other proportions. The actual section of the propeller blades is Eiffel No. 63, the thickness of which is one-tenth of the chord. The width of the blade is 30 in. and the thickness 3 in. This section and these dimensions are uniform throughout the length of a blade which is 12 ft.

For turning the machine so as to enable it to face in different directions two planes are provided, located at the extremities of two arms. These planes are capable of being tilted about a horizontal axis passing through their centers, and are located below the

Fig. 3 The Leinweber Helicopter

propeller blades so as to receive the downdraft therefrom. These planes may be used to correct any tendency of the car to rotate as a result of unequal action of the propellers.

The Variable Pitch Propeller

The development work on the helicopter is likely to lead to an intensive interest in the improvement of the variable pitch propeller. In the first place, variable pitch propellers are already used on some of the helicopters, as, for example, in the auxiliary propeller of the Berliner machine and the main propellers of the Damblane machine. In the next place, one of the main advantages of the helicopter lies in its ability to rise and descend vertically though this latter cannot yet be considered to have been accomplished to any material extent. The aeroplane of today requires, on the other hand, quite a considerable field for rising and landing, and with many designs can effect a landing only at high speeds, which makes the operation of landing to a certain extent more hazardous than average flying. If, however, really reliable and easily operated variable pitch propellers were available, the landing speeds on aeroplanes could be cut at least in half. This is exemplified by tests made at McCook Field, Air Service, War Department, with machines equipped with the Dicks steel variable pitch propeller. In landings with the propeller at constant pitch the machine came to a full stop in 625 ft. and the same machine landed in 239 ft. when the variable pitch propeller was used. In this way the aeroplane is given one more chance to defend its position against possible competition on the part of the helicopter, providing this latter should be developed to the commercial stage.

Of course, variable pitch propellers are also of great importance in connection with high altitude flying, which is likely to become a feature of aerial transportation of the future. There, the value of the variable pitch propeller lies in the following: The engine loses power with elevation, because of the reduced content of oxygen in the volume of air inducted into the cylinders, and the resultant ability to burn less fuel. In other words, the engine at higher altitudes acts as if it were partially throttled. Supercharger devices precompress the air delivered into the induction system of the engine and in this way restore the engine power delivered to the propeller. Since, however, the medium in which the propeller operates is of reduced density, the increase in speed by itself does not produce a corresponding increase in thrust, unless the propeller pitch is varied. Because of this the variable pitch propeller becomes a natural adjunct to the supercharged aeroplane engine.

The problem of the variable pitch propeller is quite simple at first glance, it being only necessary to provide some kind of a gear device to turn the blades about their longitudinal axis. The difficulty of the problem lies, however, in the fact that in a variable pitch propeller, the blades must be separate from the hub. At the same time, the stresses induced by centrifugal forces in the propeller are so high that it becomes extremely difficult to secure a method of connection between the propeller hub and the blades that could withstand these stresses. During the war Mr. Hart of California developed a wooden blade propeller having the variable pitch feature. This propeller was taken over by the Air Service, War Department, and a great deal of experimental Work and design was applied to it at McCook Field with what are said to be highly gratifying results.

Of late an all-metal variable pitch propeller has been developed, a problem of considerable difficulty, as it was believed that structures operating under the conditions of aeroplane propellers and made up of steel would be subject to crystallization of the metal and subsequent failure.

The Dicks propeller developed by Thomas A. Dicks of Pittsburgh is shown in Figs. 4 and 5 as mounted on an aeroplane at McCook Field. It is said to be the only variable pitch propeller actually operated on the 12-cylinder Liberty motor. The blades of the Dicks propeller are machined out of a special alloy steel so as to fit over a taper mandrel. A series of specially designed reamers are used to give each section the exact dimensions. The blade is then compressed to size over a series of mandrels. The gear for turning the blades and thus varying the pitch is shown in the illustration. An interesting arrangement for holding the blades in the hub is used, not subject to publication at the present time.

In flight tests on a DH plane with Liberty motor, the same speed was developed with the variable pitch steel propeller as with the permanent pitch wooden propeller, but the ground run on landing was cut practically in half. The Dicks propeller is somewhat heavier than the standard wooden propeller, which, under certain conditions, may prove to be a handicap by displacing the center of gravity too far forward. If it should prove to be possible to use lighter alloys, such as duralumin, for the blades, instead of steel as at present, not only the weight of the unit but the centrifugal stresses produced by the blades on the hubs and connections would be materially reduced.

A special system of controls has been developed for this propeller, as well as means for regulating the carburetor throttle in conjunction with the variations of the propeller pitch. These cannot be described at the present time.

Fig. 4 Dicks Variable Pitch Steel Propeller

Development Problems of the Helicopter

Coming back to the question as to the probable field of application of helicopters, one must start with a clear understanding that any prediction as to this must be made dependent on the development of the helicopter. Thus, for example, the question of safety of flight will play an important part, as well as the ability of the machine to land on extremely restricted grounds. This latter, together with the ability of the helicopter to hover, might make it extremely valuable for military purposes for operation in connection with the Navy, as well as for commercial purposes, by enabling the helicopters to act as connecting links between ships at sea, a service which aeroplanes tried to perform, but for which they have not hitherto proved entirely suitable.

On the other hand, however, engine failure, as has been stated above, would leave the helicopter powerless against the action of gravity. There is, of course, a simple remedy to meet this situation applicable, however, only to large machines, and that is, to use more than one engine. Thus, for example, the Leinweber Brothers state that they are designing a helicopter that would use 12 engines, while Professor Crocker is willing to compromise

on the more modest number of four engines. There are good reasons to believe that helicopters if they become at all available in any form similar to that of the machines now being built would be primarily a large size machine of a type where at least two, probably four, engines might be legitimately used.

Whatever may be the development of the helicopter, there is no doubt as to its value in giving us a better understanding of aerodynamic phenomena, and, in particular, of the operation of large-diameter comparatively-slow-revolution propellers.

In this connection, Edward P. Warner, of the National Advisory Committee for Aeronautics, points out as a curious fact that whereas the aeroplane has been developed almost entirely by young men not previously noted as inventors, engineers, or scientists, the fortunes of the helicopter have been more in the hands of those with reputations previously acquired in other fields. Mr. Edison has long been a believer in the future of the helicopter as the best means of air transportation and some of the important contributions to helicopter design and invention in America have been made by the late Peter Cooper Hewitt, the inventor of the mercury arc light, and by Doctor Berliner, originally responsible for the disc talking machine. In England, important work is being done by Brennan, known as the inventor of the monorail railroad. This may perhaps be explained to a certain extent by assuming that the majority of men of achievement in the nineteenth century "knew" that aeroplane flight was impossible and therefore did not bother with it, leaving the field to visionaries like Santos Dumont and the Wright brothers. There is no question today that sooner or later a workable helicopter will be built and that it is merely a matter of design, additional information and perhaps a leaven of mechanical genius that are necessary to solve the problem, and the problem itself is big enough to be attractive to men who have already won their spurs in other fields of achievement.

Fig. 5 The Dicks Variable Pitch Propeller Partly Showing External Gear for Moving Blades

There are three sets of problems that confront the designers of helicopters of the future. The first are of a purely mechanical character. Variable pitch propellers, method of installing and holding large propellers, layout of the helicopter frame subject to heavy stresses, and yet so different from the aeroplane frame, and the thousand and one details involved in this novel structure will tax the mechanical skill of the designer. As in the case of the aeroplane, this is going to be a matter of slow development, the designers learning by previous failures, and while a great amount of ingenuity will be needed, there does not seem to be anything that would be impossible of solution.

The next great problem before the designers of the helicopter of the future will be to secure the scientific information necessary. It is not so much the genius of aeronautical engineers that made the present plane so safe, efficient and powerful, as compared with the flimsy machines of 1908 and 1909 but the immense amount of aerodynamical information gathered in such laboratories as the Eiffel, National Physical at Teddington and numerous wind tunnels in America. Some of this information will of course prove applicable to helicopter design but the conditions of operation of the helicopter and the elements of its construction are so different from those incorporated in aeroplanes that a vast amount of additional information will be needed. Thus for example, we have learned in the last ten years from numberless tests on the stand, in the wind tunnels, and in actual flight a good deal about the laws governing the performance of comparatively small high-speed permanent pitch propellers, but we have only scant and uncertain knowledge as to the operation of large low-speed propellers and still less as to the effect of slight variations of pitch under different conditions of operation.

It is a fortunate matter as far as the United States is concerned that we have in this country at present research facilities that can hardly be matched by any other country in the world. The wind tunnels at Massachusetts Institute of Technology, Langley Field, McCook Field, Leland Stanford, Jr. University, not to mention smaller institutions, are excellently equipped, and what is more important manned by engineering staffs who have already shown their ability to carry on difficult path-bearing research in a highly skilled manner. In the development of aeronautical instruments and methods of investigation the United States probably leads the world. Just as an instance might be mentioned the fact that under the auspices of the National Advisory Committee for Aeronautics there have been developed recently methods for determining the pressure on every part of an aeroplane in actual flight which will rapidly eliminate the great uncertainty still prevailing as to this important factor.

The development of the helicopter is also apt to bring about changes in engine design. Most of our aeroplane engine design is still under the influence of war conditions. For military purposes single machines of maximum output for a given plan are preferable to multiple units because while single machines carry a lower general factor of safety they have a higher military factor of safety, the idea being that if one of two machines fails the flyer under actual conditions would still be able to safely reach the ground with the other engine. Under war conditions, however, the failure of a single engine would reduce the safety of the plane so as to place the flyer at the mercy of his faster adversary.

Helicopter conditions of operation from the engine point of view are, however, vastly different. As far as one can see now the safety of helicopter flight will depend on engine performace although of course unforseen developments in design can meet these conditions in a manner of which we know nothing about today. As far as we can see now, however, if the engine power of the helicopter should stop the machine would come down to the ground faster than would be desired from the point of view of at least comfort if not safety of the flyers. It has been suggested already that this difficulty might be at least partially solved by using multiple units, e.g., by Professor Francis Bacon Crocker who suggested the use of four engines.

It is an interesting fact that while important progress has been made in the design of large aeroplane engines, the field of smaller engines has been comparatively neglected and it is rather significant that practically all experimenters with helicopters are using engines dating to the early days of the war, the favorite in America being the LeRhone 110-hp. rotary.

If multiple units are to be used on helicopters these units will be comparatively small which will mean a demand for small, light and yet efficient units. Some work in this direction, called forth however by a different set of conditions, is being done already. Small engines with an output of not to exceed 60 hp. are being vigorously developed in Germany, one having been placed on the market last spring by the Siemens-Halske Company. The interest of the Germans in small engines is due to the fact that for the next two years at least, beginning with May, 1922, no civilian machines will be permitted to fly in Germany under the Treaty of Versailles if powered with more than 60 hp.

Acid-Resisting Metals and Alloys

An Account of Research Work Carried Out on Various Non-Ferrous Metals and Alloys, with Especial Reference to Their Use in the Manufacture of Mine Pumps and Chemical Apparatus

By GEORGE A. DRYSDALE,[1] INDIANAPOLIS, IND.

FOR many years past, there has been a great demand for true acid-resisting metals, more especially in the chemical and coal-mining industries. In fact, their production has become one of the great metallurgical problems of the day, for up to the present time no metal or alloy giving satisfactory results, in a broad sense of the term, has been discovered. However, a great deal of thought is now being given to the subject and much experimental work is being carried on by large manufacturing corporations interested in developing such metals. Also the United States Government, through its Bureau of Mines at Pittsburgh, Pa., is conducting a series of tests on the various known metals and alloys, to determine their acid-resisting properties.

Wherever ferrous or non-ferrous metals are used, attacking or destructive agencies in the nature of oxidation, corrosion, erosion, etc., are always present and have their detrimental effects in varying degrees. Mine pumps and apparatus for chemical industries have been made of either steel, cast iron, brass, bronze, lead, or a combination of these metals. Brass and bronze, under ordinary working conditions, have been found in the majority of cases to be superior to steel or cast iron, and lead or antimonial lead superior to brass or bronze. However, none of the metals mentioned gives satisfaction when used in the manufacture of mine pumps; in other words, none of them will stand up for a reasonable period of time against corrosion and erosion.

CONDITIONS GOVERNING THE PRODUCTION OF PRACTICABLE ACID-RESISTING METALS AND ALLOYS

It is common knowledge that an alloy containing approximately equal parts of cobalt and tin is practically acid-proof (aqua regia included), but such an alloy would be too brittle for mine pumps or chemical apparatus, and its cost would be almost prohibitive. Alloys of copper, nickel and tungsten are also highly resistant to sulphuric acid in different strengths; high-silicon ferrous alloys (14 to 15 per cent Si) are also resistant to sulphuric, nitric and other acids, but on account of their excessive hardness and brittleness their use is limited, and therefore none of them complies with the four major conditions which must be the basis of consideration in perfecting a true acid-resisting metal and placing it on a commercial basis. These conditions are:

1 The metal or alloy must be good from the foundry standpoint—a metal or a perfect alloy that gives a very dense structure, is free from a tendency toward segregation on cooling, pours well, does not excessively oxidize in melting, does not burn the sand in pouring, takes a good impression of the mold, has a normal shrinkage, and makes castings that are easily cleanable.

2 The metal or alloy must machine well and not be too hard. Some acid-resisting metals, especially ferrous, pour well but are too hard and brittle to machine, and consequently their field of usefulness is limited.

3 The metal or alloy must have certain physical properties which are under control and which enable the manufacturer to comply with any reasonable specifications that may be called for, such as degrees of toughness, malleability and strength.

4 Such a metal or alloy in the form of castings, bar stock, plates, etc., must be reasonable in price. Therefore, outside the cost of the virgin metal used for such a metal or alloy, the other three major conditions have a great deal to do with the cost of the parts made.

Three or more years ago the Midwest Engine Company requested its metallurgical department, of which the author has charge, to conduct experimental work for the purpose of developing an acid-resisting metal for use in pumps which the company supplied to coal mines in the anthracite and bituminous regions; consequently the tests dealt more especially with sulphuric acid. Heretofore most of the pumps were made of so-called acid-resisting bronzes, but their life was short, especially in certain districts where the mine water was very bad. For example, in mine waters with free acid (as sulphuric) ranging from 13.67 grains per gallon in one particular instance to 91.96 grains in another, and mineral matter from 74 grains per gallon to 479 grains, it is with apparent difficulty that these mines retain a pump in good working condition for any reasonable length of time, withstanding the action of the acid and also the erosion from mineral solids in suspension in the water. Laboratory tests were therefore started with the purpose of finding a metal or alloy that would comply with the four major conditions stated above.

Experience along these lines first taught the author that when comparative tests are run on acid-resisting metals, it is best to divide the samples into three classes, namely: rolled and drawn stock; that cast under pressure, using very heavy risers—these sometimes weighing more than the casting itself (which is expensive); and castings poured in the ordinary way or following along the lines of usual procedure in a brass foundry. This is done for the reason that widely different results are obtained both as to the acid-resisting qualities and the physical properties. As an example, an alloy well known under the trade name of monel metal may be cited. In testing out this metal in sulphuric acid of different strengths and temperatures, it was found that the degree of resistance was greater in the rolled and the cast-under-pressure stock than in the ordinary cast metal. The physical properties were high in the first and second instances, but low in the third. The average results from a number of test bars poured under pressure were as follows: Yield point, 37,000 lb. per sq. in.; ultimate tensile strength, 72,000 lb. per sq. in.; elongation in 2 in., 34 per cent; reduction in area, 32 per cent. When cast not under pressure the tensile strength was 25,750 lb., with low percentages of elongation and reduction in area. Monel metal gives the highest test results when poured under the highest pressure. This has also been noted with various other alloys, consequently it is now the practice of the company to only pay attention to the physical properties of test bars which give the true working conditions under which the castings are made. It has also been noticed that the rolled and drawn metal and that poured under pressure and with chills resist the corrosive and erosive action of mine water to a greater degree than do metals cast in the ordinary way. This is of course on account of the finer structure or closer grain in the former; in other words, when the cast metal is in the granular form, the corrosive action is much greater than when in the more dense or fibrous form of structure, where the penetration is naturally more difficult.

A very good example of the penetration and absorption of an acid solution in a coarse-grained metal, and the care which must be exercised to eliminate, before weighing, any salts or adherent acid, is a sample of an acid-resisting metal that was immersed in a concentrated solution of sulphuric acid for 500 hours. When the test was completed the sample was removed from the solution, carefully washed in the usual manner in distilled water, and weighed. The loss in corrosion was 1.460 per cent. However, within 24 hours after this weighing the dry sample showed a slight incrustation of sulphates on the surface. It was then placed in a beaker of distilled water where it remained for 24 hours to remove any remaining acid or salt formation. The water at the end of this time was distinctly acid, and when the sample was again dried and weighed the loss from the original weight was 2.003 per cent, the difference from the first weight after the test being 0.543 per cent. As this instance demonstrates, great care must be exercised to obtain a

---

[1] Metallurgical Dept., Midwest Engine Co. Mem. Am.Soc.M.E.

Presented at a meeting of the Indianapolis Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Indianapolis, Ind., October, 28, 1921. Slightly abridged. All papers are subject to revision.

clean sample after tests are made, otherwise the results obtained will be incorrect. It also demonstrates the fact that this particular piece had an exceedingly open or coarse structure at the center, or perhaps some segregation.

Acid-Resisting Qualities Due Largely to Fineness of Grain

In consequence, the conclusion has been reached that the structure or grain of the metal or alloy is the major point in its acid-resisting qualities. This applies to ferrous and non-ferrous metals alike. With metals such as copper, tin, lead, zinc, nickel, antimony, etc., their structure may be referred to as dense and, in most instances, *fibrous;* while the cast alloys made up of these metals may be referred to as fine, medium or coarse *grained* in the majority of cases; and because of this coarseness of grain many acid-resisting alloys do not work out satisfactorily. It has also been found that the different alloys when poured in a chill mold resist the action of corrosion and erosion to a greater extent than when poured in a green mold; and when poured in a green-sand mold, more than in a dry mold. In the first instance the grain is finer than in the second, and in the second instance finer than in the third. As an example of the difference in their resistance to acid, in testing the metals separately, virgin copper, when placed in concentrated sulphuric acid (sp. gr. 1.84, 66 deg. B.), at room temperature, was readily attacked within 24 hours; when placed in a 30 per cent solution (sp. gr. 1.224, 26.5 deg. B.) the action in 30 days was almost negligible, and in a solution of 10 per cent sulphuric acid (sp. gr. 1.070, 9.5 deg. B.) the action in 30 days was very slight. The same conditions were found to exist with nickel, tin and antimony. Zinc was readily attacked by concentrated sulphuric acid, however, more especially so in the 30 per cent and 10 per cent solutions. When these metals are cast in different combinations, for example,

	Copper	Tin	Zinc	Lead
Standard bronze	88	10	2	..
Standard red brass	85	5	5	5
Yellow brass	59	3	38	..

also alloys with copper or nickel base plus zinc, with small percentages of iron and silicon, etc., it has been observed that within 24 hours they are readily attacked in the same strengths of acid solutions mentioned.

As another example, two samples, designated as A and B, of approximately the same weight were obtained from an acid-resisting alloy and were so machined that sample A exposed more of the outside or closer-grained part, and sample B more of the inner or coarser grain. They were then forwarded to the chemist of a mine in West Virginia, so as to enable him to test them out in the running mine water, which test is believed to be much nearer to the actual working conditions of a pump than laboratory tests. The results obtained were as follows:

	Sample A	Sample B
Loss in 14 days, per cent	1.78	3.68
Loss in 28 days, per cent	2.35	4.63

In other words, the loss from the coarser-grained sample was approximately twice that from the one of finer grain.

The company has succeeded in producing an alloy of a very dense structure, which is practically immune to the action of sulphuric acid of different strengths and temperatures; this metal has also been tested in the worst kind of mine water, with very gratifying results. Tests were made on this metal, designated as M-3, similar to the tests on the samples A and B previously mentioned, covering periods of 14 and 28 days. The loss in 14 days was 0.05 per cent, and in 28 days, 0.13 per cent. The tests are being continued for 90 days or a longer period, as long as interesting results are obtained. The alloy complies with the four major conditions mentioned earlier, with one exception. At the present time it has not been found possible to give this metal the strength necessary to withstand the ordinary wear and tear of mine pumps. Consequently it is not as yet a good commercial proposition.

In dealing with synthetic alloys a great deal of trouble has been encountered with segregation, especially in the larger castings. An example of such segregation would be, for instance, in an alloy of copper, nickel and zinc (placing it in the german silver group), which, if the casting has any free zinc segregation, is immediately attacked by sulphuric acid and in a short time becomes useless.

In dealing with metals used in mine pumps, it is found that the laboratory tests and the actual working conditions are vastly different. In the first instance there is but one destructive agency to be dealt with, namely, corrosion, while in the actual workings of a mine pump there are two, corrosion and erosion, and sometimes electrolysis. Therefore laboratory tests have a tendency to give results which cannot always be relied upon. For instance, two samples of acid-resisting metal were cut from the same piece in the same manner. Laboratory tests covered the immersion of one of these samples in the mine water received from a mine in West Virginia, the loss over a period of 90 days being 1.200 per cent. The second sample was forwarded to the mine and placed in the running water for a period of 14 days, with a resultant loss of 1.78 per cent.

Again, in the pumps made of the company's acid-resisting metal known under the trade name of Meco, it is found from experience that in pumping sulphuric acid of various strengths and temperatures the conditions are not as severe as when pumping mine water.

Tests on the Rate of Corrosion of Various Metals and Alloys

A series of tests on the rate of corrosion for a definite period of time, by weight, at room temperature, in concentrated sulphuric acid (sp. gr. 1.84), and a 10 per cent solution of the same acid (sp. gr. 1.07), on various metals and alloys, gave the results presented in Table 1. The samples were of approximately the same size and weight, about 15 grams, and the acid was renewed after every 100 hours' run.

TABLE 1 TESTS ON THE CORROSION OF VARIOUS METALS AND ALLOYS IMMERSED IN DILUTE AND CONCENTRATED SULPHURIC ACID

500 Hours in Sulphuric Acid—10 per cent Solution:

Metal or alloy	Base	% Loss	Condition of piece	Remarks
New Meco	Copper	6.851	Copper vigorously attacked	Cast, fairly dense
Meco	Copper	3.551	Copper and nickel vigorously attacked	Cast under pressure
Monel	Nickel	3.066	Copper and nickel vigorously attacked	Rolled, very fine
M-3	Lead	0.606	Copper and tin slightly attacked	Cast, medium grain
Lead	Lead	0.0317	Very slightly attacked	Cast, very dense
Lead (90%) and Antimony (10%)	Lead	0.019	Very slightly attacked	Cast
Tobin bronze	Copper	1.447	Moderately attacked	Rolled
88–10–2	Copper	2.980	Vigorously attacked	Cast, medium grain
M–3–1	Lead	0.506	Slightly attacked	Cast

500 Hours in Concentrated Sulphuric Acid:

Metal	Base	% Loss	Condition of piece	
C-New Meco	Copper	0.580	Slightly attacked	....
O-Meco	Copper	0.994	Mildly attacked	....
M-3	Lead	1.584	Moderately attacked	....
F-Monel	Nickel	1.027	Moderately attacked	....
Lead	Lead	1.104	Moderately attacked	....
Lead and Antimony	Lead	1.105	Moderately attacked	....
Tobin bronze	Copper	4.834	Vigorously attacked	....
88–10–2	Copper	4.612	Vigorously attacked	....
M–3–1	Lead	1.467	Moderately attacked	....

These figures clearly demonstrate that lead-base alloys are more resistant to dilute sulphuric-acid solutions than copper- and nickel-base alloys. The nickel-base alloy (monel) and the copper-base alloy with nickel (Meco) are more resistant to the concentrated acid than to the diluted form. Copper-base alloys with tin and zinc (88–10–2) also copper-base alloys with zinc (Tobin bronze) are readily attacked in both solutions.

An example of the very detrimental effect of a mine water on various metals and alloys follows, with the analysis of the mine water showing a trifle less than 479 grains of mineral matter and a little less than 92 grains of free acid (as sulphuric) per gallon. When placed in a ditch of this running water for varying periods the losses were as follows:

	Period of immersion, days	Loss per cent
Bronze (acid-resisting)	42	1.38
Ordinary brass	13	2.04
Monel metal	27	3.73
Bronze (acid-resisting)	14	3.89
Cast iron (acid-resisting)	7	7.45
Cast iron (acid-resisting)	14	11.26

Numerous tests have also been made with different metals and alloys to note their acid-resisting properties in solutions made up

(Continued on page 621)

Tests on Welded Cylinders

By E. A. Fessenden,[1] Troy, N. Y., and L. J. Bradford,[2] State College, Pa.

In order to compare the methods of constructing cylinders for handling anhydrous ammonia, four types of construction were tested, namely: Flange-steel shell, acetylene-welded longitudinal seam, concave heads forge welded to shell; seamless-pipe shell, convex head acetylene welded to shell; seamless-pipe shell, concave heads forge welded to shell; and flange-steel shell, acetylene-welded longitudinal seam, convex heads acetylene welded to shell. This paper describes the method of conducting the tests, presents the data obtained, and discusses the results.

The authors conclude that vessels having forge-welded heads are the least reliable and that burnt steel is often present in the weld. Also that the principal defects in acetylene welds are the course granular structure and the occasional porous spots and pinholes that develop with high pressures and the poor adhesion of the welding material to the original plate. Reasonable practical remedies for these defects are given.

AT THE request of a large machinery-manufacturing company, the following impartial tests on the five welded containers described below, were conducted by the authors.

The tests were carried on without interference or suggestions from outside sources, and the idea uppermost was that the results should indicate the relative merits of the containers under consideration.

The object of the tests was to compare several different methods of constructing the cylinders for handling anhydrous ammonia in refrigerating-plant practice. The cylinders tested involved the following four types of construction:

a Flange-steel shell, acetylene-welded longitudinal seam, concave heads forge welded to shell
b Seamless-pipe shell, convex heads acetylene welded to shell
c Seamless-pipe shell, concave heads forge welded to shell
d Flange-steel shell, acetylene-welded longitudinal seam, convex heads acetylene welded to shell.

All of the dished cylinder heads were hot pressed from flat disks in a large press or flanging machine manufactured by R. D. Wood & Co., Philadelphia, Pa.

Methods Used in Making Welds

In making the forge-welded heads the shell and head were heated to the welding heat in an ordinary forge fire and the welds were made by hand hammers and sledges. Fig. 1 shows the construction of one of these forge-welded heads.

The following description of the method of making a cylinder of seamless pipe will indicate the methods used for all the acetylene-welded cylinders.

A piece of seamless pipe of the required length to make the shell is cut off by an acetylene torch. The ends of this shell piece are not scarfed, the heads being welded directly to the ends as they are left by the cutting torch. The head is made of flange steel pressed into the dished shape, convex outward, commonly used for cylindrical vessels made to withstand internal pressure. The edge of the flange of the head is turned so as to make a square face and then the outer corner is beveled off to form a scarf. The shell and the head are then placed close together but not touching, the distance between the end of the shell as left by the cutting torch and the nearest edge of the scarf on the head being about $^1/_8$ in. Fig. 2 is a detail of the method of scarfing for making the joint and Fig. 3 shows a head in the process of welding.

When the torch is applied the metal of the shell and the head are first heated until they melt into a viscous fluid which flows down and closes up the gap between the two edges. Most of this material is taken from the shell, so that this melting-down process is practically equivalent to scarfing the edge previously left by the cutting torch. The metal from the welding wire is introduced not by melting it off the end of the wire and dropping it into the crevice between the parts to be welded as in a soldering operation, but by stirring the end of the welding wire in a little pool of molten material formed from the metal of the shell and head. Welds made in this manner are often called "ripple welds." Only very rarely was the hottest part of the torch flame allowed to play upon the welding wire, material from the wire being almost invariably introduced into the weld by the puddling process just outlined.

For longitudinal seams the welding operation was carried on in the same manner as that described for girth seams, the process being as follows: The plate used to form the cylindrical shell is rolled into shape so that the edges of the longitudinal joint nearly touch, the shell being laid longitudinally with the joint uppermost. The seam is then started at one end and welded for a distance of about 2 in. For the remainder of the seam the edges are spread apart and held in position by a jack. The amount of spreading is about $^1/_2$ in. to $^3/_4$ in. per ft. length of seam and thin shells are spread the most. As the welding progresses toward the end where the jack is placed, the strain on the edges is gradually reduced so as to allow the edges to be welded to approach each other. This device is used to eliminate as far as possible temperature stresses due to a high temperature of the welded seam.

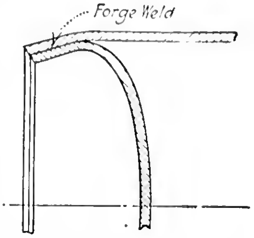


Fig. 1 Construction of Forge-Welded Head

Method of Conducting Tests

The cylinder under test was blocked up on a light truck and filled with water through openings left for the purpose. The diameter was then carefully measured at five points equally spaced along the length of the cylinder. In the cylinders made of seamless pipe these diameters were measured only horizontally as the cylinder lay in the testing rack, but in the cylinders rolled out of flange steel vertical diameters were also measured at all of the five points where the supporting blocking did not interfere with the use of calipers. Careful measurements were also made to determine the contour of each cylinder head.

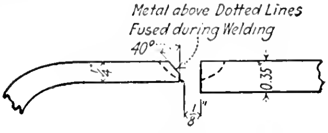


Fig. 2 Scarfing method for Making the Joint

The cylinder was then connected to a hand-operated hydraulic-testing pump, with a new and calibrated hydraulic-pressure gage in the connecting pipe line. The pressure was then gradually increased, stopping occasionally to observe carefully the condition of the cylinder and to repeat the measurements indicated above whenever it seemed desirable to record changes in the shape of the cylinder. This was continued until the cylinder failed to such an extent that the defects which developed caused leaks which made it impossible to operate the pump rapidly enough to cause further increase in the pressure.

When a cylinder had failed a number of samples were marked on the cylinder and ordered to be cut out for microscopic, metallurgical and physical tests. These samples were later shipped to the authors at State College, Pa., where they were properly prepared and examined as to their physical properties and microscopic structure. The tension tests were made by Prof. Thomas S. Patterson (Assoc-Mem. Am.Soc.M.E.), of the Department of Mechanics and Materials of Construction in the School of Engineering at The Pennsylvania State College. The microscopic and metallurgical examination was made by Prof. O. A. Knight (Mem. Am. Inst. Mining and Metallurgical Engineers, American Electrochemical Society and American Society for Steel Treating), of the Department of Metallurgy in the School of Mines of the Pennsylvania State College,

---

[1] Prof. Mechanical Engineering, Rensselaer Poly. Inst. Mem. Am.Soc. M.E.

[2] Asst. Prof. Machine Design, State College, Pa. Jun. Mem. Am.Soc. M.E.

Abridgment of a paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. The paper is an amplification of one presented by E. A. Fessenden at the May, 1921, meeting of the American Society of Refrigerating Engineers. All papers are subject to revision.

whose report is published in an appendix to the complete paper.

Test Results on Cylinder No. 1

The construction of cylinder No. 1 is shown in Fig. 4. The shell was made of flange steel, $^1/_4$ in. thick, with the longitudinal seam acetylene welded. The heads were pressed from $^1/_4$-in. flange-steel plate to a dished shape, and with a straight cylindrical flange about $2^1/_2$ in. long. The heads were inserted into the end of the shell with the convex side inward and the edge of the flange of the head forge welded to the shell, the depth of the weld being from 1 in. to $1^1/_2$ in. in the case of this cylinder. The welded ends were then crimped over to reinforce the weld as shown previously in Fig. 1.

Fig. 3 Partly Completed Acetylene Weld

The cylinder set up for testing is shown in Fig. 5. The outside diameters, measured before testing on the lines between the numbered sections, were as follows:

Between sections	1–2	2–3	3–4	4–5	5–6
Horizontal diameter, in.	12.17	12.28	12.34	12.34	12.28
Vertical diameter, in.	...	12.41	12.38	...	12.44

The following observations were made during the test at the pressure indicated:

500 lb. per sq. in. The concave head of section 1 began to reverse curvature, becoming completely convex shortly afterward.
700 lb. per sq. in. The concave head of section 6 began to reverse curvature, and very rapidly became completely convex.
950 lb. per sq. in. Leakage began through forge weld at head of section 1.
1350 lb. per sq. in. Forge weld at head of section 6 began to leak slightly.
1450 lb. per sq. in. Very bad leak through weld at head of section 6. Complete failure.

Fig. 6 shows the head of section 6 after complete failure had occurred at 1450 lb. per sq. in. internal pressure. The defective spot in the forge weld which caused final failure is on the upper left-hand quadrant.

This illustration also shows very clearly the final shape of the head after complete reversal of curvature had taken place. Accompanying the deformation of the heads the ends of the shell which were crimped over to reinforce the weld were straightened out by the bending stress on the flange of the head. As a result, after the head had completely reversed its curvature it was found that the crimping had nearly all disappeared. This obviously introduced a circumferential tensile stress upon the weld that probably contributed to the final failure. The spreading of the crimped end can be seen by a comparison of Figs. 5 and 6 and is particularly noticeable along the upper side of the shell.

During the test measurements were taken to give the contours of the heads in order to show their progressive deformation under increasing pressures. These readings were later plotted.

The factor of safety may be considered to be any one of a number of values, depending upon what is considered to be the point of failure of the cylinder. The cylinders were similar to those used by the company for holding anhydrous ammonia at an internal working pressure of 185 lb. per sq. in. gage. Using this as a basis the authors find the following factors of safety:

a If failure is considered as occurring at the first indication of deformation of the concave heads, the factor of safety is 2.70.
b If the vessel be considered to have failed as soon as the first leakage occurred, the factor of safety is 5.13.
c On the basis of the maximum pressure attained in the test with complete failure of the forge weld, the factor of safety is 7.85.

At the maximum pressure attained in the test the stress in the material forming the shell was 34,400 lb. per sq. in. of cross-section, computed on the basis of the original mean diameter of the shell. If the effective thickness of the weld is considered to be the same as that of the shell material, this value is also the stress safely withstood by the acetylene-welded longitudinal seam. On the samples cut out of this cylinder for physical tests the actual mean thickness of the weld itself was carefully measured, and for welds made in $^1/_4$-in. plate the average thickness was found to be 0.350 in. Hence the actual stress withstood by the acetylene-welded seam during the test without any sign of failure was 24,500 lb. per sq. in. This amounts to 8590 lb. per linear inch of acetylene-welded seam. The stress which caused final failure of the forge-welded seam was one-half of this or 4295 lb. per linear inch of seam.

Four samples were cut from one of the circular flange-steel blanks such as are used for making the dished heads. The results obtained when tested for tensile strength are presented in Table 1.

TABLE 1 TENSILE-STRENGTH TEST OF CYLINDER NO. 1 SPECIMENS

Sample	Dimensions, in.	Area, sq. in.	Load, lb. Yield point	Load, lb. Ultimate	Tensile strength, lb. per sq. in. Yield point	Tensile strength, lb. per sq. in. Ultimate
A	0.243×2.00	0.486	17,000	24,500	35,000	50,400
B	0.242×2.01	0.486	17,580	25,100	36,200	51,750
C	0.241×2.01	0.484	17,690	25,180	36,500	52,000
D	0.242×2.025	0.491	16,950	25,520	34,500	52,000
Average					35,425	51,538

The ultimate strength of the plate tested was thus somewhat below that specified for flange steel as set forth in the Boiler Code of The American Society of Mechanical Engineers (p. 11, Par. 28, edition of 1918), where the requirement is given as 55,000 to 65,000 lb. per sq. in. The elastic limit, or yield point, is above the requirement which states that at the yield point the stress shall have a minimum value of one-half the ultimate tensile strength, i.e., 27,500 to 32,500 lb. per sq. in. The fractures were typical flange-steel fractures showing a very fine grain. The amount of elongation and the reduction in area were not determined.

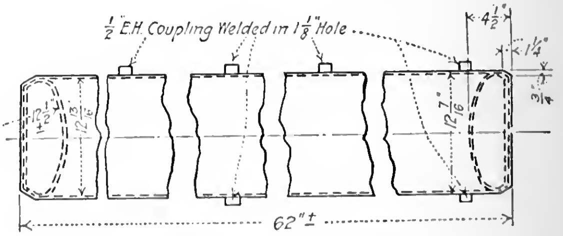


Fig. 4 Construction of Cylinder No. 1

Three samples containing sections of the acetylene-welded longitudinal seam were cut out of the cylinder and subjected to tension tests. Professor Patterson's report upon these specimens gave the results presented in Table 2.

The average ultimate strength was slightly above the value of 28,500 lb. per sq. in. specified by the Boiler Code of The American Society of Mechanical Engineers, for properly made forge welds (p. 45, Par. 186, edition of 1918). The average ultimate strength per linear inch of acetylene-welded seam was 10,097 lb.

The fractures occurred in every case through the body of the weld

TABLE 2 TENSION TEST OF CYLINDER NO. 1 SPECIMENS

Sample	Dimensions at weld, in.	Area at weld, sq. in.	Ultimate load, lb.	Tensile strength, lb. per sq. in.
E	0.362 × 1.452	0.526	13,800	26,250
F	0.333 × 1.504	0.504	13,820	32,000
G	0.334 × 1.734	0.611	17,810	29,000
	Average			29,083

itself, practically at the center line of the seam. In every case the fracture started with a crack which grew larger as the tension was increased. The final fracture did not occur suddenly and with a strong pronounced snap, as would be the case with a good flange steel, but was slow and gradual, as might be expected from a loosely knit, coarse, granular material, and was very similar to that obtained when a piece of putty is pulled in two. The elongation was not measured, but if any occurred it was very slight indeed. There was no apparent reduction of area. The fractured surfaces exhibited a very coarse granular structure quite similar to cast iron, with occasional brighter crystalline areas and flaws. There was evidence of poor adhesion between the metal of the shell and the welding material, especially along the bottom edge of the seam below the bevel of the scarf.

In Fig. 6 the horizontal lines chalked on the shell and the radial lines on the head indicate approximately the boundaries of sections later cut out for microscopic and metallurgical examination. The section containing the leak in the forge weld which caused final failure was cut into small pieces for examination and designated as specimens *PO*, *PI*, *PE* and *PZ*. These samples were cut in the order given reading from left to right in Fig. 6, *PE* being the small sample containing the crack which caused final failure. (See Appendix to complete paper for examination report.)

Cylinder No. 2

The construction of cylinder No. 2 is shown in Fig. 7. The shell was made of seamless-steel pipe approximately 0.34 in. in thickness. The heads were of dished form, with a straight cylindrical flange of the same external diameter as the shell and about 1¹/₄ in. long. The heads were welded to the shell by the acetylene torch with the convex face outward.

The cylinder was set up for testing like cylinder No. 1 and marked off into sections. Outside diameters (in inches) were measured only in the horizontal plane, before and during the test, as follows:

Between sections	1–2	2–3	3–4	4–5	5–6
Before test	12.65	12.73	12.78	12.78	12.73
At 2550 lb. per sq. in.	13.08	13.05	13.05	13.05	13.05

Fig. 5 Cylinder No. 1 Ready for Testing

The following observations were made during the test at the pressures indicated:

600 lb. per sq. in. Faint cracking sounds heard at end of section 6.

1200 lb. per sq. in. Scale cracks were observed in the forge scale on each head at the sharp bend where the flange is formed on the head. These scale cracks are shown very clearly in Fig. 8, and indicate that sufficient deformation of the convex head to crack the scale had occurred.

2000 lb. per sq. in. A very slight leak through the acetylene-welded circumferential seam joining the cylinder head to the end of section 1. This leakage was so slight, more in the nature of barely perceptible seepage, that during the entire test not more than three or four drops of water escaped.

2550 lb. per sq. in. A small leak occurred where a ½-in. extra heavy pipe coupling was acetylene welded to the shell in section 5 of the cylinder.

2600 lb. per sq. in. The leak observed at 2550 lb. per sq. in. where the coupling acetylene welded to the shell in section 5 became so large as to constitute complete failure.

The progressive approach toward the truly hemispherical head was quite apparent.

The factor of safety, computed on the same basis as for cylinder No. 1, may be taken as one of the following figures:

a If failure is considered as occurring when the first indication of deformation was observed (the cracking sounds heard near the head of section 6), the factor of safety is 3.24.

b If the vessel is considered to have failed at the first apparent leakage, the factor of safety is 10.81.

c On the basis of the maximum internal pressure reached, the factor of safety is 14.06.

Assuming the effective thickness of the weld to be the same as that of the shell material, i.e., 0.34 in., the stress in the circumferential seam at a pressure of 2000 lb. per sq. in., when the first very slight leakage was observed, was 17,700 lb. per sq. in. on the basis of the original mean diameter of the shell. This amounts to 6020 lb. per linear inch. On the same basis and the maximum pressure reached during the test, the stress on the seam was 23,000 lb. per sq. in. or 7830 lb. per linear inch of seam.

Fig. 6 Head of Cylinder No. 1 After Test, Showing Forge Weld Which Failed. Point of Failure Marked by Arrow

Two test pieces containing circumferential-seam samples were cut out for tension tests. Careful measurements of the actual mean thickness of the seam gave an average value of 0.442 in. Using this figure instead of the nominal thickness of 0.34 in., the stresses withstood by the seam during the test were as follows:

At the first slight seepage	13,620 lb. per sq. in. of seam
For the maximum pressure	17,690 lb. per sq. in. of seam

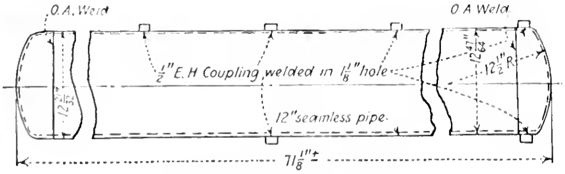


Fig. 7 Construction of Cylinder No. 2

A number of samples were cut from this cylinder for tension tests. They were located as follows:

Sample H was cut from the head of section 1. This sample may be located by reference to Fig. 8. It contained the letters GC shown at the top of the head. The very small seepage leak was also in this sample.

Sample I was similar to sample H and was cut out of the head at the end of section 6.

Sample J was a circumferential section cut out of the shell. The location was about 5 in. to the right of the coupling that caused final failure.

Fig. 8 Head of Cylinder No. 2, Showing Scale Cracks Indicating Distortion

Sample K was a longitudinal sample cut from the shell at a point about 6 in. away from the coupling that caused final failure and on the back side of the cylinder.

Professor Patterson's results for the tension tests of these samples are given in Table 3. For the shell material the elastic limit and the ultimate strength were each above the value specified for boiler-plate steel in the Boiler Code of The American Society of Mechanical Engineers. The elongation and reduction in area were not measured but were considerably less in amount than were obtained for the flange steel used for the heads in the tests described in connection with cylinder No. 1. The fractures were fine-grained.

TABLE 3 TENSION TEST OF CYLINDER NO. 2 SPECIMENS

Sample	Dimensions, in.	Area, sq. in	Load, lb. Yield point	Load, lb. Ultimate	Tensile strength, lb. per sq. in. Yield point	Tensile strength, lb. per sq. in. Ultimate
H	0.46 ×2.38	1.094	...	28,200	...	25,820
I	0.424×2.05	0.87	...	25,850	...	29,750
	Average of acetylene-welded seams					27,785
J	0.345×1.55	0.535	27,000	35,620	50,500	66,700
K	0.341×1.51	0.515	21,000	33,310	46,700	64,700
	Average of shell material					65,700

The average ultimate strength of the acetylene-welded seams was slightly below that specified by the Boiler Code for good forge-welded joints. On the basis of the average ultimate strength of the acetylene-welded seam, it would require a load of 12,010 lb. per linear inch of seam to detach the head from the shell. The fractures of the acetylene-welded joints exhibited in general the same characteristics as were described for the acetylene-welded joints of cylinder No. 1, except that in sample H the welding material pulled away from the head, opening up the spot where the slight leakage occurred. At this point the color was somewhat darker than for the remainder of the fracture. All the indications thus point to poor adhesion at the junction of the head and the welding material, probably due to oxidation.

Cylinder No. 3

The shell was made of the same kind of seamless pipe as that used in the shell of cylinder No. 2, but about 6 ft. long. The heads were similar to those used in cylinder No. 1 and were forge welded to the shell in the same manner.

The ends of the shell were crimped over to reinforce the forge weld, and like the other two cylinders, the shell was marked off into sections. The outside diameters (in inches) of the shell measured in the horizontal plane before and during the test were:

Between sections	1–2	2–3	3–4	4–5	5–6
Before test	12.64	12.76	12.81	12.81	12.75
At 550 lb. per sq. in.	12.66	12.76	12.83	12.81	12.75
At 1300 lb. per sq. in.	12.70	12.76	12.81	12.80	12.75

The following observations were made during the test at the pressures indicated:

200 lb. per sq. in. The concave head in the end of section 1 began to show tendency to reversal of curvature, distortion beginning at a place where the head had been somewhat flattened (presumably) during the process of forge welding to the shell.

550 lb. per sq. in. The concave head in the end of section 1 completely reversed in curvature.

1000 lb. per sq. in. The concave head in the end of section 6 became convex. The distortion of the head in the end of section 1 had increased markedly.

1300 lb. per sq. in. The head at section 1 was stretching rapidly and slight leaks appeared through the forge-welded joint at both heads.

1380 lb. per sq. in. Complete failure resulted from excessive leakage through the forge weld joining the head to the shell at the end of section 1. The leakage was so great that it was not possible to increase the pressure further with the pump available.

During the test, measurements were taken to show the progressive distortion of the cylinder heads. The final shape of the head of section 1 is shown in Fig. 9, and the excessive distortion in the upper left-hand quadrant coincides in position with the flattened area previously mentioned as being present in the head before the test was started and presumably caused accidentally during the forging of the joint. The final failure of the welded joint occurred in this same quadrant at a point about 30 deg. above the horizontal diameter and on a radius through the region of most excessive distortion. This is the result that would be expected, since the greatest peeling action on the weld would occur where the distortion is the maximum.

No samples were taken from this cylinder for further tests. The failure was quite similar to that of cylinder No. 1, and there was no reason for believing that further examination of the forge weld which failed would yield results differing materially from those found for the joint in the first cylinder. There was no open crack similar to that in cylinder No. 1 but the welded joint very clearly opened up to the outer edge of the joint. The opening could be distinguished easily by the naked eye.

The factor of safety, computed on the same basis as for cylinder No. 1, may be taken as one of the following figures:

a If failure is considered as occurring when the first sign of deformation of the head of section 1 was observed, the factor of safety is 1.08.

b If the cylinder is considered to have failed at the first apparent leakage, the factor of safety is 7.03.

c On the basis of the maximum internal pressure reached during the test, the factor of safety is 7.46.

The stress withstood by the forge-welded joint was 3920 lb. per linear inch of joint on the basis of the first apparent leakage, and 4040 lb. per linear inch when the leakage became so great as to constitute complete failure.

Cylinder No. 4

The shell was made of $^1/_4$-in. flange steel rolled to an average outside diameter of approximately $12^{11}/_{16}$ in. and with the longitudinal seam acetylene welded. The shell construction was thus practically

Fig. 9 Final Shape of Head of Cylinder No. 3, Showing Forge Weld Which Failed

identical with that of cylinder No. 1. The heads were pressed out of $^1/_2$-in. flange steel, and of the same construction as those of cylinder No. 2, being acetylene welded to the shell with the convex face outward.

Like the others, this cylinder was marked off into sections and the outside diameters (in inches) of the shell measured before and during the test were as follows:

Between sections	1–2	2–3	3–4	4–5	5–6
Horizontal, before test	12.19	12.38	12.41	12.41	12.31
Vertical, before test	12.55	12.52	12.44	...	12.39
Horizontal, 800 lb. per sq. in.			12.44		..
Vertical, 800 lb. per sq. in.			12.41	...	...

The following observations were made during the test at the pressures indicated:

1000 lb. per sq. in. Scale began to crack at bend of flange in head at end of section 1.

1200 lb. per sq. in. Distortion of head at end of section 1 continued; head at end of section 6 began to show distortion.

1400 lb. per sq. in. Considerable distortion apparent in both heads. The head at the end of section 1 showed an increase in diameter in the part flanged over into cylindrical shape as indicated in Fig. 10.

1700 lb. per sq. in. Complete failure occurred suddenly by tearing the acetylene-welded longitudinal seam. Failure apparently began by the material which had been added from the welding wire tearing away from the plate for a distance of about 3 in. Then the tear extended in both directions through the body of the weld itself until the total length of the tear was about 16 in. The broken surface exhibited a very coarse granular structure. Fig. 11 shows the final fracture. The part which is thought to have failed first is below and to the right of figure 2 in the photograph. Where the tear left the weld and extended into the shell material at the left-hand end is also shown.

The factor of safety, computed on the same basis as for cylinder No. 1, may be taken as one of the following figures:

a On the basis of the first noticeable distortion of the cylinder head, the factor of safety is 5.41.

b On the basis of final complete failure, the factor of safety is 9.18.

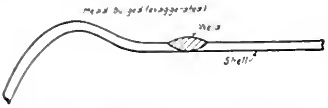


FIG. 10 DISTORTION OF HEAD AT THE END OF SECTION 1 OF CYLINDER NO. 4

For the pressure at which the acetylene-welded longitudinal seam failed and assuming the effective thickness of the weld to be the same as that of the shell material, the stress in the seam was 40,500 lb. per sq. in. Measurements on samples of the weld cut out for tests showed the average actual thickness of the weld to be 0.358 in., so that the actual ultimate strength of the weld was 28,300 lb. per sq. in., or 10,140 lb. per linear inch of welded seam.

FIG. 11 FINAL FAILURE OF ACETYLENE-WELDED LONGITUDINAL SEAM OF CYLINDER NO. 4

Three samples were cut from the longitudinal seam at a point well removed from the section which failed and subjected to tension tests by Professor Patterson. The results are given in Table 4.

TABLE 4 TENSION TEST OF CYLINDER NO. 4 SPECIMENS

Sample	Dimensions at weld, in.	Area at weld, sq. in.	Ultimate load, lb.	Tensile strength, lb. per sq. in.
L	0.336×1.919	0.645	22,710	35,200
M	0.373×1.670	0.623	17,590	28,200
N	0.365×1.924	0.693	18,170	26,200
	Average			29,870

The average ultimate strength is above the requirement of the Boiler Code of The American Society of Mechanical Engineers for good forge welds. The fractures exhibited the same characteristics as were described for the test pieces of cylinder No. 1, except that one specimen, sample L, failed by pulling the welded-in material away from the shell material instead of tearing through the center of the weld. The other two specimens showed a discolored region in the fracture that indicated the same poor knitting together at the bottom of the scarf already commented upon in the description of the fractures of weld specimens in connection with cylinder No. 1.

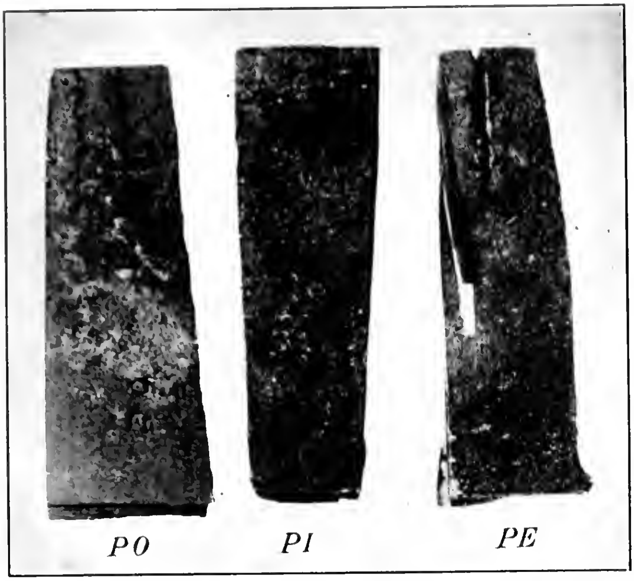


FIG. 12 CRACKS IN SPECIMENS OF CYLINDER NO. 1 REVEALED BY ETCHING AND THE CRACK IN SPECIMEN *PE* WHICH PROBABLY CAUSED FAILURE; MAGNIFICATION 1.5

The average ultimate strength of the acetylene-welded seam per linear inch of seam computed from Professor Patterson's tests, is 10,770 lb.

CYLINDER NO. 5

The shell of this cylinder was made of seamless pipe $12^3/_4$ in. in outside diameter, with pressed dished heads acetylene welded to the shell with the convex face outward, the construction being the same as that of cylinder No. 2, except that the finished cylinder was only about 3 ft. long instead of 6 ft.

A short time before finishing the tests on the first four cylinders already described, it was decided to test an additional cylinder taken out of stock. Therefore, cylinder No. 5 was chosen from a pile in the welding shop. One of the welded girth seams did not appear to be as good as those in some of the other cylinders, a second course of welding apparently having been run around the seam.

As this cylinder was tested simply as a check to compare the workmanship on stock cylinders with those submitted for test, it was not considered necessary to take detailed observations during the test. The cylinder behaved in practically the same manner as cylinder No. 2, except that no leakage through the circumferential seams was observed. Final failure occurred at a pressure of 1900 lb. per sq. in. by serious leakage through an acetylene weld securing a pipe coupling in one of the heads. The scale cracks along the bend of the flange of the head and the tendency of the head to assume a hemispherical shape were also noticeable.

On the basis of final failure and assuming that the working pressure for which the cylinder was designed was 185 lb. per sq. in. as in the other cylinders tested, the factor of safety is 10.28.

Using the same initial diameter as in cylinder No. 2 and assuming that the effective thickness of the acetylene-welded circumferential seam is the same as that of the shell material, this seam safely withstood a stress of 16,820 lb. per sq. in. of cross-section without any sign of leakage or distress. If the actual thickness of the weld is taken to be 0.442 in. as was found on carefully measured

specimens of similar welds in cylinder No. 2, the stress safely withstood was 12,930 lb. per sq. in. The stress per linear inch of seam safely withstood was 5715 lb., without any sign of leakage or distress of any kind.

Summary

Table 5 summarizes the results of the tests. It is somewhat difficult to make a comparison between the acetylene-welded and the forge-welded seams on the basis of tensile strength, because the stress on the acetylene-welded seam is a direct tension while that on the forge-welded seam is shearing. Possibly the fairest comparison is the load which the seam will carry, expressed in pounds per linear inch of seam. Table 6 gives the strength of the several joints, using the results of the tests on the five cylinders as well as those obtained by Professor Patterson. Even this is not an entirely fair comparison, because some of the acetylene-welded seams are thicker than others. The average stresses per linear inch of seam are as follows:

	At first leakage through seam, lb.	At final failure of seam, lb.
Forge-welded seams.............	3365	4168
Acetylene-welded seams..........	8080	10754

Discussion and Recommendations

In considering the results here presented it must be borne in mind constantly that the object of the investigation was to compare different methods of constructing containers for anhydrous ammonia for use in refrigerating-plant practice. Even a comparatively small ammonia leak is sufficient to make the room in which it occurs untenable. If the leak occurs in a confined space where ventilation is poor, as, for example, on shipboard, the results may be quiet serious. In boiler practice absolute tightness is not nearly so important as adequate strength against serious rupture, but it should be emphasized that in the case of containers for anhydrous ammonia, *leakage constitutes failure.*

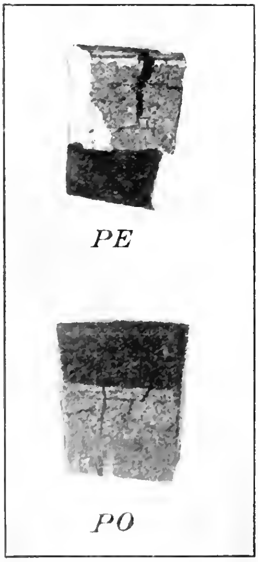


Fig. 13 End Views of Specimens *PO* and *PE*, Showing Cracks Extended Deeply into Metal; Magnification 1.5

From all of the data secured by the tests themselves and also by subsequent investigation and analysis it appears that the vessels having forge-welded heads are the least reliable. The entire circumference of the weld is likely to have incipient cracks where the union between the flange of the head and the end of the shell is imperfect. If the common shape of dished head is used it obviously must be inserted in the shell with the concave side outward in order to make a forge weld. Under the action of heavy internal pressure the curvature of the heads is reversed and this sets up a tearing or peeling action which increases the incipient flaws in the weld and leakage follows. This result is still further aggravated by the opening out of the crimped ends due to the spreading action of the head during reversal and the consequent expansion of the material just at the weld. Furthermore, it is quite likely that the dished heads are more or less distorted during the forge-welding process. Surfaces that are subjected to pressure on the convex side are in a state of unstable equilibrium and even slight initial distortion will result in excessive distortion at much lower pressures than would be carried safely. This was shown in the case of cylinder No. 3, in which one head was somewhat flattened when received at the testing floor. This head began to reverse curvature at 200 lb. per sq. in. The initial distortion undoubtedly contributed to its low resistance.

TABLE 6 STRESSES PER LINEAR INCH OF SEAMS

Cylinder No.	At first observed leakage through seam during test, lb.	At maximum pressure reached in test, lb.	At failure of joint by tension test, lb.
1 (forge-welded).....	2810	4295	....
3 (forge-welded).....	3920	4040	....
1 (acetylene-welded).	....	8500[1]	10097
2 (acetylene-welded).	6020	7830[1]	12010
4 (acetylene-welded).	10140	10140	10770
5 (acetylene-welded).	....	5715[1]	....

---

[1] Stresses marked thus are simply the highest stresses reached in tests where the final failure was due to other causes than failure of the seam in question.

TABLE 5 SUMMARY OF TEST RESULTS

Cylinder No...	1	2	3	4	5
Shell	Flange steel, longitudinal seam acetylene welded	Seamless pipe	Seamless	Flange steel, longitudinal seam acetylene welded	Seamless pipe
Heads.........	Forge welded to shell	Acetylene welded to shell	Forge welded to shell	Acetylene welded to shell	Acetylene welded to shell
Pressure at first leakage, lb. per sq. in....	950	2000	1300	1700	1900
Maximum pressure attained, lb. per sq in.......	1450	2600	1380	1700	1900
Cause of final failure......	Leakage through forge weld	Leakage through acetylene-fitting weld	Leakage through forge weld	Rupture of acetylene-welded longitudinal seam	Leakage through acetylene-fitting weld
Factor of safety on first leakage.........	5.13	10.81	7.03	9.18	10.28
Factor of safety on final failure.........	7.85	14 06	7.46	9.18	10.28
Stress in longitudinal seam, lb. per sq. in.	34,400	...	...	40,500	...
Stress in circumferential seam, actual, at first leakage.........	...	13,620	...	28,300[1]	12,930
Same at final failure......	...	17,690	...	28,300	12,930

---

[1] Caused final complete failure.

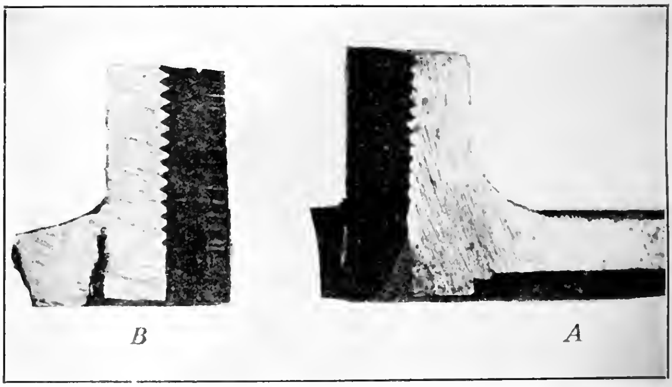


Fig. 14 Two Pipe-Coupling Specimens. *B* is the Nipple of Cylinder No. 2 Which Leaked Through the Weld. *A* is Sound Nipple Welding That Did Not Leak; Magnification 1.5

In the forge-welded specimens examined microscopically, evidence of burnt steel was found in all cases. In general, burnt steel may be expected in forge welds because the burning temperature and the welding temperature for steel are quite close together. Some time must elapse, and hence some cooling takes place, between the instant the pieces are removed from the forge and the time at which the welding actually takes place. It is essential that the pieces be at the welding temperature at the time the blows are struck. The comparatively thin pieces in question lose heat rapidly and this leads to their requiring a higher forge temperature than pieces of more compact form, thus increasing the danger of burnt steel. Burnt steel and overheated steel are very weak and brittle as compared to steel not treated so. When burnt steel is forged, cracks like those in specimen *PE* (Fig. 12) are formed. This action renders leakage under pressure and consequent failure easy.

(Continued on page 592)

Steam Utilization in a Modern Newsprint Mill

An Analysis of the Conditions Obtaining in a Modern Paper Mill Manufacturing Newsprint, Dealing with the Selection of a Prime Mover, Electric vs. Rope Drive for Paper Machines, the Drying of Paper, Ventilation Requirements, Etc.

By S. W. Slater[1] and J. E. A. Warner,[2] Cape Madeleine, Que., Canada

The purpose of this paper is to show the heat required in the manufacture of newsprint on a modern basis. It is, in general, a detailed study of the concrete conditions found to exist in a modern paper mill with which the authors have been associated. Other conditions found to exist in paper mills have been treated, however, with a view of showing their bearing upon the different subjects which are covered herein, and also to facilitate comparison by other mills whose installations are different from the one cited.

In general, the importance of heat conservation has not been appreciated in this industry and, in view of the national movement to conserve natural resources, all newsprint paper mills are in duty bound to study their own particular problem, so that their coal or fuel-oil requirements may be reduced to a minimum. It is hoped, therefore, that this paper may be of assistance to those who, no longer content with operating by rule of thumb, desire to analyze their heat load, in order to assist in conservation and to reduce the cost of manufacture.

A survey made as of January 1, 1922, shows that the United States and Canada have a combined daily output of about 8500 tons. The tonnage produced during the year 1921 was approximately 2,038,095 tons, and the value of this tonnage, at a representative figure of $100 a ton, would be $203,809,500.

On the basis of the familiar statement that "One ton of coal is required to produce one ton of paper," the newsprint industry has a yearly fuel demand equivalent to about 2,040,000 tons of coal. In the United States, it has been quoted as occupying sixth place in capital invested and value of product, while in horsepower installed it probably ranks fourth.

Description of Mill Investigated

The building housing the two paper machines is 288 ft. long by 88 ft. wide and has a total height of 45 ft. It is of standard brick and steel construction, with concrete floors and roof, the latter being waterproofed with tar and felt. The paper machines are carried on an operating floor which is 27 ft. from the roof. Underneath is a basement having a height of 18 ft. and its floor at grade level. Only the northeast side is exposed, other buildings adjoining the remaining side and ends. The openings in the exposed wall have a total area of 3000 sq. ft.

The greater part of the driving mechanism for this installation is located in the basement. The prime movers are steam turbines of the single-stage non-condensing type, direct-connected through flexible couplings to reduction gears, and have a rated capacity of 400 b.hp. at a speed of 2675 r.p.m. This gives a speed reduction of about 7 to 1. The turbo-gears in turn drive an English system of rope transmission, in which each section of the paper machine has its own jackshaft, carrying a cone pulley and sheaves.

By means of belts, power is transmitted from the cone pulleys on the jackshaft to the cone pulleys driving each section of the paper machine. The cone pulleys transmit through a friction clutch and herringbone gears to each of the sections. In the case of the drier sections further spur gears are used to drive from one drier to the next in the section.

The Paper Machines

The paper machines are of the Fourdrinier type, are 166 in. wide and have three presses. The drier sections consist of one fore drier, 24 in. in diameter by 162 in. face; 32 driers, 60 in. in diameter by 162 in. face; and two felt driers, one for each section, 48 in. by 162 in. All driers are of cast iron, bored on the inside, and turned and polished on the external surfaces. Each drier is equipped with a dipper, to remove the water of condensation. These machines are designed for a maximum speed of 700 ft. per min.

Newsprint consists of from 70 to 85 per cent of ground wood and the remainder sulphite pulp. After the mixture has been reduced to a consistency of about $^1/_2$ per cent, it is caused to flow onto the wire of the paper machine in amounts carefully regulated so as to finally produce finished paper weighing 32 lb. per ream of 500 sheets, size 24 by 36 in.

The web is formed by the oscillating motion of the Fourdrinier section. Water is removed through the wire, assisted by the capillary attraction of the table rolls, which also act as carriers for the wire. The suction boxes remove a large quantity of water and assist in closing the sheet. The paper then passes between the couch rolls, which press out additional moisture.

In passing through the press sections the sheet is carried on woolen felts between weighted rolls, further reducing the moisture content.

The paper is then ready to enter the driers, where water is removed from the sheet by contact with steam-heated cylinders and is carried through same on canvas felts. The last drier is equipped for cold-water circulation, so as to dampen the sheet before it passes through the calender stack for ironing and polishing, prior to cutting to specified size and winding on cores.

Heat Required for Newsprint Manufacture

In order to show more clearly the heat required for newsprint manufacture, simultaneous tests were conducted on one of the previously mentioned machines to determine the heat demand for driving, drying and ventilating.

The data pertaining to the turbine test are given in Table 1. The steam supplied to the turbine was the same as that used by the driers. In other words, the turbine water rate balanced the drier heat demand and no auxiliary live steam was required.

TABLE 1 TURBINE TEST

Initial steam:	
Pressure, lb. per sq. in. abs.	160.7
Temperature, deg. fahr.	401.3
Total heat per lb., B.t.u.	1217.3
Exhaust steam used by driers:	
Pressure, lb. per sq. in. abs	23.7
Temperature, deg. fahr.	248.1
Total heat per lb., B.t.u.	1164.7
Lb. steam per hour	16,822.00
Lb. steam per min.	280.37
B.t.u. per min. to turbine	14,747.30
Equivalent B.t.u. per b.hp. (as given by manufacturers)	44.17
B.hp. developed	334.00
Water rate, lb. per hp-hr	50.37

In selecting a suitable prime mover the governing factor is the amount of steam required for drying the paper; consequently it does not follow that the engine or turbine having the lowest water rate is the most suitable.

The water rate of the prime mover, in conjunction with the initial steam pressure and quality, must also be such as to insure approximately dry exhaust steam, at drier pressure, as it is undesirable to have steam of a high moisture or superheat content entering the driers.

Fig. 1 has been prepared to show the effect of the water rate of the turbine upon the quality of the exhaust. It will be noted that for the rate existing at the time of the test the exhaust was superheated 11 deg. fahr., and that when 45 lb. were used per b.hp. per hour the exhaust steam would be dry-saturated.

In the past it has been very difficult to obtain data showing the horsepower requirements of paper machines, but with the advent of motor drives more information is becoming available. It is impossible to give a formula that will cover all installations, for the power requirements will vary with the type and mechanical design

---

[1] Engr., St. Maurice Paper Co., Ltd. Assoc-Mem. Am.Soc.M.E.

[2] Asst. Engr., St. Maurice Paper Co., Ltd. Assoc-Mem. Am.Soc.M.E.

Paper to be presented at the Springfield Regional Meeting of The American Society of Mechanical Engineers, Springfield, Mass., Sept. 25–27, 1922. Slightly abridged. All papers are subject to revision.

of the machine, the conditions under which it is operated and the efficiency of transmission. The following, however, is cited to show approximately the power demand of the variable-speed drive, and is based on a speed of 100 ft. per min. and 100 in. width:

1	Modern high-speed motor-driven machines, having four presses, forty 72-in. driers and operating at speeds varying between 700 and 1000 ft. per min.	25 to 30 hp.
2	Turbine-driven machines, rope-drive transmission, having three presses, thirty-two 60-in. driers, and operating at speeds of 550 to 700 ft. per min.	30 to 34 hp.
3	Engine-driven machines, Marshall drive, three presses, thirty-two 48-in. driers, and operating at speeds of from 350 to 600 ft. per min.	33 to 38 hp.

ELECTRIC DRIVES FOR PAPER MACHINES

Much attention of late has been given to electric drives for paper machines, and in some recent installations the electric energy for driving is generated by a hydroelectric plant. The steam required for the driers is then obtained from high-pressure steam reduced through a pressure-reducing valve to a lower pressure, with consequent superheat; as will be shown later, however, superheat is not suitable for use in the driers.

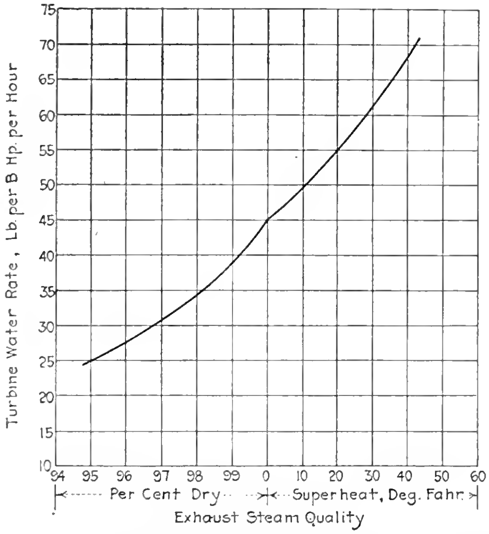


Fig. 1 Curve Showing Effect of Water Rate on Quality of Exhaust

Further, unless electrical power can be purchased at a cheap rate, it is not thought that such an installation is economical, and for the purpose of illustrating this point the following computations have been made to determine at what price electrical energy would have to be purchased to be the equivalent of steam assumed to cost $0.75 per 1000 lb.

Referring to Fig. 2, which is based on the test given in Table 1, straight line *A* (205.1 B.t.u.) represents the heat of the drier condensate, and line *C* (1217.3 B.t.u.) the total heat of one pound of steam under the conditions given. Curve *B* shows the relation between the water rate of the turbine and the heat contained in the exhaust available for drying.

AC (1012.2 B.t.u.) therefore represents the heat per pound of steam which would be available for drying if a pressure-reducing valve was used. *BC* (52.6 B.t.u.) represents the amount of heat abstracted from the initial steam in doing work in the turbine.

It will be seen that the quantity expressed by *BC* is small in comparison with that represented by *AB* (959.6 B.t.u.), and that the exhaust steam contains nearly as much heat as the initial steam.

From the preceding data and based on 7600 operating hours per year, to develop one brake horsepower-year, 20,136,000 B.t.u. are required. This is equivalent to 19,900 lb. of steam which, at an assumed cost of 75 cents per 1000 lb., makes the steam cost of a horsepower-year, approximately $15.

Assuming the efficiency of the electric drive to be 95 per cent and that of the drive described to be 75 per cent, the cost of purchased electrical power must not exceed $19 per hp. year.

This comparison does not take into consideration interest and depreciation on capital invested or the maintenance and operation costs; but as the initial cost of the electric drive is approximately two and one-half times that of a turbine rope-drive installation, it is thought, that if these costs were considered, the comparison would be favorable to the turbine rope drive.

The electrical installation, however, offers many advantages from the standpoint of operation, and with the development of high-speed machines will no doubt become the most acceptable type of drive. It is the opinion of the authors that the application of the motor drive will prove most economical when the necessary electrical power is developed by a turbo-generator, the exhaust from which would be utilized for drying the paper.

The bleeder or extraction type of turbine would have the advantage of greatest flexibility in that a minimum amount of steam would be wasted during periods of light loads, when practically no steam is required in the driers.

DRYING PAPER

In the drying of paper it is requisite that the moisture be removed gradually to prevent scorching and cockling of the sheet, and this requires a definite temperature gradient through the machine. It is also necessary that the temperature of the paper be kept within certain limits to produce a good, strong sheet.

The authors believe that the logical method to employ in these heat calculations is to base all figures on the pounds of moisture removed from the paper, instead of on the actual production. This is due to the fact that the moisture content is variable, depending upon the number and efficiency of the machine presses and the amount of moisture desired in the finished sheet.

The amount of moisture in the paper entering the drier section generally varies from 65 to 76 per cent, with an average of about 72 per cent. The amount of moisture in the finished sheet varies from 5 to 10 per cent, with an average of about 8 per cent. It is important that enough moisture remain in the finished sheet to insure proper finish and strength.

By the use of the following formula the number of pounds of moisture to be removed per pound of finished paper can be readily determined:

$$W = \frac{M_1 - M_0}{100 - M_1}$$

where W = pounds of moisture removed per pound of dried paper
M_1 = percentage of moisture in sheet entering drier section, and
M_0 = percentage of moisture in dried sheet.

It is important that as much moisture as possible be removed from the sheet before it enters the driers. It should be understood, however, that there are limitations to the amount of moisture that can be removed by mechanical means, namely, the possibility of crushing the delicate web of newsprint and the effect on the life of the press felts. Each mill, by considering the above in conjunction with the cost of steam, should determine the most efficient point of moisture removal.

In order to determine the economical life of machine clothing, in relation to steam cost for drying, a study of results obtained in several mills was made. This showed that the relation between life of felts and the percentage of moisture entering the driers followed a straight line, and that it is the combined felt-days of all the press felts which determines the moisture in the sheet entering the driers. This is a fortunate relation, in that the operating days of each of the three press felts is seldom the same at any one time.

Fig. 3 shows the relation between the combined felt-days of the three press felts and the average percentage of moisture leaving the presses for the period considered; this period being taken as one-third of the combined felt-days.

Table 2 is self-explanatory and shows the relation between combined felt-days of the three presses and the cost per day, in dollars, for steam and felts. The calculated costs do not take into account the labor and the loss of production due to changing clothing. Further, this study only applies for a particular period of fixed steam and machine-clothing costs, and should be revised as conditions change.

Some plants, thinking to economize, have tried to dispense with

drier felts. This procedure has not proved satisfactory, for the reason that intimate contact of the sheet with the drier surface is of vast importance in heat transfer. The drier felt also assists in the removal of moisture.

TABLE 2 COST OF STEAM AND FELTS

Felt days. (1)	% Moisture entering driers at end of period (2)	Avg. % moisture for period (3)	Period in days (1) ÷ 3 (4)	Moisture evap. per lb. of paper (5)	Lb. steam per day F. & A. 212° F. $\frac{(5) \times 5400 \times 24 \times 1361}{970.4}$ (6)	Cost of steam per day Dollars $\frac{(6) \times 0.75}{1000}$ (7)	Cost of press clothing per day. Dollars (8)	Cost of steam and felts per day. Dollars. (7) + (8) (9)
30	69.60	68.40	10.00	1.911	347,360	260.52	68.00	328.52
35	69.93	68.58	11.67	1.928	350,440	262.83	58.20	321.03
40	70.30	68.75	13.33	1.944	353,347	265.01	51.00	316.01
45	70.75	68.98	15.00	1.966	357,347	268.01	45.35	313.36
50	71.10	69.15	16.67	1.982	360,253	270.19	40.80	310.99
55	71.45	69.33	18.33	2.000	363,533	272.65	37.10	309.75
60	71.90	69.55	20.00	2.021	367,347	275.51	34.00	309.51
65	72.25	69.73	21.67	2.039	370,613	277.96	31.40	309.36
70	72.65	69.93	23.33	2.060	374,440	280.83	29.10	309.93
75	73.05	70.13	25.00	2.080	378,067	283.55	27.20	310.75
80	73.45	70.33	26.67	2.101	381,893	286.42	25.50	311.92
90	74.20	70.70	30.00	2.140	388,973	291.73	22.65	314.38
100	75.00	71.10	33.33	2.183	396,800	297.60	20.40	318.00
110	75.80	71.50	36.67	2.228	404,973	303.73	18.55	322.28
120	76.60	71.90	40.00	2.274	413,333	310.00	17.00	327.00

Note. 8 per cent moisture in dried paper. Steam cost assumed at $0.75 per 1000 lb. No tests are available for moisture entering driers with complete new press clothing, but from a study of results which might be expected, it is assumed that moisture entering under these conditions would be 67.2 per cent.

It has been noted that a new drier felt results in a decreased steam consumption of about 300 lb. per ton of production as compared with an old one. This is due to the fact that as the felt ages, the meshes gradually become closed.

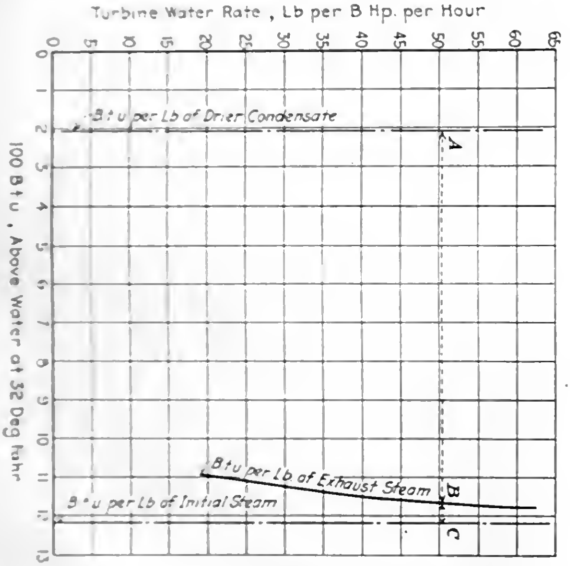


Fig. 2 Curve Showing B.t.u. per Lb. of Exhaust Steam Available for Driers

In investigating the action of the driers, that portion of them in intimate contact with the sheet has been termed the "effective" surface, while the remainder has been called "free" surface. In making comparisons between different machines the ratio of the effective surface to the total surface should always be stated.

The amount of radiating surface which does no direct useful work increases with the drier diameter, and to show the effect of diameter on effective surface, Table 3 has been prepared for a 166-in. drier with an actual working face of 156 in. This table is of interest in connection with the design of modern machines, where the high speed required must be obtained either through large diameter of driers or the greater relative speed of those of smaller diameter.

TABLE 3 EFFECT OF DRIER DIAMETER ON EFFECTIVE SURFACE

Diam. of driers, ft.	Total surface in sq. ft. (T)	Effective surface in sq. ft. (E)	Ratio $\frac{E}{T}$
4	199	104	0.523
5	257	130	0.506
6	317	156	0.492

To obtain the maximum value of the ratio E/T, the drier section should be designed so as to obtain as large an arc of contact as possible, consistent with ease of handling paper and changing drier felts. Experience shows that with an open pit under the drier section the life of the felts is materially increased, owing to the better ventilation afforded.

There are two methods in general use for removing condensation from driers, namely, siphons and revolving dippers; and opinions are at variance as to which is to be preferred. Unfortunately, neither system is capable of completely removing all the condensation, and there is always present a small depth of water in the bottom of the driers.

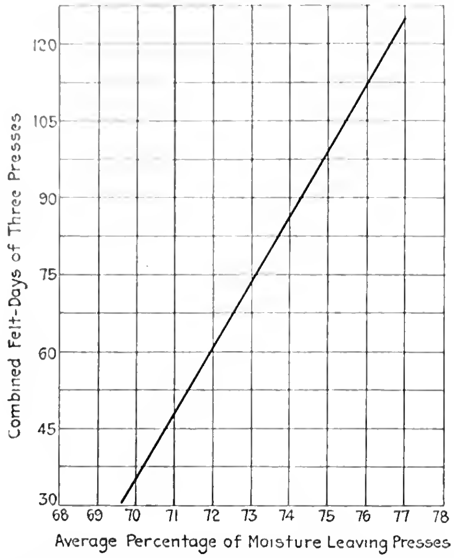


Fig. 3 Curve Showing Life of Felts in Relation to Moisture in Sheet Leaving Presses

Owing to the fact that the machines must be operated from the front side, it is the practice to locate the inlet and condensation outlet in the back side of each drier. This arrangement does not permit of a uniform or rapid circulation of steam within the driers. It is the authors' opinion that some system whereby a more rapid circulation of steam were made possible, would increase to a considerable extent the heat transfer. This could be accomplished, if it were possible to connect a number of driers in series in such a manner that the circulation of steam would follow the desired temperature gradient.

Air and other incondensable vapors, allowed to accumulate in the driers, retard heat transmission and also result in unequal temperature across the drier face. A suitable air valve should be installed to permit of rapid extraction, without allowing steam to pass.

Absolutely clean internal surfaces are required to obtain maximum heat transfer. With engine-driven machines the internal surface of the driers becomes coated with a film of oil, as oil separators do not completely remove all the lubricant from the exhaust. The turbine, however, requires no internal lubrication, and is therefore superior to a steam engine as a prime mover. The external surfaces must also be kept clean of all accumulations of dirt, grease and lint from the paper.

Superheated steam, while undoubtedly of great value for prime movers, is not desirable for drying purposes, in that it is similar in its properties to gases and parts with its heat much less readily than saturated steam. No doubt some will contend that superheated steam would tend to become saturated by contact with the

condensate, but it is thought that this would take place to a very limited extent. The amount of water in contact with the steam varying from time to time, would result in variations in temperature within the drier. Some expert papermakers contend that superheated steam produces an inferior quality of newsprint as compared with that dried by saturated steam.

The test of the drier part of the machine is given in Table 4. As shown by this table, 269,043 B.t.u. were absorbed by the driers, equivalent to 1342 B.t.u. per pound of moisture evaporated. It will be shown later that the air in passing through the drier sections absorbed 272,837 B.t.u. per min., equivalent to 1361 B.t.u. per lb. of moisture evaporated. The higher value has been used in subsequent calculations.

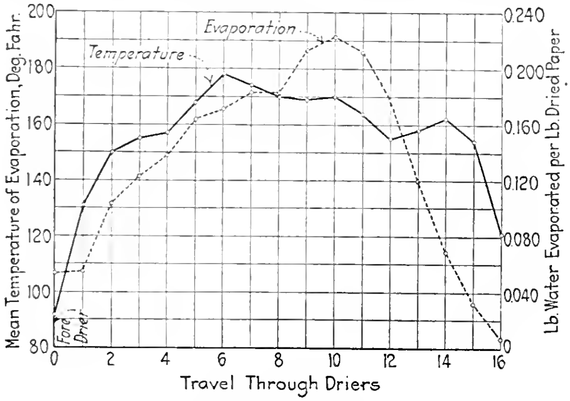


Fig. 4 Curves Showing Temperature of Evaporation and Water Evaporated in Driers

TABLE 4 TEST OF DRIER

Working width, inches, (deckle)	156
Speed, ft. per min.	650
Effective heating surface, sq. ft.	4401
Total surface, sq. ft.	8272
Ratio of effective to total surface	0.532
Weight of paper (lb. per 500 sheets 24 × 36 in.)	32
Lb. paper dried per minute	90
Percentage of moisture in sheet entering driers	71.5
Percentage of moisture in sheet leaving driers	8.0
Lb. moisture evaporated per lb. of dried paper	2.228
Lb. moisture evaporated per minute	200.5
Steam pressure in driers, lb. per sq. in. abs.	23.7
Temperature of steam in driers, deg. fahr.	248.1
Total heat of steam supplied to driers, B.t.u. per lb.	1164.7
Heat of condensate, B.t.u. per lb.	205.1
B.t.u. absorbed by driers per lb. of steam	959.6
Lb. steam per hour to driers	16,822
Lb. steam per minute to driers	280.37
B.t.u. absorbed by driers per minute	269.043
B.t.u. absorbed by driers per lb. of moisture evaporated	1342

At the time that the test was conducted to determine the heat absorbed by the driers, data were also obtained giving the temperature gradient throughout the driers and the amount of moisture evaporated per pound of dried paper in each increment of travel, as shown by Fig. 4. By integration the theoretical amount of heat required to evaporate the moisture was determined, as shown by Table 5.

It will be noted in this table that 2.228 lb. of water were evaporated from the sheet in its complete travel, and that the theoretial heat required to do this work amounted to 2412 B.t.u. Therefore, the theoretical heat required to evaporate one pound of moisture from the sheet, under the conditions as shown, is 1083 B.t.u.

In making drier calculations it is well to remember that the only useful work performed is the evaporation of moisture from the sheet, and that therefore the theoretical amount, as determined by the conditions of the test, divided by the heat supplied, must give the efficiency of the driers.

Based on the figure of 1342 B.t.u., determined by the drier test, the efficiency is 80.7 per cent, while on the basis of 1361 B.t.u., derived from the air test, it is 79.6 per cent.

To dry paper efficiently the temperature conditions throughout the drier sections must be closely regulated. In the past, temperature control has been obtained by means of a thermostatic valve, which was dependent upon the temperature existing in one drier only. While this has given good results, the latest practice calls for sectional control, which has improved the ease of regulation.

TABLE 5 THEORETICAL HEAT REQUIREMENTS OF DRIERS PER LB. OF PAPER

Drier No.	Moisture leaving drier	% stock in sheet	Lb. water per 0.92 lb. stock	Lb. water evap'ted in travel through drier	Mean temp. of evap., deg. fahr.	Latent heat	B.t.u.	Heat of liquid
	[1]71.5	[1]28.5	[1]2.308	.....	[1]80	......	......	.....
Fore	71.0	29.0	2.254	0.054	92	1040.0	56.16	0.65
1	70.5	29.5	2.199	0.055	131	1018.2	56.00	2.81
2	69.5	30.5	2.096	0.103	150	1007.4	103.76	7.21
3	68.2	31.8	1.973	0.123	155	1004.5	123.55	9.23
4	66.6	33.4	1.835	0.138	157	1003.4	138.47	10.63
5	64.5	35.5	1.671	0.164	168	997.0	163.51	14.43
6	62.0	38.0	1.500	0.171	178	991.1	169.48	16.76
7	59.0	41.0	1.317	0.183	174	993.5	181.81	17.20
8	55.2	44.8	1.1336	0.1834	170	995.8	182.63	16.47
9	50.0	50.0	0.9200	0.2136	169	996.4	212.83	19.05
10	43.1	56.9	0.6969	0.2231	170	995.8	222.16	20.07
11	34.5	65.5	0.4846	0.2123	164	999.3	212.15	17.81
12	25.0	75.0	0.3067	0.1779	155	1004.5	178.70	13.34
13	16.9	83.1	0.1871	0.1196	158	1002.8	119.93	9.33
14	11.3	88.7	0.1183	0.0688	162	1001.1	68.88	5.64
15	8.6	91.4	0.0866	0.0317	154	1005.1	31.86	2.35
16	8.0	92.0	0.0800	0.0066	121	1023.9	6.76	0.27
Total				2.2280			2228.64	183.25

[1] Condition of sheet entering the drier.

Without suitable experimental equipment it is very difficult to proportion the total heat transfer into that quantity absorbed by the sheet and that acquired by the surrounding air. It is thought that these quantities, once determined, would be of great assistance to the designers of paper machines, as at present, so far as the authors are aware, all calculations are based on an arbitrary figure.

Heating and Ventilating

Ventilating air supplied to a machine room may be considered as serving three distinct purposes:

1 It maintains such temperatures and humidities within the room that the operators may perform their work in comfort
2 During the period of low outside temperature it supplies sufficient heat to replace the radiation loss from the building
3 It acts as a carrier for the moisture liberated by the machine, so that this moisture is conveyed to the outside air without condensation taking place in the room.

The quantity of air supplied to a machine room depends to a large degree upon the desired machine-room temperature and humidity; and it will be found for the ordinary room, all other conditions considered, that the quantity of air insuring greatest economy is largely exceeded. This practice is only adhered to because of the resulting comfort of the operators.

Even under the best conditions the temperatures found in a machine room are quite high. Particularly is this true in the vicinity of the roof and in monitors, where the average temperature may vary from 80 to 100 deg. fahr. Further, the walls of a modern machine room contain a large glass area, resulting in a considerable heat transfer to the outside air. The radiation loss for the building under discussion may be calculated from the formula $y = 5.1 - 0.0583x$, where y is the radiation loss per pound of air in B.t.u., and x the outside or initial air temperature in deg. fahr. This formula is based on an exhaust-fan discharge of 5422 lb. of air per minute, and it shows that the radiation loss from the building makes a very appreciable demand upon the heating load for ventilation.

The air supplied for carrying away the moisture from the machine may be considered as ventilating the machine, apart from the ventilation of the room. This air, in its passage through the machine room, acquires from the wet end a certain amount of moisture, but no heat, and from the driers, both moisture and heat. It must, therefore, when expelled from the room, contain this moisture and heat, together with that which it contained whem coming in contact with the machine. Provided, therefore, that the initial and final conditions of the air are known, and also its quantity per unit of time, the amount of moisture and heat liberated by the machine can be readily calculated.

In order to determine these quantities, so that they could be used as constants in further calculations, a test, previously referred to, was conducted on a still day in summer when the machine-room windows were all open and air of a uniform temperature was supplied to the room. The advantage of making this test in summer, rather than in winter is apparent when it is considered that in winter considerable leakage takes place through openings from adjoining buildings and from the outside air, which renders it difficult to arrive at a representative value of the temperature and relative humidity of the incoming air. Also the outside tempera-

ture at the time being 83.3 deg. fahr., the radiation loss from the building could be neglected without introducing any appreciable error. The results of this test are shown in Table 6.

In making this test the discharge of hot air from each of the stacks was determined by dividing their rectangular cross-section into 24 equal divisions, and the velocity at the center of each of these divisions was determined by means of an anemometer. Wet- and dry-bulb temperatures were taken at the same time, and the discharge as computed in cubic feet per minute was converted into pounds per minute. Carrier's pyschometric charts were used to determine the moisture per pound of dry air and the total heat above 0 deg. fahr. per lb. of air. These charts were of great assistance in simplifying the calculations.

It is thus seen that the quantity of heat given up by the driers per minute as calculated on the ventilating-air basis, checked that as calculated on a steam basis within 1.5 per cent.

TABLE 6 VENTILATING-AIR TEST

	Stack No.	Dry bulb temp., deg. fahr.	Wet-bulb temp., deg. fahr.	B.t.u. per lb. of air above 0° F.	Grains moisture per lb. dry air	Lb. air per min.	Lb. dry air per min.	Lb. moisture in air	B.t.u. above 0° F. contained in air
Final air in stack	1	110	108.5	85	396	1788	1692	96	151,980
	2	118	107.0	82	360	1766	1680	86	144,812
	3	121	113.0	95	415	1868	1756	112	177,460
	Total					5422	5128	294	474,252
Initial air entering room		83.3	76	38.6	123.3	5218	5128	90	201,415
Difference in moisture and heat content between final and initial air								204	272,837

The difference between the moisture acquired by the air, 204 lb., and that liberated by the driers, 200.5 lb., can, in the opinion of the authors, be reasonably taken as the amount of moisture acquired by the ventilating air from the wet end of the machine, and in this case amounted to 3.5 lb., or less than 2 per cent of the total.

When, therefore, the machine is operating at 650 ft. per min. and 5422 lb. of air are expelled by the exhaust fans, the heat given up by the machine per minute is 272,837 B.t.u. and the moisture liberated in the same time is 204 lb.

If then values are assumed for the initial air condition, it is possible, by utilizing the above figures, to determine the final moisture and heat content of the air per pound, and by comparing the heat content of air containing this moisture with that of air containing the same moisture and at saturation, or 80 per cent relative humidity, it is possible to determine to what degree the initial outside air must be heated before entering the machine room, in order that it may function properly.

It must be borne in mind that the above statement presupposes that for low outside-air temperatures the ventilating air is preheated before admission to the machine room. Consequently, upon reaching the machine its temperature will be practically the same as applied when the test was made, and therefore the heat transfer from the driers, and the moisture absorbed from the wet end, will not, for practical purposes, be changed.

Table 7 has been prepared on a basis of initial air at 70 per cent relative humidity. From this table Fig. 5 has been plotted, which serves the purpose of estimating the machine heating load for various outside temperatures.

By referring to Fig. 5, it is seen that for the ventilation of the machine only, there is some critical temperature, in this case 66 deg. fahr., below which the outside or initial air must be preheated before coming in contact with the machine. In practice, however, this critical temperature would be slightly higher, as it is not common practice to expel the air from the machine room at a relative humidity (R. H.) as high as 100 per cent. If the final air had a relative humidity of 80 per cent, the critical temperature would be 78 deg. fahr.

By combining the quantity of heat per pound of air required by the machine with that necessary to replace the radiation loss from the building, the total heat per pound of air required for the purpose of ventilation can be determined.

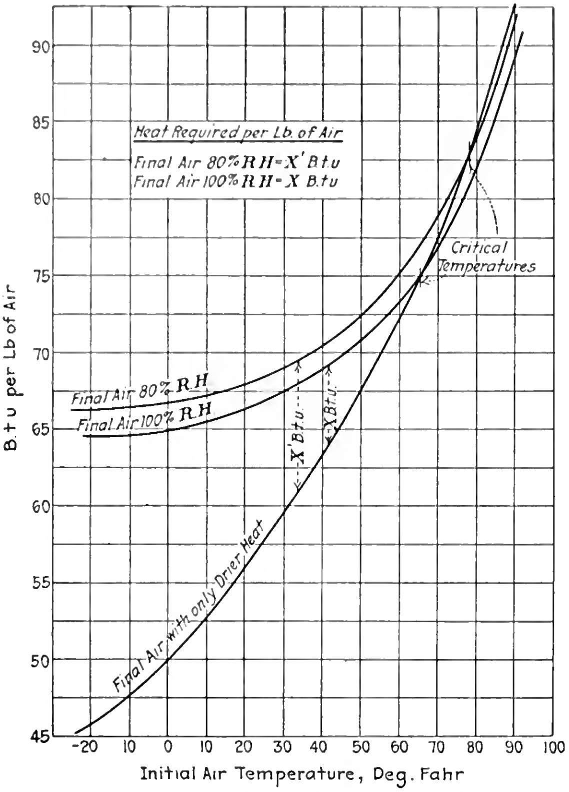


Fig. 5 Curves Showing Heat Required for Paper-Machine Ventilation

The important factor which influences the ventilating requirements of a paper mill is the amount of moisture liberated by the machine per unit of time. This in turn is dependent upon:

1 Speed of the machine
2 Moisture in sheet entering the driers
3 Moisture in sheet leaving the driers
4 Moisture absorbed from the wet end.

TABLE 7 SHOWING CHANGE IN AIR CONDITION WHILE PASSING THROUGH THE MACHINE

Initial Air Condition								Absorbed From Machine			Final Air Condition							
Temperature °F.	% Relative Humidity	Gr. Moisture per lb. of dry air	Heat above 0°F. per lb. of air, B.t.u.	Lb. of air per min.	Lb. dry air per min.	Total moisture, lb.	Total heat, B.t.u.	Moisture from wet end, lb.	Moisture from driers, lb.	Heat from driers, B.t.u.	Total air, lb.	Total Moisture, lb.	Dry air lb.	Gr. moisture per lb. of dry air	Heat above 0°F. in total air, B.t.u.	B.t.u. per lb. of air	B.t.u. per lb. of air, 100% R. H. and same moisture	B.t.u. per lb. of air, 80% R. H. and same moisture
—20°	0	0	—4.8	5218	5218	0	—25046	3.5	200.5	272,837	5422	204	5218	274	247,791	45.7	64.5	66.3
10	70	6.5	2.5	5218	5213	5	13045	3.5	200.5	272,837	5422	209	5213	280	285,882	52.7	65.5	67.1
20	70	17.0	9.75	5218	5205	13	50876	3.5	200.5	272,837	5422	217	5205	292	323,713	59.6	67.5	69.0
40	70	25.6	13.6	5218	5199	19	70965	3.5	200.5	272,837	5422	223	5199	301	343,802	63.3	69.0	70.5
50	70	37.3	17.9	5218	5190	28	93402	3.5	200.5	272,837	5422	232	5190	313	366,239	67.5	70.7	72.4
60	70	54.0	22.8	5218	5178	40	118970	3.5	200.5	272,837	5422	244	5178	330	391,807	72.2	73.3	75.2
70	70	76.0	28.3	5218	5162	56	147669	3.5	200.5	272,837	5422	260	5162	353	420,526	77.5	76.8	79.0
80	70	107.0	35.6	5218	5140	78	185761	3.5	200.5	272,837	5422	282	5140	384	458,598	84.5	82.3	84.2
90	70	149.2	44.2	5218	5110	108	230636	3.5	200.5	272,837	5422	312	5110	427	503,473	92.7	89.4	91.6

The old practice, therefore, of specifying paper-mill ventilation on a basis of so many minutes air change, without due regard to the moisture liberated, is not correct, as it is obvious that the amount of moisture liberated in two machine rooms of the same size might be entirely different.

Much of late has been written regarding the proper distribution of air in the machine room, but it is not the intention of the authors to discuss this further, except to state that, in their opinion, the greater part of the ventilating air should be delivered in the vicinity of the driers and the wet end, so that the moisture may be confined at its source. Further, that sufficient warm dry air should be supplied to the roof and all pockets, such as monitors, in order that the moisture-laden air shall not become chilled below the dewpoint, causing drip.

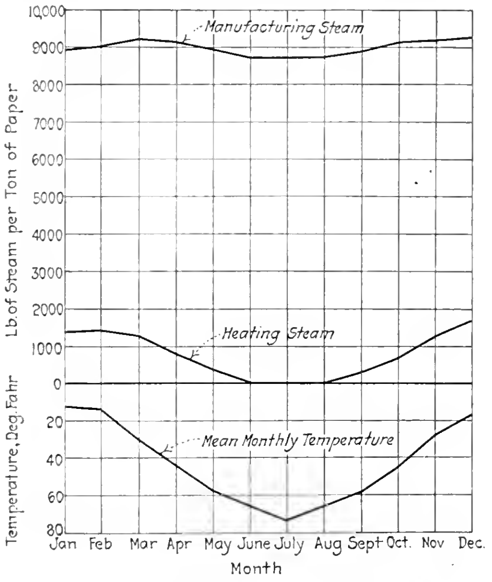


Fig. 6 Curves Showing Temperature and Steam for Manufacturing and Heating, by Months

The amount of heat lost to the process by the expelled ventilating air is in all probability the greatest unpardonable waste in the manufacture of paper.

By referring to Table 7, it can be seen that, with initial air at 10 deg. fahr. and of 70 per cent relative humidity, the total heat above zero deg. fahr. is 2.5 B.t.u. per lb., and the heat content of a pound of final air at 100 per cent relative humidity is 65.5 B.t.u. above 0 deg. fahr., the difference in the heat content per pound of air being 63 B.t.u.

Only 12.8 B.t.u. per lb., however, have to be furnished in order to preheat the incoming air, the balance of this difference being supplied by the driers. It is here that an economizer could be used to great advantage in reclaiming from the expelled air enough heat to condition the incoming air.

Owing to the high relative humidity of the outgoing air, a few degrees' drop in temperature in the economizer would be sufficient to supply heat necessary to preheat the incoming air, with the result that no live or exhaust steam would be required for ventilation.

The saving in operating cost which would result in winter from such an installation is apparent when it is considered that, for the conditions under consideration, at least 5900 lb. of dry steam, at 10 lb. per sq. in. pressure, would be required per hour for preheating the ventilating air when the outside temperature was 10 deg. fahr. and the relative humidity 70 per cent.

Fig. 6 shows for the period of one year the manufacturing and heating load in pounds of steam per ton of product, also the mean monthly temperature which prevailed. It is interesting to note the relative importance of the heating load, and it can be readily realized that the manufacturing cost could be considerably reduced if, by the installation of an economizer, this were done away with.

Conclusion

This paper does not make a complete survey of the subject under discussion, but the authors, in seeking to collect material for the subject-matter, have been impressed with the lack of detailed information which is available. It may be that some mills have studied their problems in great detail, but if so, the information is treated as strictly confidential. It can be understood that, once a paper machine is installed, the owners are reluctant to decrease production while making experimental tests. Therefore, paper-machine manufacturers are unable, in certain respects, to procure reliable operating data upon which to base their designs.

TESTS ON WELDED CYLINDERS

(Continued from page 586)

Oxide inclusions along the surfaces joined by forge welding are practically inevitable. Where an oxide inclusion exists the union between the two pieces welded together is obviously imperfect, thus weakening the weld.

If the forge-welding process is to be used it is recommended that decisive steps be taken toward much more careful temperature control.

The work also indicates clearly that the best type of vessel tested was that made up of a seamless-pipe shell with acetylene-welded dished heads, convex outward. This construction places the welds where they have to sustain a minimum stress and eliminates the danger of a failure such as occurred in the cases of cylinder No. 4.

In the five cylinders tested there were two acetylene-welded longitudinal seams and six acetylene-welded circumferential seams, a total of eight important acetylene-welded seams. The authors were able to rupture but one of these, a longitudinal seam. Very slight leakage was obtained at one other, a circumferential seam. Of the four forge-welded seams every one failed by excessive leakage at pressures considerably lower than those safely sustained by the acetylene welds.

There were a total of 28 pipe fittings acetylene-welded to the five cylinders. Leakage was observed through two of those, in each case finally resulting in failure.

The tests also indicate that the acteylene welds are likely to have occasional porous spots and that pinholes may often develop when high pressures are reached. They also indicate that the welds where fittings for pipe connections are joined to the vessel are almost as likely to cause failure as are the longitudinal and circumferential seams.

The acetylene welds also have non-metallic inclusions, but they are more globular in form than those found in the forge welds and are also scattered in all directions through the material instead of being concentrated along the contact surface. They are therefore less likely to cause leakage.

The principal defects in the acetylene welds examined seem to be the coarse granular structure and porous spots obtained and the occasional poor adhesion of the welding material to the original plate. Poor adhesion may be due to the plate cooling below a good welding temperature, or becoming oxidized along the surface before the welding material is added. These defects suggest the following possible remedies:

a The plate should be heated for as short a distance ahead of the fused-in material as possible. This should render cooling less likely and reduce the chance of oxidation.

b The work should be done as rapidly as possible in order to reduce the grain size to a minimum. As low a temperature as possible, consistent with good welding, is desirable for the same reason.

c The weld should be cooled as soon as possible after being made, in an effort to reduce the growth of ferrite crystals.

d Possibly oxide inclusions might be reduced by using a flame so adjusted as to be neutral or slightly reducing rather than oxidizing in nature. This would require some experimentation.

e Defects in welding attachment couplings to shells or heads, similar to those which caused the failure of cylinders Nos. 2 and 5 (see Fig. 14), could probably be avoided by scarfing the edge of the hole into which the coupling is set. While defects of this character can be avoided by careful workmanship, it would seem that scarfing would render the difficulty much less likely to occur. A scarfing tool similar to a pipe reamer could be devised easily.

f In the case of the samples of seams examined, poor adhesion was noticed in a number of cases, particularly at the bottom of the weld. This might be improved by scarfing both edges to be joined and carrying the bevel nearly if not quite to the bottom of the plate.

Progress in Synthetic-Gasoline Production

Particulars Regarding the Processes Employed—Results of Tests of an Improved Synthetic-Crude System—Comparative Costs of Manufacturing Gasoline by Different Processes

By DR. ROY CROSS,[1] KANSAS CITY, MO.

AT THE present time gasoline and other motor fuels have three principal sources, the chief of these being the gasoline found in natural crude petroleum, which amounts to about 70 per cent of the total production of the United States. The next most abundant source is synthetic gasoline, which supplies about 23 per cent of the total. The light gasoline obtained from natural gas amounts to about 5 per cent of the total, while coal furnishes about 2 per cent of the total in the form of benzol or naphtha.

Assuming that there may be no increase in the production of gasoline-bearing crude oil, we may consider the possible expansion in gasoline production on the basis of the present production of crude. Crude oil must first supply for other purposes about 26 per cent of its volume, consisting of lubricants (6 per cent), kerosene (10 per cent), and indispensable miscellaneous petroleum products and losses (10 per cent). With an average natural gasoline content of 20 per cent, 46 per cent of the natural constituents of crude oil is not an additional source of gasoline. Of the remainder (54 per cent), nearly 60 per cent, or 30 per cent of the original crude oil, can be made into synthetic gasoline, of which something like 5 per cent is now made. This makes a total of 25 per cent of the present crude production available for making gasoline and which is not now made use of. A sufficient amount of fuel oil still remains to take care of those industries which require fuel oil to the exclusion of coal. In other words, the possible production of gasoline with the present production of crude may be doubled without disorganizing other industrial requirements for oil.

It is quite apparent that the amount of gasoline from natural gas is limited. The supply of motor fuel from coal distillation is likewise limited by the requirements for the main products from coal. The immediate future source of gasoline, then, must come from cracking unless crude-oil production increases more rapidly.

Decomposition of Heavy Petroleums

When crude oil is subjected to ordinary distillation by fire the light products naturally present in the oil are distilled off as such up to a temperature of about 300 deg. cent. (572 deg. fahr.), comprising both the gasoline and the kerosene. Above this temperature the hydrocarbons undergo partial decomposition while distilling, with the result that some light products are produced and distilled along with the heavy products. Olefins as well as paraffin compounds of lower molecular weight than the oil being heated are formed. By vigorous firing, the entire oil residue may be distilled, leaving only a variable amount of residual carbon as a product of decomposition. The amount of carbon and gas formed by this pyrogenic decomposition is greater with the asphaltic or naphthene petroleums than with the paraffin-base petroleums.

This property of all heavy petroleums of decomposing into hydrocarbons of lower molecular weight by heating is generally known as "cracking." The chemical reactions involved in cracking are not definite. It was originally supposed that cracking involved the formation of a large amount of olefins according to the following reaction:

$$C_nH_{2n+2} = C_{n-m}H_{2(n-m)+2} + C_mH_{2m}$$

a specific illustration of which would be—

$$\text{Pentadecane} = \text{Octane} + \text{Heptylene}$$
$$C_{15}H_{32} = C_8H_{18} + C_7H_{14}$$

This reaction however, does not, accord with the facts, since gas and carbon are always formed in varying amounts. A reaction which corresponds to the yields as were found experimentally under certain conditions is the following equation:

$$2C_nH_{2n+2} = 2C_{n-m}H_{2(n-m)+2} + mCH_4 + mC$$

or as a specific illustration –

$$C_{15}H_{32} = C_8H_{18} + 7CH_4 + 7C$$
$$\text{Pentadecane} = \text{Octane} + \text{Methane} + \text{Carbon}$$

Yet under certain other conditions the amount of gas formed is very small, indicating that the following reaction was partly carried out:

$$(2m + 2)\ C_nH_{2n+2} = (2n + 2)\ C_nH_{2n+2} + 2(n-m)C$$

or as an illustration:

$$\text{Pentadecane} = \text{Octane} + \text{Carbon}$$
$$9C_{15}H_{32} = 16C_8H_{18} + 7C$$

The cracking of oil is not simply a decomposition of the hydrocarbon molecules. Both heavier and higher-boiling hydrocarbons as well as lighter and lower-boiling hydrocarbons are produced simultaneously. There must be polymerization to yield hydrocarbons of both higher boiling point and higher specific gravity. By continued cracking there may be made from water-white distillate, solid and ductile asphaltic cement of typical conchoidal fracture.

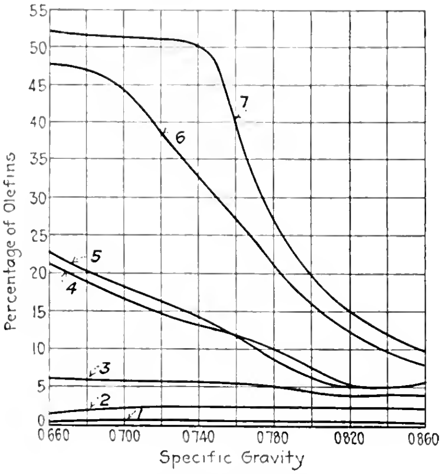


FIG. 1 Olefins or Unsaturated Compounds in Various Fractions Made by Different Processes

(1, Aluminum chloride process; 2, Burkburnett crude oil; 3, High-pressure cracking (750 lb.); 4, Burton process; 5, Low-pressure process; 6, High-temperature process; 7, High-temperature vapor-phase process.)

The gases produced by cracking likewise are not simple split-off hydrocarbons, but vary according to the method of cracking. In liquid phase cracking the chief variation is in the olefin and hydrogen content. In a general way there seems to be a tendency for low percentages of hydrogen to be associated with low percentages of olefins. A typical gas made in a Burton still gives the following percentage analysis: Methane and ethane, 82; olefins, 8.5; hydrogen, 9.5.

One of the problems in cracking is to limit the amount of hydrogen lost in the gas. This has been partly done by allowing the hydrogen to remain in contact with the cracked distillate under high pressure and at a temperature somewhat below the ordinary temperature of cracking.

Fig. 1 shows some of the relative properties of light hydrocarbons made by various processes used more or less in a commercial way for the production of gasoline from heavy oil. Gasoline made

---

[1] K. C. Testing Laboratories.

Abridgment of a paper presented at the Kansas City Regional Meeting of The American Society of Mechanical Engineers, March 6–7, 1922. All papers are subject to revision.

by the aluminum chloride process has the lowest percentage of olefins—even lower than gasoline made from natural crude oil. Gasoline made from synthetic crude comes next in order of quality. Gasoline by the pressure-distillate system is much superior to gasoline made by the high-temperature vapor-phase processes.

There are more than a thousand devices or processes relating to the production of synthetic gasoline on which patents have been issued by the United States Patent Office. Very few, however, are practical, and those that are have been made commercially successful only by extensive mechanical experiments.

Processes Employed in the Manufacture of Synthetic Gasoline

The most important matter in the commercial production of gasoline is that of cost. There are many organic substances from which gasoline may be made, including shale oil, vegetable oil and animal oil. In the laboratory it is possible to make high-grade gasoline from fish oil and the time may arrive when we shall depend upon this source for our gasoline, but at present the process is commercially impossible for obvious reasons. The most important processes for the production of gasoline commercially as well as from the standpoint of technical interest may be grouped as follows:

1 *Vapor-Phase Systems.* These are the outgrowth of the old processes for making Pintsch gas, oil gas, Blau gas and the like. They employ very high temperatures, usually above 1500 deg. fahr., and the products are of the nature of unsaturated compounds and aromatic compounds. Some of these processes use steam or natural gas mixed with the oil vapor, and various mechanical devices are employed to prevent the accumulation of carbon in the tubes. Some are operated under considerable pressure, among them being the Rittman process, which operates at a temperature of 950 deg. fahr. and upward, and the Hall (1100 deg. fahr. and upward). Others in this group are the Greenstreet and the Parker processes. By using lower temperatures, products containing a large amount of paraffin hydrocarbons or gasoline may be obtained, and some practical work is now being done in cracking oil vapors at temperatures as low as 800 to 950 deg. fahr.

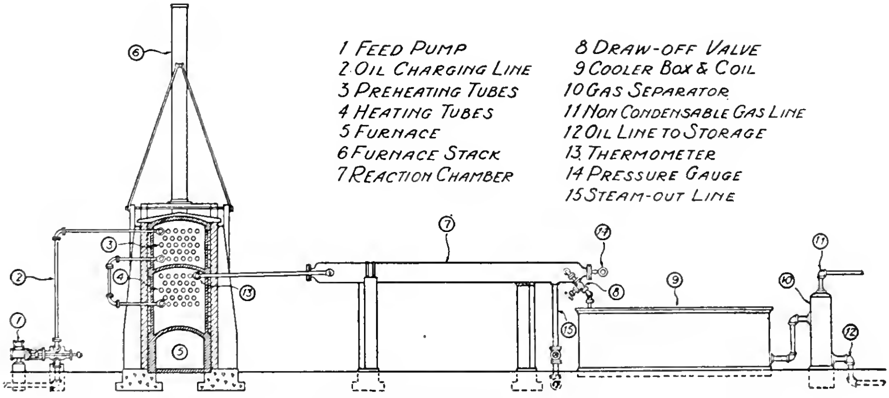


Fig. 2 Synthetic-Crude System in which the Heating and Reaction Zones Are Distinct

One of the most recent patents for cracking oil in the vapor phase provides for heating the vapor of gas oil as it comes from the crude still. The cracked vapor is then sent into a dephlegmator where the gasoline is separated and condensed. The uncracked portion is returned to the still. This method saves the fuel expense required to heat the gas oil for the second time. Electrical sources of heat have been used, but are considerably more expensive and therefore impractical. No truly catalytic processes have been commercially developed for the cracking of oil.

2 *Pressure-Distillate System.* Nearly all of the synthetic gasoline now placed on the market is made by the pressure-distillate system. The most outstanding example of it is the Burton process, the total still capacity of which in 1921 was 200,000 bbl., with an output of 2,000,000 gal. of gasoline per day. Other processes operating on this general system are the Dubbs, Coast, Jenkins, Isom, Adams, Fleming, Dewar and Redwood, Bacon and Clark, and E. M. Clark's modification of the Burton process. All of these systems operate under pressure, some with pressure on the condenser and some without, the pressure on the condenser being merely an economical means of condensing. The production of pressure distillates with this type of process is an operation necessity and refined distillate is obtained in practically none of them. The pressure distillate must be rerun and the crude benzine treated in essentially the same manner as a natural crude oil. It is in this type of process that litigation chiefly exists.

The chief disadvantages of this method of operation are the large fuel consumption, the large amount of oil under treatment at one time, the slowness of the conversion, and the expensive plant equipment.

3 *Chemical Methods.* When the heavy fractions of petroleum distillates such as kerosene, gas oil or paraffin oils are slowly heated with a small quantity of perfectly dry and active aluminum chloride, the salt dissolves, imparting a reddish to black appearance to the solution. If this dark liquor is then subjected to slow fractional distillation at a temperature below that at which aluminum chloride volatilizes, a sweet, water-white light distillate is obtained having all the properties of light high-grade gasoline that has been subjected to complete refining with sulphuric acid. Other chemicals which have essentially the same effect as aluminum chloride but to a lesser degree are anhydrous ferric chloride, tin chloride, manganic chloride, zinc chloride and phosphorus pentoxide. In the experience of the author, about 60 per cent of 55 deg. B. water-white naphtha can readily be obtained by this process with one distillation. The advantage lies in the fact that the product is completely refined. However, large quantities of hydrochloric acid gas are given off in the distillation, and the residue has very little value. The chief commercial disadvantages are the excessive cost of aluminum chloride, the loss of the fuel-oil residue, and the corrosive action of hydrochloric acid. Aluminum chloride requires the use of molecular chlorine, which cannot be made at this time at a sufficiently low price to allow its employment for competing with the straight heat processes for making gasoline.

4 *Synthetic-Crude Systems.* This method of operation presents at this time the greatest possibilities in reducing operating costs. There are three types:

a The intermittent-digestion type, in which a charge of oil is subjected to heat and pressure until reaction takes place and then is completely discharged. Representatives of this type are the Palmer and the Snelling processes. The disadvantages are the low yield per cycle, the time required for cooling, and inability to operate continuously.

b The type in which a body of oil is continuously charged and heated and more or less continuously discharged. The heating and reaction containers or zones are one and the same. The chief disadvantage is the limitation of the cycling time on account of the rapid accumulation of carbon in the reacting zone and its effect on the transfer of the furnace heat. The Hubbard patent is of this type.

c The third class is the type in which the heating and reaction zones are separate and distinct. This type is covered by one patent and provides for continuous operation and rapid conversion. Outstanding advantages are the long cycle (about one week) before cleaning—due to absence of carbon in the heating zone, the great speed of reaction (15 min.), the large ultimate yields (700 bbl. per day per unit), and the great capacity per unit of cost.

One or more units of the process may be added to any refinery merely as an adjunct, without any change in ordinary refinery

operation. With this process added a greater still capacity is necessary for a given amount of crude oil, or greater yields may be obtained with the same still capacity and with a smaller amount of crude oil available.

The scheme of operation is that shown in Fig. 2. The steam pump 1 forces the charging stock against the pressure in the apparatus through line 2, passing it from above downward through the preheating tubes 3 in the upper part of the furnace. No decomposition or cracking takes place in these upper tubes since they merely serve as fuel economizers, while the pressure in the apparatus is sufficient to maintain the oil in the liquid condition. The oil passes from these preheater tubes into the lower furnace tubes 4, starting in at the bottom. In this furnace the main absorption of heat takes place. The oil temperature is registered as it issues from the heating tubes at the point 13. The temperature of the oil and the character of the oil under treatment govern the rate of pumping. At the point 13 all of the heat has been applied to the tubes, but the oil has not yet been converted as the time element is lacking. It is therefore discharged into the reaction chamber 7, where it is held a sufficient length of time for an equilibrium to be reached between the vapor phase and the liquid phase. Ordinarily this requires less than 15 min. The discharge line through the valve 8 is set at the liquid level and perfectly controls this level without any other automatic device than an ordinary relief valve. The oil is then discharged through the cooling coil line 9 under a pressure of approximately 40 lb. and into the gas separator 10, from which the gas goes out through the line 11 and the oil is discharged through the line 12 to storage. This synthetic crude is run in the ordinary skimming plant in the usual manner.

A flow sheet for a complete gasoline plant in which all of the crude is made into gasoline and fuel oil is shown in Fig. 3. It is of course not advisable to run all of the residue into gasoline, as a point is eventually reached at which the fuel oil becomes so heavy that the gasoline yields are relatively poor.

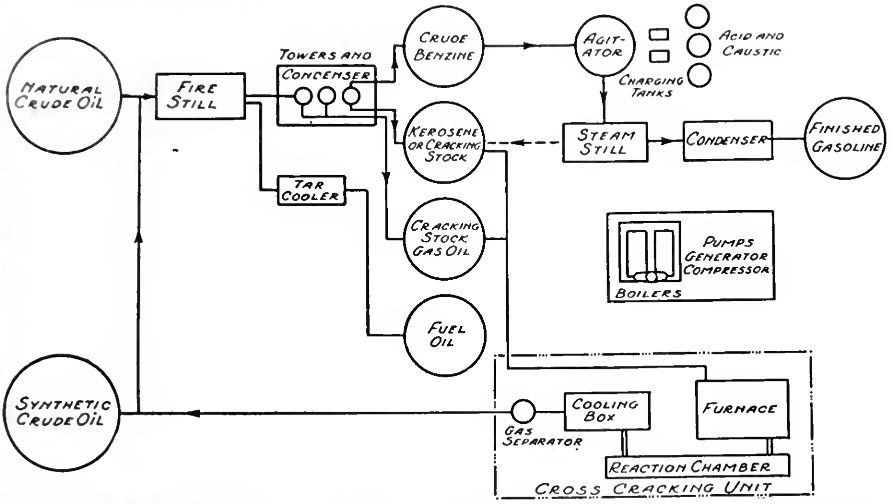


Fig. 3 Flow Sheet of Synthetic-Gasoline Plant in which All the Crude Oil is Made into Gasoline and Fuel Oil

Table 1 shows a typical run according to the synthetic crude process in which the heating zone and the reaction zone are kept separate. This plant is equipped with a forge-and-hammer-welded vapor chamber, which is being replaced in new plants now being built by reaction chambers made by the Midvale Steel & Ordnance Co. These chambers are approximately 38 in. in inside diameter and with walls 3 in. thick. With this chamber the cycle is one week, one day per week being required for cleaning. This is made possible by reason of the increased size, as the carbon accumulates in the reaction chamber and eventually fills it to such an extent that the plant must be closed down for cleaning.

TABLE 1 DATA OF RUN NO. 44 AT CRACKING PLANT NO. 1
(January 21–25, 1922)

Oil used, bbl	3030
Cracked oil delivered, bbl. (shrinkage, 4 per cent by volume)	2909
Gasoline produced, bbl.	727
Fuel used (1/8 bbl. per bbl. of gasoline produced)	91
Hours on steam	96
Hours on fire	98
Oil cracked per hour, bbl.	31.5
Fuel used per hour, bbl.	0.95
Maximum oil temperature, deg. fahr.	915
Average oil temperature, deg. fahr.	900
Maximum furnace temperature, deg. fahr.	1375
Maximum stack temperature, deg. fahr.	765
Average stack temperature, deg. fahr.	740
Pressure, lb. per sq. in.	600

The most severe strain on the apparatus is from the cooling of the reaction chamber when the plant is closed down for cleaning out the carbon. This strain tends to open welded joints but does not affect the body of the metal. All welded joints have now been eliminated with the use of the chamber forged from a single ingot.

A summary of total ultimate yields as obtained in plant No. 1 the same oil being recycled without the addition of fresh oil to the system, is as follows:

Gas oil used	10,475 bbl	= 100.0 per cent
Gasoline	6,789 bbl.	= 64.8 per cent
Fuel oil	2,600 bbl.	= 24.8 per cent
Loss	1,086 bbl.	= 10.4 per cent

As to the profits accruing from plant No. 1, the data given in Table 2 are representative of one month's operation.

Comparative Costs of Making Gasoline

While there is much variation in the absolute cost of making gasoline by any process, Table 3 outlines the comparative costs of operation of one unit of three principal systems. No satisfactory information is available for vapor-phase processes.

For convenience in estimating the cost of manufacturing gasoline the following formulas may be used as approximations. It is to be observed in these formulas that under present commercial conditions gasoline may be made by cracking methods very much more cheaply than by the skimming of natural crude.

TABLE 2 RESULTS OBTAINED FROM ONE UNIT, CRACKING-PROCESS PLANT NO. 1, FOR MONTH OF JANUARY, 1922

Charges:	
15,427 bbl. gas oil used @ $1.575	$24,297.53
420 bbl. fuel used @ $1.575	661.50
Total payroll charge for month	1,363.79
Storeroom charges for month	55.78
Fixed charge, 31 days @ $32.00	992.00
Steam, air, etc., 31 days @ $20.00	620.00
Distilling and treating 14,852 bbl. @ $0.35	5,201.70
Total charges	$33,192.30
Credits:	
4,186 bbl. gasoline @ $6.09	$25,492.74
10,622 bbl. oil returned @ $1.47	15,614.34
Total credits	$41,108.08
Less charges	$33,192.30
Estimated profit for month	$ 7,914.78

TABLE 3 COST PER BARREL OF MAKING GASOLINE BY THESE PRINCIPAL SYSTEMS

	Synthetic-crude system	Pressure-distillate system	Aluminum chloride system
Labor	$0.30	$0.90	$0.90
Materials	0.16	0.20	2.60
Fuel oil @ $1.00 per bbl.	0.10	0.40	0.40
Overhead	0.20	0.20	0.20
Fixed charges	0.25	0.75	0.60
Rerunning	1.20	1.20	0.00
Gas oil equivalent to converted gasoline	1.25	1.25	1.25
Refining loss	0.20	0.20	0.20
Degrading of gas oil	0.06	0.06	0.60
License charges	0.20	0.20	0.20
Cost per bbl.	$3.92	$5.36	$6.95

(Continued on page 621)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Thermo-Calorimetric Heating Values of Fuels

By J. Hudler

THE author brings out that a purely calorimetric determination of the heating value of a fuel is insufficient when dealing with fuels containing considerable quantities of moisture. If it should be desired to raise in a boiler the same amount of steam per hour with fuels containing high quantities of moisture as was previously done with coal, it is possible to attain such a result, but only by permitting a higher temperature in the smokestack. The lower production in units of steam per hour due to the burning on one part of the grate of wet fuels must be compensated for by an increased consumption of fuel on some other part of the grate. This can be done by burning more fuel per hour, in which case the initial temperature, owing to the greater amount of smokestack gases, falls off much slower, and the gases go to the smokestack with a higher temperature. Therefore the more moisture the fuel contains the lower will be the useful temperature head as the result of lower initial temperature and higher exhaust temperature, while the amount of exhaust gases per unit of heat will be greater. It is easy to understand what happens when burning fuels with a high percentage of moisture. It is this state of affairs that forced the adoption of larger grates on the new locomotive boilers in Austria.

At the same time, high moisture content of the fuel leads to placing the fuel in a low-grade classification, which, however, is not indicated calorimetrically. Because of this, purely calorimetric testing becomes insufficient. On account of the decisive influence of smokestack temperature on steam output per hour and furnace losses, it is impossible to obtain a clear idea as to the value of various fuels without considering the various furnace temperatures, as these are influenced by the composition of the fuels.

The author proceeds to indicate a method for determining the heating value of fuels which he claims is superior to the straight calorimeter method. The new values are of particular interest for the purpose of comparing fuels to be used for steam generation.

To do this he considers various fuels as being burned under the same boiler with the same excess of air and at the same air temperature, and with the same output of steam per hour, and then determines the useful heat per kilogram (2.2 lb.) of the fuel. This gives a series of values which the author calls thermo-calorimetric heating values. These values are not absolute for a given fuel, but show the comparative values of various fuels, which is just what is necessary to know in purchasing fuels.

If H_u is the calorimetrically determined heating value, W_A the heat loss through unconsumed carbon in the ash, W_V the loss through radiation and conduction of the boiler setting walls, and W_R the loss through smokestack gases, then the useful heat is $W = H_u - W_A - W_V - W_R$. H_u is given; W_A can be determined by ash analysis; W_V may be considered as known for a given installation; as regards W_R, we know the composition and volume of the smokestack gases, but not their outlet temperature. Recourse can, however, be had to an important factor which hitherto has not been sufficiently considered in furnace operation, namely, that each fuel has its specific initial temperature, to which for a given constant output of steam there must correspond a certain outlet temperature. This may not be observed in some cases: in particular, in comparisons between two fuels burned under the same boiler. This may be due to the fact that with fuels which give a higher steam output, lower outlet temperatures have been found to prevail for a given output of steam.

In determining his thermo-calorimetric series of values for the various fuels, the author started with a good grade of coal and assumed that in that event the smokestack gases leave the boiler heating furnace with the temperature of 300 deg. cent. (572 fahr.), whereas, the temperature of the boiler water is 183 deg. On this assumption the heat output per hour, which must be the same for all fuels, is so determined that in each case it becomes possible to compute the exhaust temperature of the gases.

Case of Coal Firing

It is assumed that the coal fired under a boiler has the following composition: Carbon, 0.760; hydrogen, 0.046; oxygen, 0.060; water, 0.040; ash, 0.095; H_u is 7456 large calories per kg.

The author has previously established the following formula:

$$W = C \frac{T_o - T_1}{\log \dfrac{T_o - t}{T_1 - t}}$$

where W is the heat in large calories per hour transmitted to the boiler; T_o the calculated initial temperature in degrees centigrade; T_1 the outlet gas temperature; t the temperature of the boiler water; and C a constant expressing the heated area and the coefficient of heat transmission. Since the actual initial temperature of combustion is smaller than the calculated temperature, an objection might be made to the above formula on the ground that it is apt to give the useful heat head greater than it actually is; but at the moment of its appearance the flame radiates amounts of heat on to the surrounding heated surfaces which are proportional to the difference between the temperatures of the respective surfaces and the temperature of the flame. This heat radiation produces a lowering in the temperature of the flame, whereas in calculation this temperature is determined on the assumption that no heat is being lost from it. Because of this, the temperature head computed on the basis of the temperature T_o determined by measurement would be too small as a basis for establishing the quantity of heat given up to the surrounding surfaces. On the other hand, since the computed temperature T_o is greater than the actual temperature by the amount of heat radiated at the instant of flame formation, the temperature head as determined by computation from this temperature is closer to what actually happens than that determined with T_o as found by measurement to start with.

Before the initial temperature is computed, it is necessary to determine the loss due to the residues of combustion. Thus, if the ashes contain 20 per cent of carbon, equivalent to $0.095/5 = 0.019$ kg., the loss of heat due to this source is equal to $0.019 \times 8100 = 154$ large calories per kg.

In the case of combustion with 50 per cent excess air, the following gases are sent up the smokestack:

$$\left.\begin{array}{l}\dfrac{0.760 - 0.019}{0.536} = 1.382 \text{ cu. m. } CO_2 \text{ with } 1.382\ O_2 \\[2ex] \dfrac{0.015}{0.09} = 0.500 \text{ cu. m. } H_2O \text{ with } 0.250\ O_2\end{array}\right\} = 1.632 \text{ cu. m. } O_2$$

$$\frac{0.010}{0.8} = 0.050 \text{ cu. m. } H_2O$$

$$\frac{0.060}{1.43} = 0.042 \text{ cu. m. } O_2.$$

The minimum oxygen required for combustion $1.632 - 0.042 = 1.590$ cu. m.; add to this 50 per cent excess $= 0.795$ cu. m., a total of 2.385 cu. m., which carries with it 8.768 cu. m. of nitrogen. The smokestack gases have therefore the following composition: $1.382\ CO_2 + 0.550\ H_2O + 0.795\ O_2 + 8.968\ N_2 = 11.695$ cu. m.

The heat content of these gases is 7456 − 154 = 7302 large calories per cu. m., and the initial temperature is therefore $T_0 = 7302$ 11 695 c, where c is the specific heat of the smokestack gases. As this latter varies with the temperature it cannot be determined in advance analytically. But for the present case, the curves of Kusell and Wigton (*Feuerungstechnik*, May 15, 1916, p. 191) give c = 0.3714, which gives for T_o the value 1680 deg. cent. The heat transmission per hour is therefore—

$$W = C\frac{1680-300}{\log(1680-183)-\log(300-183)} = 1245\ C.$$

Every fuel of which the thermo-calorimetric heating value has to be determined must satisfy this output per hour.

As regards the specific heats for the gases at 300 deg. cent. temperature, the following holds good. For carbon dioxide, 0.442; for water vapor, 0.376; for oxygen and nitrogen together, 0.318; whence—

$W_R = 300\ (0.442 \times 1.382 + 0.376 \times 0.55 + 0.318 \times 9.783) =$ 1179 large calories per kilogram.

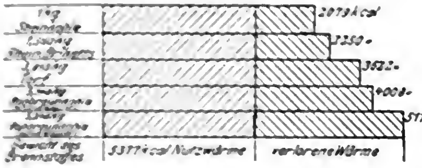


Fig. 1 Heat Balances for Various Fuels

(*First Column, reading down:* 1 kg. coal; 1.560 kg. Rhine briquets; 3.813 kg. peat; 3.340 kg. lignite (47.6 per cent water); 5.246 kg. lignite (60 per cent water); Weight of Fuel. *Second Column:* 5377 large calories, useful heat. *Third Column:* Heat loss. *kcal* = large calories.)

Therefore, if we assume that in the boiler-setting walls the heat loss amounts to 10 per cent or 746 large calories, the total useful heat is 7456 − 154 − 746 − 1179 = 5377 large calories per kilogram, corresponding to an efficiency of 72.1 per cent.

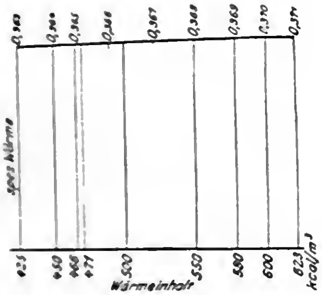


Fig. 2 Relation between Heat Content and Specific Heat of Smokestack Gases (*Spezwaerme* = specific heat; *waermeinhalt* = heat content; *kcal m³* = large calories per cu. m.)

The author carries through the same computation for lignite briquets, two kinds of crude lignite—one with 47.8 and the other with 60 per cent water—and peat. The results are presented in the form of tables and figures. As regards the latter, Fig. 1 is of particular interest as showing the dependence of heat losses on the composition of the fuel and in particular moisture content. From this figure it would appear that whereas the useful heat output remains all the time at the same level of 73.77 large calories, the heat losses rise from 2079 large calories per kilogram in the case of good coal to 5178 large calories per kilogram for crude lignite containing 60 per cent of water. These figures are particularly impressive if we take into consideration their general significance; thus, in order to produce with crude lignite containing 60 per cent water the same amount of useful heat that is produced with 1 kg. of coal, it is necessary to burn on the grate 5¹/₄ times the weight of the fuel, which means not only increased losses in the fuel itself but also a material increase in the cost of handling the fuel. Furthermore, the high-moisture fuels give a low economy from the point of view of ultimate steam generation, because they produce a lower degree of steam superheat.

The following table gives a comparison between thermo-calorimetric values for the various fuels and calorimetric values, which would indicate the comparatively low reliability of the calorimetric values.

	Thermo calorimetric heating value	Calorimetric heating value
Good coal	1 000	1.000
Rhine lignite briquets	0 641	0.656
Crude lignite with 17.8 per cent water	0 299	0.377
Peat with 15.5 per cent water	0 262	0.317
Crude lignite with 60 per cent water	0 191	0.270

The higher the moisture content in the fuel the less the information given by the calorimetric heat value; for example, in the case of crude lignite with 60 per cent water, the error as compared with the thermo-calorimetric value is 41 per cent on the wrong side.

For the purpose of simplifying the calculations involved in deriving the thermo-calorimetric heating value of a fuel, the author worked out the two diagrams shown in Figs. 2 and 3. He finds that if in accordance with the above method of calculations, one should plot a diagram in which the heat values per cubic meter of smokestack gases at the initial temperature of each case are plotted as abscissas and the specific heats thereof as ordinates, it will be found, as appears from Fig. 2, that the line connecting these values would be a straight line. Therefore, if one knows the heat content per cubic meter of a gas, one can read off from Fig. 2 the specific heat directly and thus compute T_o.

The curve in Fig. 3 shows the relation between the initial and the outlet temperatures in accordance with the method of calculation indicated above, and thus makes it possible to read directly the outlet gas temperature for each initial temperature. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, no. 20, May 20, 1922, pp. 495–497, 3 figs., *tA*)

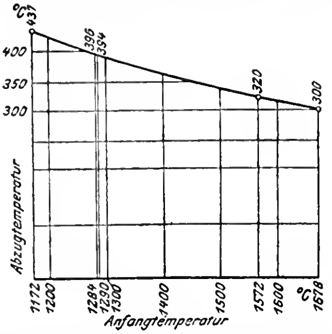


Fig. 3 Relation between Initial and Exhaust Temperatures of Smokestack Gases (*Abzugstemperatur* = outlet temperature; *anfangstemperatur* = initial temperature.)

Short Abstracts of the Month

AERONAUTICS (See also Internal-Combustion Engineering)

Flow Tests on Slotted Aerofoils. Data of experiments carried out by Lachmann at Goettingen, Germany, of particular interest because, in this case, the behavior of the eddies at various points and at various angles and velocities was shown by means of sal ammoniac smoke, a method which might be applicable in testing fans, blowers and similar apparatus. Two main flasks are used, one containing hydrochloric acid and the other ammonia.

A third flask serves as a reservoir and from it there is a connection with a tube with one or more jets through which the sal ammoniac vapor passes. The two main flasks stand in a bed of water warmed by a Bunsen burner to assist vaporization. The necessary pressure is supplied by a small pump driven by an electric motor. (*Flight*, vol. 14, no. 22/701, June 1, 1922, pp. 315–316, 15 figs., *d*)

AIR MACHINERY

Rotary Air Compressor with Laminated Springless Blades

NEW ROTARY AIR COMPRESSOR, Dr. E. Loewenstein. The new compressor is of the rotary type with springless abutment blades. The housing A, Fig. 1 is a hollow cast-iron cylinder with end plates eccentrically held in a bearing. The shaft B rotating within carries a cylindrical iron body C with three radial slots D staggered at 120 deg. In these slots are located movable brass plates interleaved with "Vulkan" fiber laminations E, the width of which is equal to the length of the cylinder. On one side the shaft comes out of the cylinder and is held there by a nut. If, now, the shaft B and with it the inner cylinder C are set into rotation, the brass plates E with their fiber laminations are forced by centrifugal force against the walls of the hollow cylinder, providing thereby an airtight joint. Because of the eccentric position of the shaft B, the dimensions of the various air chambers created thereby are non-uniform. On the other hand, the air inlet port F and air outlet port G are so located that the air always enters at the point where the blades project farthest out of the drum, i.e., where the enclosed volume is at a maximum. The air thus enclosed is compressed during the further part of the rotation owing to the gradually diminishing size of the chamber and is forced out under an increased pressure through the outlet orifice G. It follows from this that the volume of air handled and its pressure depend, according to a straight-line law, on the number of revolutions per unit of time. Should it prove that the joint between the blades and the cylinder walls is absolutely airtight, any pressure or volume can be obtained from this type of pump. In actual construction, however, the power consumption is not proportional to the pressure developed. This is explained by the losses due to the friction of the abutment blades against the cylinder walls.

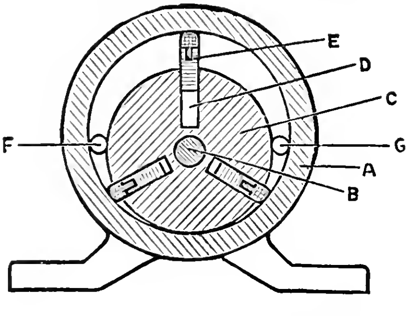


FIG. 1 NEW VALVELESS AIR COMPRESSOR

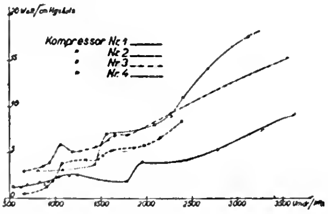


FIG. 2 DATA OF TESTS ON AIR COMPRESSOR SHOWN IN FIG. 1

The results of tests undertaken at the Goettingen Institute for Applied Electricity are shown in Fig. 2, where the abscissas are r.p.m. and ordinates, watts of power consumption per unit of pressure rise expressed in centimeters of mercury. The compressors Nos. 2, 3 and 4 in which the efficiency appeared to be rather low had blades made of brass without fiber laminations. Compressor No. 1 had brass laminations alternating with laminations of Vulkan fiber. Other tests showed the relation between air-gage pressure and speed in revolutions per minute.

The compressor may be built in very small units to be driven by a motor ranging from $^1/_{16}$ to $^1/_6$ hp. (*Deutsche Optische Wochenschrift*, vol. 8, no. 22, May 28, 1922, pp. 413–414, 4 figs., *de*)

ENGINEERING MATERIALS (See also Special Processes)

Fatigue of Metals

FATIGUE OF METALS, C. E. Stromeyer. In a paper read by the author before the Royal Society an empirical law of fatigue was proposed, expressed in the following formula:

$$S = Fl + C\ (10^6/n)^{1/4}$$

where S is the alternating stress which will cause failure after being repeated n times; Fl is the fatigue limit of the material and C is a constant. The original fatigue-testing machine used by the author was unsatisfactory. Recently, however, the Committee of the Manchester Steam Users' Association for the Prevention of Boiler Explosions ordered a larger machine, which permitted the thermometric and elastic determination of the fatigue limits. It was found that these and the calorimetric and extrapolation determinations were in close agreement, so that there are now available three quick and one slow method of determining this very important point. This machine is described in the original article.

It has been found that as soon as the fatigue limit is reached, what may be called molecular friction takes place in the sample which generates heat, and this can be detected either calorimetrically or by means of very sensitive thermocouples and galvanometers; at the same time the elastic properties of the material undergo a change, which can be determined by suitable instruments.

The first question to be settled is whether the fatigue limit is affected by permanent stress, and with this end in view Woehler's tests on wrought iron have been analyzed, as follows: His test results were entered on a diagram and with the modified fatigue law the fatigue limits were estimated by extrapolation. They evidently decreased with increasing permanent stress. The best argument with the experiments is obtained by assuming an ultimate strength estimated not on the original section of the sample but on a reduced section, this stress being therefore higher than the usual accepted ultimate strength. It sounds paradoxical that even for a single fatigue stress the fatigue limit should be higher than the ordinary ultimate strength, but this can happen.

Thus, Woehler tested the wrought-iron sample, which had a tenacity of 21 to 21$^1/_2$ tons per sq. in., yet when he subjected it to alternating stresses ranging from zero to 23 tons it resisted them 800 times.

The following are the results of the author's own tests on mild steel, the only ones which have ever been made for the determination of the fatigue limits of permanently stressed samples. With an average compression stress of 0.46 ton, the fatigue limit was reached with an alternating stress of ±11.4 tons, the range of stress being from 15.86 tons compression to 6.94 tons tension. With no permanent stress the limit was reached with 10.87 alternating stress and with an average tension stress of 4.47 tons the fatigue limit was reached with 9.32 alternating stress, the range being from 4.85 tons compression to 13.79 tons tension. The results when plotted do not lie on a straight line, but suggest a parabolic fatigue curve. The test results obtained are compared with the formula in a table, which shows that the two agree reasonably well. It is evident that as the expression following C in the above formula is large for the case of a single application of stress causing rupture, it would have to be multiplied by a factor $(T - Fl)$, where T is the ultimate stress and Fl is the fatigue limit where the permanent stress is P. When $P = 0$, $Fl = Fl_0$. Apparently, T would have to be chosen higher than the ordinary or static tenacity, in order to harmonize the result, and possibly the stress on the contracted, instead of the original, area would have to be taken. It was also assumed that the fatigue limit varied from Fl_0 to $Fl = P$ when $P = T$, and the curve marked fatigue limit was assumed to be a parabola.

The author gives a highly interesting diagram combining many of his results. Woehler, being unable to determine the fatigue limits, could only give the results which are shown in the original in a table and the empirical formula, and had to find this curve by extrapolation. That the fatigue-limit curves are not far from the truth is evident from the fact that the fatigue stresses in the table, which have been estimated with the help of the formula, are in close agreement with the actual stresses. It will also be seen that the ringed crosses in the diagram fall very close to the respective curves or cycle contours.

The arrowheads indicate the positions where this formula would have placed the results. The complete formula is:

$$S = [P + Fl_0 (1 - P^2/T^2) + KTM]/(1 + KM)$$

Here S is the combined permanent stress P, plus the fatigue stress which will cause fracture after n repetitions. Fl_0 is the fatigue limit of the material when there is no permanent stress P. In this case Fl_0 is 7 tons. The enhanced ultimate strength is T, and in this case it appears to be 26 tons. K is a coefficient which in this case is 0.30. M stands for the expression $10^6/n^{1/4}$. Thus, for this sample of iron:

$$S = [P + 7(1 - P^2/676) + 13.8M]/(1 + 0.3M)$$

For no permanent stress we have the region marked "Piston Rods;" it embraces all similar cases like connecting rods, watch springs, etc. The practical working limits of stress seem to be 3 tons for wrought iron, so that here the factor of safety is about $2^1/_3$.

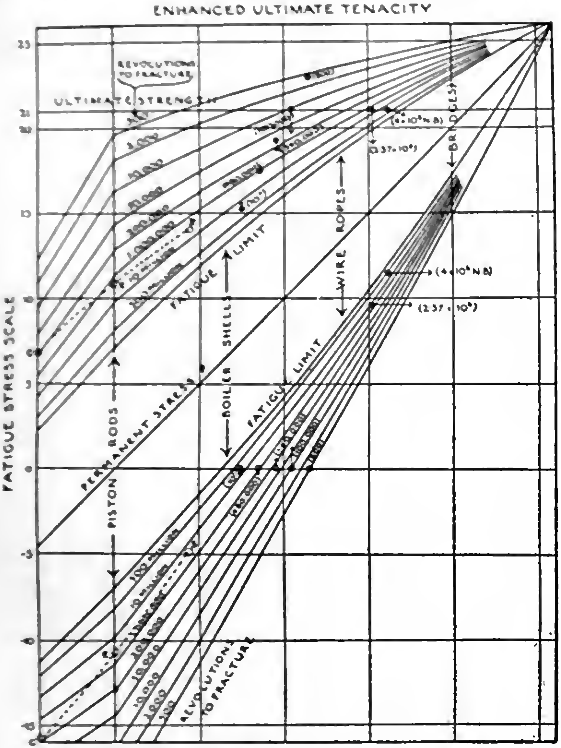


Fig. 3 Fatigue-Limit Curves

For short objects, where no buckling is possible, higher stresses are allowed. The inner tubes of large guns should occupy a position in the diagram very close to "Piston Rods," for when at rest they are subjected to severe compression stresses, whereas under pressure they are subjected to tension or rather shearing stress. As far as can be ascertained, both these stresses fall outside the fatigue-limit curve, which would mean that the factor of safety of inner gun tubes is less than one. This need cause no alarm; it means that the inner gun barrel will ultimately fail; but, according to the diagram, it will stand a definite number of repetitions of stress. In fact, partly for this reason, partly on account of wear and tear, the inner gun barrels are renewed after a certain number of rounds, say, 2000.

To the left of the "Piston Rods" region is one marked "Boiler Shells." The average stress—in this case it can hardly be called the permanent stress—is half the working stress. When at rest there is no stress; when under pressure the permanent and alternating stresses are added together. According to Fig. 2, the fatigue limit is reached when the combined permanent and alternating stress is about 13 tons. In practice a stress of about $5^1/_4$ tons for wrought iron of 21 tons is considered safe, and explosion stresses do not fall below 8 tons even with heavily corroded shell plates. Here, then, we have a factor of safety of about 2.5, using the fatigue limit as a basis. This comparatively large factor seems to be due to sentiment or fear. It is a justifiable one, for piston rods and connecting rods do occasionally break, their factor of safety being somewhat low, whereas boiler shells never burst at less than 8 tons stress if of iron. No cases are known of acid open-hearth shell failures, but basic-steel failures are frequent on the Continent and in America.

To the left of the "Piston Rods" region, but outside the diagram, would be placed "Boiler Furnaces," because their stresses range from 0 to a maximum compression stress. For long furnaces the factor of safety based on the fatigue limit is about 12. This is due to considerations about buckling and overheating, and the impossibility of insuring perfect circularity of shape. In a recent test, ovality of $^3/_4$ in. in a 36-in. furnace led to collapse when the mean stress was 2.0 tons. The bending stresses were, of course, very severe, the ovality having increased to nearly 3 in. just before collapse took place.

The next region in the diagram is marked "Wire Ropes," but embraces many objects in which the fatigue stresses are not quite as severe as the permanent stresses. This region also embraces the tension members of short bridges, in which the live stresses are relatively very severe.

"Bridges" occupy the extreme right hand of the diagram. Here the permanent stress is very severe and the alternating stress very light. This region differs essentially from that of "Piston Rods" and inner tubes of guns because the range from the fatigue limit to the breaking stress is very narrow, and whereas with guns of wrought iron the fatigue limit may be exceeded by 6 tons with a reasonable certainty that such stresses may be repeated one million times without failure, the diagram shows that the same limited life would be reached in heavy bridges if the fatigue stresses were increased over the fatigue limit by only a fraction of a ton. (Paper read May 25, 1922, before the South Wales Institute of Engineers, abstracted through the *Iron and Coal Trades Review*, vol. 104, no. 2831, June 2, 1922, pp. 822–824, 2 figs., *etA*)

White-Metal and Brass Bearing Materials. A general discussion of the subject, with particular reference to German practice. One of the tables gives compositions for white-metal alloys as used by the Prussian and Bavarian State Railways and in commercial practice in England. Data are also presented on aluminum bronzes with 10 per cent aluminum content and also titanium-aluminum bronzes, and a table is given showing the variation in physical properties of these bronzes with their heat treatment. Another table gives the melting points and freezing points of the various lead tank alloys, beginning with 120 lead to 140 parts tin and ending with 240 lead and 150 parts tin. As a good metal for wheel bearings the following composition is recommended: 72.4 parts copper; 4.7 parts tin; 29.9 parts zinc; 0.5 part iron and 1.5 parts lead. (*Zeitschrift fur die gesamte Giessereipraxis*, vol. 43, no. 23, June 10, 1922, pp. 316–317, *g*)

Causes of Failure in Cast-Iron Pipe, F. A. McInnes. Among the causes of failure not sufficiently safeguarded in specifications is the quality of the iron in the pipe. The specifications require the test bars to support a center load of 1900 to 2000 lb. and to show a deflection of 0.3 in. before breaking. The weak point in these requirements lies in the fact that no direct connection is made between the loading and deflection, with the result that in many cases the test bars do not show 0.3 in. deflection until the load is in excess of 1900 or 2000 lb., oftentimes largely in excess. The author shows that of 2183 test bars broken by the Metropolitan Water Board of Massachusetts during the past 9 years less than a half showed the proper deflection at the specified load, which would indicate the use of metal of widely different quality, varying from very hard to very soft. The author objects to establishing a specified composition of the iron, but believes that permissible sulphur content at least should be specified. With this provision, together with a logical relation between flexure and breaking load fixed in the test-bar requirements, a long step forward toward uniform and satisfactory iron will have been taken. (*Engineering and Contracting*, vol. 57, no. 24, June 14. 1922, pp. 563–564, *p*)

Improved Nickel Silver. The appearance of stainless steel has called increased attention to the necessity of research in the field of non-ferrous alloys for the purpose of finding those having the same property of "stainlessness."

One such alloy recently developed is an improved form of nickel silver containing a much larger percentage of nickel than does the ordinary alloy. This metal is harder and of a color more nearly approaching that of silver than ordinary nickel silver and costs about one-third less than stainless steel or iron.

Furthermore, the same research has resulted in the production of a more homogeneous metal than formerly, and as this means greater ductility it will now be possible to make deep stampings and pressings from sheets of alloys with a high nickel content. It is stated that spoons and forks made of such alloy can be produced at less than half the cost of such goods made of stainless steel or iron. (*Brass World and Platers' Guide*, vol. 18, no. 6, June, 1922, p. 195, *g*)

FOUNDRY

Cast Nickel-Chromium Alloys, E. F. Lake. Description of melting and casting of three grades of nickel-chromium alloys as practiced by the Hoskins Manufacturing Co. of Detroit. One grade contains 80 per cent nickel and 20 per cent chromium, with only traces of iron; a second grade is composed of 85 per cent nickel and 15 per cent chromium; while a third grade carries 64 per cent nickel, 11 per cent chromium, and 25 per cent iron. Only electric furnaces are used for this purpose, the equipment consisting of one 2-ton arc electric furnace of the Heroult type, two induction electric furnaces and three crucible-type resistance furnaces. The metals used for making these alloys are chromium (free from all impurities except iron), electrolytic nickel, and a small amount of shot nickel; and for the third alloy, 99.7 per cent iron.

Carbon must be kept out of these alloys as it increases their tendency to oxidize at high temperatures; occluded gases are also very bad. One of the reasons for using shot nickel is because it reduces the hydrogen content in electrolytic nickel. Good chrome-nickel alloy can be made without shot nickel when nickel free from hydrogen (Mond) is used.

A melt in the induction furnace generally consists of from 550 to 650 lb. From 325 to 375 lb. of this is usually drawn off into the ladle for each cast. This leaves a heel of from 225 to 275 lb. to start a new melt. In that way each melt can be drawn off in less than two hours, or five melts in nine hours.

The molds have to be very dry. One way of accomplishing this is by a coil of resistance wire dropped into the mold and heated by an electric current. It would appear that the alloy flows freely and does not chill quickly enough to cause cold shuts. Tubes have been cast with 1-in. cores and $^1/_4$ in. of metal around them in lengths as great as 40 in. Considerable trouble was encountered at first, the greatest difficulty being to anchor the long core so that it would not sag or float. These tubes are cast in pairs with no risers. (*The Foundry*, vol. 50, no. 11, June 1, 1922, pp. 452–454, 6 figs., *d*)

FUELS AND FIRING

Froth-Flotation Tests on Bituminous Coking Coal, Oliver C. Ralston and Gaichi Yamada. Data of research on applicability of froth flotation to the treatment of the fine size of coals of the Pacific Northwest, carried on by the Northwest Experiment Station of the Bureau of Mines in coöperation with the University of Washington, at Seattle. Only the conclusions of this interesting article can be reported here.

Tests on a bony coking coal from the Wilkeson mine, at Wilkeson, Wash., have shown that the cleanest coal can be floated first, the bony coal next, and the ash last by ordinary froth flotation. Very thin oils or soluble frothing agents work best. The fine sizes of coal float the most easily and the coal in the very fine slime will float to some extent without the use of any flotation oil whatever.

Due to the tendency of fine sizes to float so easily, they are probably "overboiled" and produce dirty concentrate when enough oil is added to float the coarser sizes. Screen analyses of the flotation concentrate show increasing percentages of ash in the finer sizes.

To take due advantage of the above facts, it is necessary to use a flow sheet in which roughing treatment is followed by cleaning of both concentrate and tailing from the roughing cell, discarding as tailing material which will not float in any of the retreating cells. Retreatment of middling with original feed is not desirable except for the middling obtained in cleaning the rough concentrate.

By this method of treatment a clean concentrate can be obtained; the bony portion of the coal forms a middling which may have a market value, and the tailing is too low in coal to be of any value.

Attempts to control the flotation tests by sink-and-float tests with heavy solutions have failed on the fine sizes of coal, due to their supposed porosity. (*Chemical and Metallurgical Engineer*, vol. 26, no. 23, June 7, 1922, pp. 1081–1086, 2 figs., *eA*)

GAS PRODUCERS

Ash Fusion Gas Producers

Ash-Fusion Gas Producer, M. A. Fichet. Description of a type of gas producer in which the temperature is such as to obtain a fused slag. The idea basically is not new and was described by Ebelmen in a paper before the French Academy of Sciences in 1842.

The author also states that he saw in a small forge in Savoy an apparatus of this character which had been in operation for over twenty years. In developing apparatus based on this same principle the author made certain improvements, one of the first being the elimination of the use of steam and hot air and the substitution of cold air. It was found that complete fusion of the ash can be thus obtained, but not with every coal, as it was found that in various coals the fusion point of the ash varied from 1178 to 1500 deg. cent. In addition, it was found desirable to lower the melting point of the ash by the addition of fluxes, so as to produce a slag containing the silicates of several bases, alumina, lime, magnesia and the oxides of iron and other metals. The composition of this slag was found to resemble that of common glass.

Ashes of this composition when heated to proper high temperatures first soften, and then are converted into a pasty condition and finally melt. In softening, the material becomes sticky and has the tendency to agglomerate and form an impermeable mass with the fuel, preventing the passage of the gas through it. Furthermore this pasty mass tends to stick to the walls of the producer. In the pasty state of fusion the half-melted materials can surround the particles of fuel and subject them to the oxidizing action of the air. There are two dangers that must be avoided at this point. If the material sticks to the hot walls of the crucible, then the coal can no longer be fed into the crucible in a regular manner; if the cooled mass becomes covered over with a skin, then the regular course of the combustion is interrupted, the temperature decreases, the mass solidifies and it becomes necessary to break up the congealed mass with a pick, which is a very troublesome procedure.

It is for the purpose of avoiding this double danger that steam is introduced at the base of the boshes. When the water vapor comes into contact with the incandescent carbon it is decomposed, with the production of water gas. As this reaction absorbs a considerable quantity of heat, a sudden decrease in the temperature takes place, which allows the fulfillment of the condition that the high temperature of the crucible should not reach into the boshes.

There are therefore three successive stages in the gasification of the coal in this apparatus:

1 In the crucible—the production of producer gas, with fusion of the ash
2 In the boshes—drop of the temperature, with the production of water gas
3 In the shaft—distillation of the coal, with the production of illuminating gas.

In the case where coke is used as the fuel, the last step does not exist. The proportion of illuminating gas in the final mixture depends on the nature of the coal, i.e., whether it is high in volatile matter or not.

The gas produced from coke containing 15 per cent of ash had the following composition: carbon monoxide, 41.62 per cent; hydrogen, 1.08 per cent; carbon dioxide, 1.75 per cent; nitrogen,

55.55 per cent. Every kilogram of the coke gave 4644 kg. [this figure is obviously an error; perhaps, 4.644 cu. m. is meant] of gas, which had an average calorific power of 6100 cal. Such a product was obtained with the use of an air blast at a temperature of 300 deg. cent. and the injection of steam at a point above the lower end of the boshes.

In order to obtain the effective heat value of the gas leaving the gas producer, it is necessary to add the 998 cal., in the gas at the temperature of 760 deg. cent. to the above value of 6100 cal. On the other hand it is necessary to subtract 230 cal. carried out in the hot air leaving the gas producer at a temperature of 300 deg. cent., and the 293 cal. carried out in the steam. This leaves a final net value of 6554 cal. as the true heating value of the gas.

The thermal efficiency of the process is therefore 6554 cal. divided by 6868 cal., or 95.5 per cent. The 6868 cal. represent the heating value of 850 grams of carbon in 1000 grams of coal after the deduction of 150 grams of ash.

It is claimed that in gas producers operating with fusion of ash it is possible to build units capable of gasifying 2500 kg. (5500 lb.) of fuel per hr., and in addition it is possible to utilize coals of very poor quality. Thus, coke containing as much as 40 per cent ash can still be used in this apparatus and give gas of good quality.

There are now several types of gas producers which gasify coal with fusion of the ash. Among these the Rehmann producer is of particular interest because of its novel construction. This is a German invention and is shown in Fig. 4. The crucible is shown at *a*, the boshes at *b* and the shaft at *c*. A hole *h* is also provided for introducing a tool for raking the coal. The apparatus is a large one. The diameter of the crucible is 2 m., that at the center of the shaft 3.6 m. The producer is furnished with air and steam tuyeres. The shaft is surrounded with an annular chamber which is used to catch the dust that may be present in the gas. The cross-sectional area of this chamber is quite large, so that the gas passes through less rapidly. A valve is provided at the side of the chamber to release the pressure in case of an explosion.

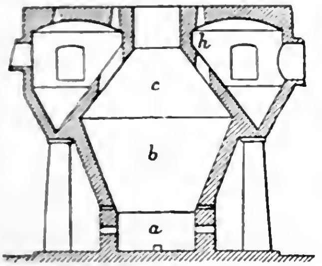


Fig. 4 Rehmann Ash-Fusion Gas Producer

While it is not certain that this apparatus has been used practically, it represents a distinct advance in design and indicates the interest that is being shown in this type of gas producer. The many advantages that it offers, the simplicity of construction, the ease of operation, the good quality of gas produced, the efficiency of the gasification, the low initial cost, all are said to tend to point to the ash-fusion producer as the logical gas producer of the future. (*American Gas Journal*, vol. 116, no. 24, June 17, 1922, pp. 550–552, 2 figs., *d*)

HYDRAULIC ENGINEERING

The Hydrautomat

The Hydrautomat. Description of a new and simple device by which a low fall may be transformed under certain restrictions into a high fall, or water can be lifted to a considerable height without the use of rotary or reciprocating pumps. The device essentially consists of a series of tanks connected by piping in proper ways.

The principle of the device is illustrated in Fig. 5. If we deliver water under a head into the bottom of a closed chamber *A*, the air in that chamber will escape upward if it possibly can. An air-vent pipe is therefore provided connected also to the top of another closed chamber *B* which is supposed to be full of water. Then if the air enters at the top of *B* it will exert pressure on the upper surface of the water. If there is a pipe from the bottom of the upper tank *B* to a still higher tank *C*, the water will be delivered into tank *C* provided the vertical distance is within limits. Now, assume that the process is reversed and that if water is discharged into *A*, the lowest tank of the three, it shall fall through a discharge pipe to the ground. A partial vacuum is thus caused at the top of the tank *A*, hence, also in the second or intermediate tank *B*. Evidently, if we throw open a valve which allows tank *B* to suck up water from below, it will replenish itself with liquid to replace the outgoing air. Here atmospheric pressure is used and a column of air acts to some extent as the piston of a pump. This combination of atmospheric pressure with the pressure of water is what constitutes the novel principle of the hydrautomat. The inventor, T. G. Allen, uses compressed air for his forcing stroke, obtaining the compression by falling water and a partial vacuum for his suction stroke, this vacuum also due to falling water.

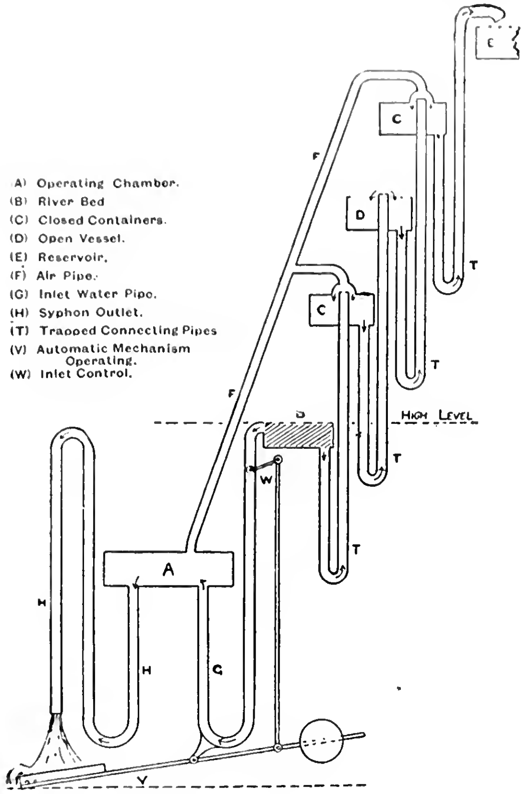


Fig. 5 Diagram Showing the General Principle of the Allen Hydrautomat

The cycle of the hydrautomat is as follows:

Pressure Stroke. This is caused by the weight of the water column, which flows into the closed chamber *A* at low level from the head race; this incoming water compresses the air in this closed chamber, and forces it out along the air-conducting pipe, whence it enters an overhead closed tank (or tanks). The effect is that the water in the overhead tank *C* is, in its turn, forced out and pushed up into a still higher tank *D*. This is an open one. One complete flight of the ascent is thus accomplished. At the end of this pressure stroke the closed operating chamber *A* at low level and the open tank *D* are full of water, but the overhead closed tank *C* is full of air.

Suction Stroke. This is governed entirely by atmospheric pressure. The contents of the closed chamber *A* at low level are drawn down, and discharged into the tail race. Simultaneously the inlet from the head race is automatically closed. The closed operating chamber then begins to feel a vacuum, and this vacuum extends

to all the other higher closed tanks through the medium of the air-conducting pipe. In consequence, the water in each open tank (these being now full) is sucked up one flight into the next higher closed tank. At the end of this suction stroke the operating chamber and open tanks are empty and the closed tanks are full of water. The inlet from the head race is then automatically opened, pressure water is admitted, and the pressure stroke is recommenced.

The pipes between the tanks are all water sealed, so that all non-return valves or mechanical checks are dispensed with. The apparatus has no moving parts other than an opening and shutting sluice gate. It is entirely self-contained, and provides its own motive power. The operation is continuous. The contrivance requires no housing, attention, or supervision. There is nothing which can wear out or lose adjustment. It may be constructed from timber, steel or concrete; in fact, from any material which can be made watertight, or practically so.

The inventor claims for his device an efficiency of 80 per cent. It should be clearly understood, of course, that only part of the falling water is lifted to a greater height and the proportion of water lifted is dependent on the height, so that, for example, if we have one gallon a second falling 3 ft. over a sill, this can be converted into 8 gal. per sec. falling through 30 ft. It is expected that this device might be extensively used for purposes of irrigation. (*The Electrical Times*, vol. 61, no. 1600, June 15, 1922, pp. 573–574, 2 figs., *dA*)

INTERNAL-COMBUSTION ENGINEERING (See also Railroad Engineering)

Siemens-Halske 60-Hp. Five-Cylinder Radial Air-Cooled Engine. Under the Versailles Treaty Germany is limited to the use of engines not exceeding 60 hp. for single-seater civilian aeroplanes for the next two years. Because of this limitation of power, one may look forward to see considerable progress made in the efficiency of German aircraft. Since the Germans, if they wish to fly at all, will have to make such improvements in aircraft as will enable them to do the work with the limited power permitted.

The new Siemens-Halske engine comes within the permissible limits of power. No figures as to weight, revolutions, fuel consumption, etc., are available. It is known that the engine has five cylinders and is of the four-stroke type with two valves to each cylinder. The bore is 100 mm. and the stroke 120 mm. The cylinders are of steel with aluminum jackets having fins machined on them for cooling and the pistons are of aluminum or aluminum alloy.

The inlet valve is operated by double rockers actuated by a push rod from the cam gear on the front of the engine. The exhaust valve is operated also through push rods by a single rocker arm placed between the two rockers of the inlet valve. All rocker arms are carried in ball bearings.

The valve-stem guide of the exhaust valve is situated inside a tubular T-piece, so that the exhaust gases escape through two openings. It is believed that the manufacturers have designed a standard exhaust-ring collector for this engine, so that from each exhaust-valve cage, two short L-pipes run to the exhaust ring, which is placed behind the cylinders and from which a single exhaust pipe projects upward. In the standard form the engine is provided with one magneto and one spark plug per cylinder, but dual ignition may be installed. (*Flight*, vol. 14, no. 23/702, June 8, 1922, pp. 326–327, 3 figs., *d*)

MACHINE PARTS

Autopitch Gear

Autopitch Gear. Description of a new gear proceeded by a brief historical discussion on gearing in general.

In starting on his work the inventor of the autopitch gear, W. Rus Darling, compiled the following list indicating the requirements of a perfect gear: (1) Strength sufficient to insure safety; (2) durability unlimited; (3) adaptability to all possible variation of conditions; (4) elasticity sufficient to absorb unavoidable vibrations of other parts; (5) noiselessness approaching to silence; (6) economy both in cost of production and in power. Of this list the third requirement appears to be the most difficult to fulfill, the others being within the scope of modern knowledge and practice.

In considering various types of gears, the author came to the conclusion that the old mill wheel with its continuous stream of water "gearing" into it, adapts itself to almost any conceivable variation of a nature corresponding with those to be met with in mechanical gears. If the mill stream could be rolled up into a circle of a suitable diameter and provided with a shaft and bearings, it would form a pinion of the required adaptability. Machine-cut teeth are not always correctly shaped. The bearing between opposing teeth may be only at a point, or points, instead of on a line the full width of the wheel. But even this line contact when acquired is not a mechanical ideal. Teeth slide as well as roll and concentrated pressure and friction are therefore of great importance, and it is only the high quality of the material available that enables thousands of horsepower to be transmitted through one, two or three lines of contact of 1-, 2-, or 3-ft. lengths.

The oil film plays an important part. If this volume of oil is actually constant it must be concluded that the pressure, the wear, and the transmission are all effected through its medium. It is estimated that in modern high-speed gears the period of contact is about one one-thousandth of a second, and from that fact is deduced the retention of the oil film.

From the foregoing it may be reasoned that the thicker the film the better, and to carry this reasoning to its logical end, if the teeth of one wheel were eliminated and only the oil left, the theory of the endless mill stream would be realized in practice. While this cannot be actually done, the question is how near can one get to a continuous oil film.

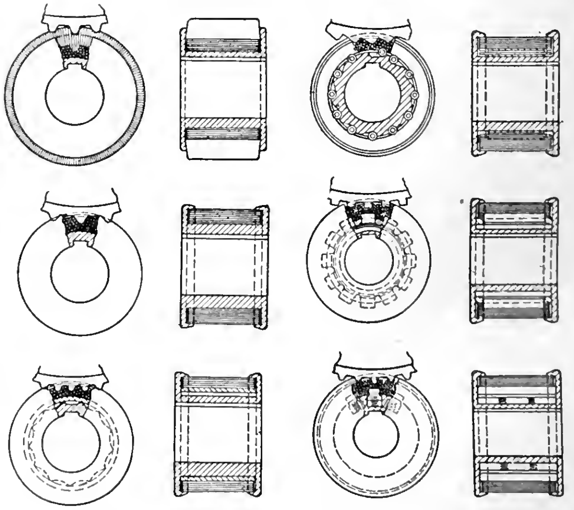


Fig. 6 Autopitch Gear

Reverting to the rational forms and materials of gear teeth, it is found that the finer the pitch, the closer together and therefore more nearly continuous become the successive films of oil. But if the teeth are made too fine to carry the load, all the advantage is lost. It must be concluded, therefore, that for the present, at least, the continuous film is impossible in practice. On the other hand, however, there is an element which is neither a fluid nor a solid and yet possesses something in the nature of both. The only familiar form of it is found in balls. If a number of balls are poured into a vessel, they will find a common level; if run out on a table, they will behave much like water. Rollers behave somewhat similarly but can only flow in two opposite directions, and it is this limitation that enables them to be harnessed in the form of an endless mill stream within the compass of an ordinary pinion as indicated in Fig. 6. This illustration shows how this "semi-fluid" can be controlled and kept in its appointed place. The density of the element may be varied by having more or fewer rollers in a given space; each roller being supported by all the others; their individual diameter does not materially affect their strength as a combination, which, in fact, forms one solid "fluid" tooth, equal in thickness to almost the circumference of the pinion.

Reverting to the "absurd" proposition of a continuous oil film, it may be seen how nearly approach has been made to its realization. It is at once apparent that each roller provides a line of contact with the engaging wheel tooth, so that, instead of one line of contact per tooth, there is a number varying with the depth of gear mesh. Further, each roller has a film of oil over its entire length and circumference, therefore there is actually that continuous oil film which was previously thought absurd. Not only that, the metal-roller element upon which the film is built is almost as fluid as the oil itself.

The pinion of the construction shown is able to accommodate itself to any straight tooth in a wheel and will continue to do so until the tooth is entirely worn away. It is therefore independent of the contour and thickness of the tooth; also the teeth may engage with it at any point of its circumference and the engagement is thus independent of pitch. This eliminates the necessity of having the teeth geometrically designed and also indicates that irregularity of pitch and missing teeth will not interfere with smooth and continuous running. Further, there are no tooth clearances and therefore no backlash. Other irregularities are provided for in the fact that the rollers are free to incline in either direction across the face. The alignment may be faulty, parts may expand or contract, the foundations may warp and twist without materially affecting the gear. (Paper read before the Institution of Engineers and Shipbuilders in Scotland, abstracted through *Engineering Production*, vol. 4, no. 88, June 8, 1922, pp. 545–548, 24 figs., *dA*)

MACHINE SHOP

Grinding-Wheel Breakage and Its Causes, Harold E. Jenks. A general discussion of the causes producing stresses that result in wheel breakage. The author lists eleven primary causes that may produce the breakage of a grinding wheel while in operation. Among these, particular mention may be made of overspeeding and heating of the wheel. As regards overspeeding, the author states that reliable grinding-wheel manufacturers test all wheels before they leave the factory by running them at a speed approximately twice that for which they are designed and recommended, thus obtaining a factor of safety of about four, and because of this breakages due to speed are few in number. They occur occasionally from such causes as shifting thoughtlessly from large to small pulleys, placing wheels of large diameter on spindles running at speeds intended for smaller diameter, or substituting for a wheel running at the correct speed, one of different grain and grade designed for lower wheel speeds. In other words, most of the breakages due to overspeeding are really due either to carelessness or ignorance on the part of the operator.

As regards heating of the wheel, the author states that stresses due to this cause and produced by the unequal expansion of different parts of the wheel may account for many breakages. Stresses produced through excessive heating of the wheel are similar in character to those produced by centrifugal force and are of two kinds, radial and tangential. The greatest tensile stress is apt to occur at the circumference of the hole and hence combines at that point with the maximum tensile stress due to the centrifugal force. This is important as both these stresses may be large and their resultant may easily cause breakage.

A few years ago the writer assisted in making some tests of the effect of heat alone upon grinding wheels. An electric heating coil was arranged to cover the entire surface of the face of the wheel to be tested, and heat was gradually applied. The wheel was not in motion, so that the effect could be due only to heat. At a temperature of the circumference averaging from 70 to 115 deg. cent., the wheels tested cracked along the diametral plane, some with sufficient force to entirely separate the two halves of the wheel. With the heat thus applied, from 40 to 70 min. elapsed before breakage occurred. It should be borne in mind that the stress due to centrifugal force was not present in these tests, so that it is reasonable to conclude that under similar heating conditions a wheel of the same type in operation would break at a still lower temperature and probably in a shorter time. Actual heat breakages in operation are in very close agreement with this condition.

As stated above, the typical heat break is a diametral crack, the same as in the case of breakage due to centrifugal force. It is evident that a fracture resulting from a combination of heat and speed stresses would be of the same type.

Tight or insufficiently lubricated bearings on a grinding machine may cause heating of the spindle wheel. In case the wheel bushing fits the spindle tightly, the expansion of the latter may cause tensile stresses of considerable magnitude in the wheel. This is clearly the case of a thick cylinder under internal pressure. The stresses produced are similar in character to both those due to centrifugal force and those due to heating of the wheel. They are of two kinds, radial and tangential, as in those cases, and the maximum tangential tensile stress occurs at the circumference of the hole. Hence the maximum stresses would combine at that point and breakage might occur from the resultant stress. The typical break due to heating of the wheel spindle would be a diametral crack, as in the case of breakage due to centrifugal force. (*American Machinist*, vol. 57, no. 3, July 20, 1922, pp. 98–100, 3 figs., *pe;* serial article)

MACHINE TOOLS (See also Machine Shop)

Electrodepositing Iron on Steel

"Putting on" Tool for Steel Parts, David R. Kellogg. Description of apparatus and process for electrodepositing iron on steel. The process is a development of the method first described by Thomas and used in the British Army repair shops and also in commercial work. The solution used by Thomas consisted of 75 grams of crystallized ferrous ammonium sulphate per liter of water and was used cold at low current density, namely, 0.33 ampere per sq. dm. Under these conditions the deposit was smooth, bright and adherent, and withstood bending and chipping.

The extensive series of tests undertaken at the Westinghouse Research Laboratory made it possible to lay down a fairly definite set of rules of procedure, by following which one could be sure of a good coating. After most of the grease had been removed from the piece to be coated, and the portions on which no deposit was desired had been covered with a mixture of 90 per cent hydroline (M.P. 100 deg. cent.) and 10 per cent paraffin, it was made the cathode for three minutes in a 10 per cent solution of commercial lye and sal soda in equal proportions. From three to five amperes per square inch were used in this portion of the cleaning—the exact figure, as well as the exact concentration of the solution, being, according to the original article, of no moment. The piece was then washed in running water and made the anode for an equal time in 30 per cent commercial sulphuric acid, using about the same current density. In the acid-cleaning bath it is important to have the current density sufficiently high so that the iron becomes passive and gasses freely. If too low a current density is used, the piece is attacked by the acid and cleaning does not take place. With sufficient current to produce passivity, as indicated by free gassing of the work, the piece comes from the acid-cleaning bath with a beautiful pearly luster, and upon washing in running water and transferring to the plating bath without touching in any way the cleaned portion or allowing it to dry, a satisfactory coating is obtained. While the work is in the acid-cleaning bath, any motion of the work will sometimes result in a decrease in current and cessation of gassing of the work, showing that it has become active, i.e., is being attacked by the acid. When this tendency is very pronounced it is an indication that the current density is too low. After cleaning in this manner and transferring immediately to the plating bath, it was found possible to produce satisfactory coatings at the rate of 0.0059 in. per hr., corresponding to a current density of 1 ampere per sq. dm., which is three times the rate attained by Thomas.

This process gave smooth, tough, adherent coats which, when deposited on a carefully ground rod 0.485 in. in diameter and then ground to a thickness of 0.001 in. (0.025 mm.), could be pressed through a hole in 1-in. cold-rolled steel 0.0005 in. smaller than the finished size of the rod, and then pressed back again with no signs of stripping. These test rods could be bent and mishandled in various ways with no damage to the coat.

A motor shaft having bearings 0.625 in. in diameter by 1.5 in. long was purposely finished 0.002 in. small in diameter, plated oversize, reground on proper dimensions, and then assembled

and run in bronze bearings for 1000 hr. with a load of 50 lb. per sq. in. of projected area, using a short stiff belt with a clipper joint in order to give a pounding effect as well as friction. At the end of the run it was found that the wear was 0.0002 in., which is just a trifle less than the original material shows in factory life tests. Plug and thread gages have been repaired by this means and have given good satisfaction, although they are not as hard as heat-treated tool steel.

Next, experiments were made with hot concentrated bath and stirring, the solution used being 300 grams of ferrous ammonium sulphate per liter. The deposits obtained with useful current densities up to 10 amperes per sq. dm. were softer than those from the cold bath, perfectly adherent and of a velvety appearance. This method gave a greater increase in the rate of deposit than corresponded to the increase in current density.

One of the uses suggested for the deposition on cast iron is in giving cast-iron bearing shells a preliminary coating of pure iron so that they may be tinned and the babbitt made to adhere directly to the shell as in the case of bronze shells. This would do away with the necessity for the anchor holes and enable the use of a layer of babbitt about one-third as thick as that used in cast-iron shells with anchor holes.

Attempts to produce a coating while the work was revolving in a horizontal position did not succeed. On the other hand, numerous tests on the working qualities of deposits produced by the successful methods proved the high quality of the material of the coatings and their perfect adherence. While there are several methods of producing good-looking deposits, such deposits for all their good looks may prove to be hard, brittle and lacking in adherence. It seems that only by bending, hammering and cutting can a satisfactory test of working qualities be obtained. (*The Electric Journal*, vol. 19, no. 6, June, 1922, pp. 249–251, *ep*)

Tool for Turning Down Nuts. Description of an electric tool designed for turning down nuts, cap screws, wood screws, and similar fastenings, and arranged to operate in either direction. The machine may be made either stationary or portable. The novel feature is the driving mechanism of the tool, which incorporates a multiple-disk slip clutch, adjustable for any tension within the capacity of the motor and operating through a spline shaft to a positive clutch. The arrangement is such that the positive clutch automatically disengages when the disk clutch fully releases, thus relieving the driving spline from torque. This permits the removing of the wrench, chuck or screwdriver from the driven member and their engagement with the new nut or stud while the motor is running at full speed. The motor can be overloaded or burned out, as the clutch can be tightened to a degree that will stall the motor. The speed of the driving spindle of the machine is variable and during the actual setting-up operation is only about one-third of the speed prevailing while the nut or screw is being driven down. The motor can be reversed by means of a special reversing control mechanism. (*The Iron Age*, vol. 110, no. 3, July 20, 1922, p. 146, 3 figs., *d*)

MARINE ENGINEERING (See Power-Plant Engineering)

METALLURGY (See Special Processes)

New Process for Mechanical Puddling. Description of an installation and process in an American plant (Titan Iron & Steel Co., Newark, N. J.). The principle of the process, which is the invention of Henry D. Hibbard, is in producing an intimate mixture of molten iron and oxide of iron by making the charge of the mixture pour repeatedly over a dam in a thin stream in an oscillating furnace.

The melting stage is carried on in a cupola from which the molten iron goes into the puddling furnace, where the operations of purifying, boiling and balling follow mechanically the hand method. Essentially, the furnace consists of a cylinder of steel plate about 6 ft. in diameter and 5 ft. 6 in. long with projecting trunnions 18 in. in diameter. The cylinder is lined with magnesite brick to an inside diameter of about 4 ft. The dam, which consists also of magnesite brick, extends up nearly to the center line. The operation is carried on at a temperature of about 2650 deg. fahr., the flame temperature (oil fuel) being 2850 deg.

As soon as the iron begins to form into a ball, the oscillating motion of the furnace is stopped and it is rotated clear over. The ball is carried to a squeezer, where it goes down through a passage of continuously decreasing dimensions and thence it is expelled in rough cylindrical form at the far side, free from surface slag and prepared for the breaking-down rolls. The iron is used largely for pipe and sockets, engine bolts, staybolts and high-grade merchant bars. Its physical properties are reported to vary in tensile strength from 45,000 to 52,000 lb.; elongation, 15 to 30 per cent. The original article gives some photomicrographs of mechanically puddled iron and a view of the installation. (*The Iron Age*, vol. 110, no. 3 July 20, 1922, pp. 143–145, 7 figs., *d*)

MOTOR-CAR ENGINEERING (See also Railroad Engineering)

10-Hp. Trojan Motor Car. This car, of British construction, has several unconventional features. The chassis may be described as a shallow box or tray, in and across which is mounted a two-stroke power unit and epicyclic gear, and at the corners of which are attached semi-elliptic cantilever springs supported at their free ends on tubular axles.

The engine has four cylinder bores arranged in a square in a single casting. It is, however, of the two-cylinder, two-stroke, three-port type, for each pair of cylinders has a common combustion chamber and a single spark plug. In each cylinder there is a three-ringed cast-iron piston with a long skirt and a plain head, the usual deflector employed in the majority of two-stroke engines being absent. The camshaft has two throws at 180 deg. The inlet pipe is taken to the center of the cylinder block and is led down between the cylinders where it branches into ports formed in each of the two lower cylinders. The opening of the ports is controlled by the difference of movement of the pistons due to the offsetting of the cylinders in relation to the crankshaft. As the pistons travel toward the top of the cylinders the mixture is drawn through the inlet port in the lower cylinder into the crankcase until the transfer port at the side of the upper cylinder is encountered, when it rushes through to the combustion space and is compressed there as the pistons ascend and draw in the next charge from the crankcase. As the pistons approach the top of this compression stroke, the mixture is fired by the spark plug in the upper cylinder. The upper piston is just behind the lower piston in its travel and there is a movement of the now burning mixture in the upper combustion chamber through the connecting port to the lower combustion chamber, so that turbulence of the gases is permitted right up to and during the period of combustion. As the pistons pass down the cylinders on the power stroke, the mixture in the crankcase is being compressed ready for transfer, and owing to the lead of the exhaust piston, the exhaust port in the lower cylinder is opened before the transfer port is uncovered. Thus the gas follows a circular path in its passage through the engine, for it enters at the base of the lower cylinder, passes through the crankcase, through the transfer port to the upper cylinder, thence to the lower cylinder, and out through the exhaust port.

The original article contains interesting details as to the lubrication and transmission system and it is stated that notwithstanding the use of solid tires, the riding in the car is comfortable. The body work is described as an "occasional" four-seater, for although four adults may be carried with ease, owing to the limitations imposed by wheelbase and the special design of the chassis as regards springing, the leg room is hardly sufficient for a long journey. (*The Autocar*, vol. 48, no. 1392, June 24, 1922, p. 1071–1072, 7 figs., *d*)

POWER-PLANT ENGINEERING (See also Steam Engineering)

Condenser-Tube Packing. Discussion of the subject, with particular reference to corrosion and crushing of tubes, and description of the John Crane flexible metallic-ring packing.

The author claims that corrosion is assisted by the insulation of the condenser tube from the iron shell by non-metallic packing, either at one or both ends, and that it may be reduced or eliminated

by bonding the tubes in good electrical contact with the tube sheets at both ends. It is said that the John Crane packing provides such a bond and in addition does not deform the tube at the point of packing contact.

In this particular device metal rings are used as packing material. These rings are built of many spiraled layers of very thin babbitt foil, so that while they are of metal they are also flexible and compressible. Each ring is die-formed so that it fits accurately the stuffing box for which it is intended.

In addition to this, special so-called expansion rings are used and each tube end requires two metal rings and two expansion rings, the expansion rings being apparently of fabric (asbestos). A special tool may be used for installing both types of rings. This tool may be of the hand-operated type for small condensers or of the pneumatic type for large condensers. (*The American Marine Engineer*, vol. 17, no. 6, June, 1922, pp. 25–31, 19 figs., *d*)

RAILROAD ENGINEERING

Gasoline-Driven Passenger Rail Cars

Some Recent Developments in Gasoline-Driven Passenger Rail Cars, W. L. Bean. An extensive paper covering the subject of design of gasoline-driven passenger rail cars. The general field of utility of this type of rolling stock is for short-line railroads where traffic is not sufficiently dense to pay for operation by conventional steam trains.

Self-propelled railway cars have been in use for a considerable number of years, but it is only quite recently that they have found extensive application.

The author believes that the gasoline engine may be the main type in use, although light-weight Diesel-type machines may offer competition, and even steam is not out of the running on self-propelled rail cars. While the gasoline mechanical drive is at present in the forefront, there is a renewed interest and endeavor to revive the gas-electric system along new lines embodying lighter construction and less power than formerly used.

Many railroad men have been extremely doubtful about the success of a single pair of wheels operating on rails at speeds necessary for passenger service. It can be stated, however, that the greatest success has resulted and over a sufficient period of time to demonstrate there is nothing to be feared in the trailing of a single pair of wheels under a car of this sort. It is not recommended, of course, that cars be operated at high speed in reverse motion, but even so, it has not been noticed that any difficulty has been experienced in backing six-wheel rail cars; the usual backing movements being under speeds of 25 m.p.h.

In further consideration of the six-wheel arrangement, it may be stated authoritatively that there is no advantage in using more wheels under a car which can be propelled by any of the existing automotive-truck power plants. However, in order to secure acceptable riding qualities in the rear of a six-wheel vehicle, it is desirable to have a wheel of a relatively large diameter; namely, 36 to 40 in., and arrangements to absorb shocks by rubber and other devices in connection with springs. Special consideration should be given to keeping the unsprung weight to the absolute minimum.

Very casual investigation of the operation of six-wheel rail cars shows low operating costs per mile. Cars built on two- to three-ton chassis will travel eight to eleven miles per gallon of gasoline, and cars built on five-ton chassis from four to six miles. The consumption, of course, depends on atmospheric temperature, length of run, loading, grades and especially speed. Maintenance should not exceed five cents per mile on the smaller car or eight cents per mile on the larger ones, over a considerable period of time. Other operating and maintenance costs depend on local conditions, particularly as to wages. One man is required for the mechanical operation of the car, but whether he can handle the collection of tickets and the performance of such other duties, depends altogether on local conditions, and each railroad man can figure that out for himself. First cost of a car of the smaller type is usually around $9000, and of the larger one, around $16,000, depending on the refinements of construction of chassis and body, and particularly whether or not the body is built for severe or mild weather conditions.

The use of self-propelled cars may be novel to railroad men accustomed to think only of trains containing a multiplicity of units, and an earnest study of the engineering problems of single self-propelled car operation is important, as it will lead to better development of this class of rolling stock.

While, under some conditions, trailer operation may become desirable, the need at present is to develop a real single unit within the limits of weight carried by two 4-wheel trucks. The author discusses in detail some of the engineering features involved, one of which is the relation between engine speed and car speed, especially from the standpoint of vibration; and also the comparative features of gear-driven and gas-electric types.

The problem of heating self-propelled cars is discussed and some data given on wind resistance, chiefly taken from previously known sources.

In the discussion which followed, J. C. Cain, manager of purchases, American Short Line Railroad Association, has given some of the figures on the cost of maintenance and operation, as follows:

"We were furnished records of cars that had made as high as 300,000 miles, and which had been in practically continuous service for a period of five years. The operating cost varied from 10 to 25 cents per mile, and gasoline consumption from 5 to 10 miles per gal.

"We found maintenance cost surprisingly low, averaging about $15 per month on these smaller-type cars, and only slightly above this on the larger ones. By smaller type I mean those using a two and one-half or three-ton motor-truck chassis, and by larger cars those using five-ton chassis. The operating cost of 10 cents per car-mile was, of course, confined to the former, which were being operated by one man. But some of the larger types using two men were being operated at as low as 20 cents per car-mile, as follows:

Gasoline	$0.030	per mile
Labor, 2 men at $125 per month	0.085	" "
Depreciation, rate 12½ per cent	0.042	" "
Interest and insurance	0.022	" "
Maintenance	0.021	" "
Total	$0.200	per mile

"These figures were made on a basis of $12,500 purchase price of the car, and an operation of 106 miles per day." (*Official Proceedings of the New York Railroad Club*, vol. 32, no. 7, June 19, 1922, pp. 6713–6726, illustr., and discussion pp. 6726–6744, *g*)

Diesel-Electric Motor Cars for Railway Service in Sweden. The first Diesel-electric car in Sweden, built in 1913, had an engine of 75 hp., but lately cars have been built of 160 hp. and 250 hp., both types being now in regular service.

Cars of 160 hp. weigh 37,500 kg. (82,500 lb.) and, when grades do not exceed 1 per cent, are capable of hauling a trailing load of 67½ metric tons (74¼ short tons) at ordinary speeds. This is a total train weight of 105 metric tons (115½ short tons). Cars of 250 hp. weigh 50,000 kg. (110,000 lb.) and under the same conditions can haul a trailing load of 115 metric tons (126½ short tons), which corresponds to a train of 165 metric tons (181½ short tons), including the motor car. Plain trucks are used on the engine-compartment end of these cars, and motor trucks, one motor for each axle, under the other end. The cars can be operated equally well from either end. With the passenger cars used in Sweden, which are much lighter than are customary on American roads, the 160-hp. car can haul a train with about 225 passengers, while the 250-hp. car can haul a train holding 375 passengers.

When hauling full trains the fuel-oil consumption for the 160-hp. engine should average about 0.7 kg. per train-kilometer or 2.5 lb. per train-mile, while the consumption for the 250-hp. engine should average about 1.0 kg. per train-kilometer or 3.5 lb. per train-mile. Oil records of a 160-hp. motor car for an extended period in regular service handling a train of metric tons (99 short tons) showed a fuel-oil consumption of about 0.5 kg. per kilometer or 1.8 lb. per train-mile. By weight, the fuel-oil consumption of the Diesel engines averages about 6 per cent of that of the coal used by steam locomotives of the same power.

The 160-hp. engine has eight cylinders and the 250-hp. twelve cylinders, but otherwise they are similar in general design to the

smaller engines. A number of improvements have, however, been introduced in the later designs of motor cars. The cooling water for the Diesel engines in now recooled in a number of radiators similar to those used for gasoline motor trucks, mounted on the roof of the car as shown in one of the illustrations in the original article. Cooling is effected by means of a fan blower driven directly from the main engine and is thus independent of speed. The motors are now arranged to be connected either in series or in parallel.

In addition to low fuel costs, one-man operation, and little time or attention required at terminals, experience has shown that Diesel-electric motor cars can make a greater mileage per day, spend less time in the shop, and run for much longer periods without a general overhauling than steam locomotives. They are capable of making 50,000 to 60,000 miles per annum. Even after being taken in for overhauling after some 60,000 miles, it has been found that the largest item of expense is for dismantling and reassembling.

While the Diesel motor car or locomotive will undoubtedly be still further perfected and adapted to a wider railroad field of usefulness, indications point to a much more general employment of this type of motor in the near future. (*Railway Mechanical Engineer*, vol. 96, no. 6, June, 1922, pp. 314–315, 2 figs., *d*)

The Steam Unit Car, E. S. French. Brief data on a self-propelled steam-driven car. The car weighs in the vicinity of 60,000 lb. and uses oil as fuel. The boiler is of a water-tube sectional design.

The main engine is of the two-cylinder piston-valve type. At 800 lb. pressure the mean effective steam pressure at cylinders is around 450 lb. Temperatures of superheated steam run from 450 to 800 deg. fahr. The speed of the engine is quite low. At 25 m.p.h. the engine makes approximately 270 r.p.m. and at 60 miles, approximately 890 r.p.m. The horsepower developed at maximum speed would be about 1000 hp. (*Official Proceedings of the New York Railroad Club*, vol. 32, no. 7, May 19, 1922, pp. 6745–6746, *d*)

SPECIAL MACHINERY

An Automatic Hot-Billet Scraper, R. C. Rohrabacher. The method now generally employed for removing surface defects on billets before they pass to the finishing mill involves the use of air hammers and chisels, which is expensive and unhandy.

The new mechanism is to be set up between two of the stands of rolls in the series, and another precisely like it installed immediately following the last stand of rolls so that the billets leave the second scraper machine ready to be finished into whatever final product the plant makes.

The mechanism comprises sets of stellite scrapers designed to engage the surfaces of the passing billets at whatever pressure may be required to remove the flaws, means being provided also for automatically guiding the billets to the scrapers. Pressure is applied independently to each scraper blade, each machine having four cylinders, two of which operate horizontally and two vertically. The apparatus may be operated under air, steam, or water pressure.

Stellite is used for the scraper knives because of its high degree of red-hardness. (*The Irom Age*, vol. 109, no. 17, Apr., 1922, pp. 1126–1128, 5 figs., *d*)

Hydroelectric Bloom Shear. A new type of shear has been developed for cutting hot blooms as they come from the blooming mill in plants driven entirely by electricity. The new element which makes it possible to provide a powerful hydraulic shear with the advantages in speed possessed by a steam-hydraulic shear is a motor-driven hydraulic intensifier.

Hydraulic pressure for the lifting cylinders and the gag cylinder is supplied by a separate hydraulic accumulator directly connected to them by pipes and at a constant pressure of 1000 lb. per sq. in. Low-pressure water for the intensifier and the main hydraulic cylinder is supplied from a prefiller tank under an air pressure of about 60 lb. per sq. in. This makes the whole water system a closed one in which the only water wasted is that lost by leakage.

Power to the intensifier is supplied by a flywheel motor-generator set to a direct-current shunt-wound reversing motor of 700 hp. with a full-load speed of 86 r.p.m. This motor, through a pinion and rack, operates a hydraulic ram with a working stroke of 14 ft. running in a cast-steel intensifier cylinder. The intensifier unit has a length of about 63 ft. overall. (*The Iron Age*, vol. 109, no. 16, Apr. 20, 1922, pp. 1078–1079, 4 figs., *d*)

SPECIAL PROCESSES

Calorization, Prof. Leon Guillet. The author discusses in a general manner the various processes for protecting against external chemical action of surfaces of metallic objects, in particular the process known as calorization.

He became interested in this process in 1915 when he was searching for a method of protecting in case-hardening the parts of the surface where it was desirable to preserve the original properties of the material. There were several methods considered, such as a clay coating, immersion of the article in a bath of sulphate of copper, deposition of metal by the Schoop process, and electrolytic deposition. All of these methods, however, proved unsatisfactory in one way or another and then calorization was resorted to.

It is of interest to note that the author obtained apparently satisfactory results by calorizing not only iron and steel articles, but also articles made of copper and copper alloys. He found, however (the same as in this country), that the calorized surface is very hard and unsuitable for machining, so that all parts of calorized objects must be machined before calorization. Moreover, calorization is an expensive process, especially on pieces of any considerable dimensions, and is entirely unapplicable to very large pieces, which makes it desirable to evolve some method for producing the same result by simpler means.

In this connection it is stated that in 1919 in Germany attempts were made to calorize grate bars on four freight locomotives of the Prussian State Railways by the Schoop process, and that the very first tests showed that the resistance of the grate bars so treated was four times that of untreated bars. Similar experiments on grate bars of express locomotives have shown that while non-treated bars have to be replaced every six weeks, none of the treated bars showed any appreciable signs of wear after a service of four months. Similar experiments are being carried out on a large scale in Denmark. One of the interesting features discovered in the experiments made in Germany is that clinkers do not stick to the treated grate bars, which materially reduces the work of cleaning fires. Alumino-treatment by the Schoop process is said to be much simpler, cheaper and of more general application than calorization. At the same time it requires probably the observance of certain precautions, and the author states that he knows cases where the aluminum layer peeled off. (*Bulletin Technique du Bureau Veritas*, vol. 4, no. 4, April, 1922, pp. 83–86, 3 figs., *deh*)

Wire Manufacture in England and France, Kenneth B. Lewis. A brief description of the processes used in Europe as compared with American processes, of particular interest because it shows the reason for the difference in practice in the various countries.

In the opinion of the author the British make better wire than the Americans, largely because in America a good deal of the wire produced by the wire-drawing mills is consumed by some finishing department of the same concern and the raw material, in this case, wire, can be made cheaper if the finishing department can make a product less accurately sized. In England, the wire maker buys finished rod and sells the wire, as, for example, to the nail maker. The latter demands first-class wire in order to maintain a high output from the nail machines, and the wire maker has to deliver such wire and insists on getting high-grade rod.

Furthermore, the wire drawer and the nail maker are 100 per cent unionized. They are on a piece-work basis, and if they do not like the raw material they get, they walk out.

The labor union is the outstanding factor in the industry from every angle. In conditions under which the American wire drawer handles four, five and even six blocks, the British wire drawer is permitted by the union to run only two. He has an abundance of time on his hands, which makes it possible for the boss to insist on a high degree of accuracy in the finished product.

The wire drawer is required to fix his own dies. He points his wire frequently with a hammer and anvil. The arrangement is crude and wasteful of time, but the wire drawer has time to waste.

In some mills the wire drawer must walk into the baker, pick up the bundle of rod on the floor and carry it in his arms to the bench—at that the rod bundles are small. The practice is apparently wasteful of time, but the wire drawer's time is paid for anyway and does not cost the boss anything for these particular operations. The expenses for improved machinery for production and handling of large bundles would fall on the proprietor, while all the profits would go to the union wire drawer, which is the reason for maintaining the current practice.

The British wire drawer is a highly skilled artizan. He serves a long apprenticeship and works his whole life at the bench. He knows instinctively how to vary his drafting and the shape of the die hole to suit the variations in the stock, and he does make beautiful wire.

British wire-drawing companies are old concerns firmly established, mostly family affairs. Consolidations are not usual, some of the reasons being psychological and others due to the difficulty of buying land that would be necessary for a consolidation involving expansion. There is practically no land held for speculative purposes. Land may be leased, but, generally speaking, cannot be bought, and people are reluctant to invest in a big undertaking on leased land. Furthermore, the established units of business are chiefly in congested districts and if they are to be brought together, it must be in a new place. If this should be done, it is an open question as to whether the workmen will follow the plant. The British workman does not care to change from place to place, and the British manufacturer cannot count on attracting to a new location a sufficient number of floaters. There are no immigrants in England, no great floating body of unattached young men ready to be shaped into skillful or semi-skilled laborers. The manufacturers can look only to the ranks of union labor. He cannot make wire drawers or nail makers. The union makes them and the boss takes them. (*The Blast Furnace and Steel Plant*, vol. 10, no. 6, June, 1922, pp. 323–325, *gc*)

SPECIAL PROCESSES

The Manufacture of Seamless Steel Tubes. Abstract from a recent issue of the *Ebbw Vale Works Magazine*, describing, among other things, the process used at these works.

Essentially this process does not differ from the standard methods, consisting of a piercing mill and a Pilger mill for rolling, the billet being then cold-drawn over a mandrel. (*The Iron and Coal Trades Review*, vol. 104, no. 2832, June 9, 1922, pp. 849, 1 fig., *d*)

STEAM ENGINEERING

High-Pressure Steam Generation

New Development in High-Pressure Steam Generation. Description of an experimental boiler designed for high pressure by the Power Specialty Co. and developed in coöperation with Thos. E. Murray, Inc.

The boiler is operated experimentally at 225 lb. pressure, but it is said that with slight modifications in structure it can be built for reliable operation at pressures up to 1000 lb. with the usual fluctuations in capacity required to be carried by modern single-service stations.

In this boiler the economizer delivers water to the boiler at approximately steam temperature, the boiler adding the heat of evaporation, and the steam is then led downward to the superheater on the rear furnace wall.

Each unit tube consists of two straight tubes rolled into a connecting member so as to form a hairpin shape from header to header, and the heating surface of the tubes is increased by means of "gilled rings" shrunk on the tubes. Each gilled-ring section contains five rings and by means of these rings the heating surface and the total heat transfer is increased to about six times that of the bare tube, in addition to which the shrunk sections increase the tube strength. A sealed spacing tube is contained internally and forces the water and steam into a thin annular path between it and the 2-in. tube.

Each section of the boiler receives water from a common horizontal drum and delivers steam through a vertical header into a horizontal drum. Water enters the lower end of each hairpin-shaped tube by means of a vertical water header. An equalizing pipe connects the vertical steam headers together. Since a small circular drum is much stronger for the same thickness of metal than one of larger diameter, the advantage of a large drum is obtained from a combination of small seamless structures, which are better suited for high pressure.

The relatively small boiler element absorbs heat at temperatures varying from approximately 2700 deg. fahr. to 700 deg. fahr. This produces a higher rate of heat transfer than in types with usual lower temperature of escaping gases, so that 90 per cent of the work ordinarily done by the boiler element is here accomplished with approximately 60 per cent of the usual heating surface.

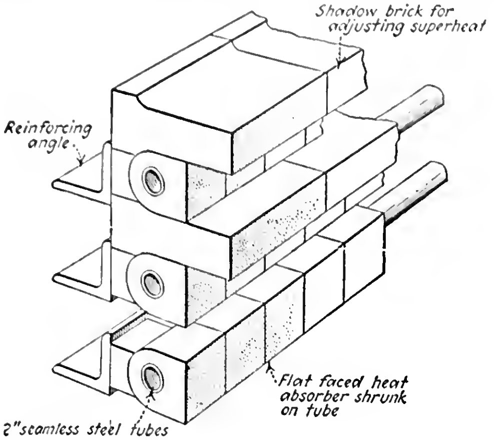


Fig. 7 Radiant-Heat Superheater Details

The economizer is composed of tubes similar to those of the boiler and has to be usually large as it is designed for entering gases of 700 deg. fahr. in order to produce feedwater close to steam temperature.

Water from the service pump at 100 lb. per sq. in., 80 deg. fahr. was employed in cleaning the heating surface once every twenty-four hours. This operation required ten to fifteen minutes and did not interfere with regular performance of duty, except in lowering the boiler-feed temperature for a period of less than one-half hour.

The Foster radiant-heat-element superheater is used, its advantage in this case lying in the fact that it is not affected by the weight of gas produced and therefore gives fairly steady superheat over a large range of capacity.

Fig. 7 shows a detail of shadow brick, tubes and flat-faced heat absorbers which are shrunk on the tubes. These produce 80 sq. ft. of heating surface. Reinforcing angles are bolted to these absorbers at intervals of 18 in. The amount of superheat may be adjusted by changing these shadow brick. The main blow-off valve is placed at the bottom of the superheater, while an auxiliary valve, adjusted for a higher blow-off pressure, is placed on the main boiler header. Piping is led from the economizer, making it possible to flood the superheater while the fire is being raised, or whenever required otherwise.

The original article gives results of two steaming tests. It is stated that the unit has been in service over an extended period, been tested under a large range in capacity, and is now in successful daily use with the other plant boilers at the Municipal Gas Company Plant, Albany, N. Y. (*Power*, vol. 56, no. 4, July 25, 1922, pp. 131–133, 4 figs., *dA*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Aeronautics A1-22. Radiators for Aircraft Engines. Technologic Paper No. 211 of the Bureau of Standards, available for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at fifty cents per copy, describes the laboratory investigations relating to aircraft-engine radiators which were conducted by the Bureau during the World War and in the two years immediately succeeding it. Individual reports covering many phases of the subject have been published previously by the National Advisory Committee for Aeronautics and in scientific and engineering journals. These reports, however, lack the systematic coördination, uniform terminology, and unified mathematical treatment which should characterize a handbook on the subject. Moreover, the problems which were investigated first because of their greater importance and which were the subjects of the earliest reports are for that reason not so well covered as is now possible because the later work has thrown much additional light upon matters not settled at the time of the publication of the earlier reports. Accordingly, the present paper is a revision and recompilation of the material available.

Refrigeration A1-22. Ammonia Tables. The Bureau of Standards has completed the measurements for a table of the thermodynamic properties of ammonia. The entire series of separate but correlated researches relating to the behavior of ammonia as a refrigerating agent has extended over a period of 8 years.

The results of the entire series of measurements are embodied graphically in a Mollier chart which was presented May 25 at the Detroit meeting of the American Society of Refrigerating Engineers. This chart is doubtless the only similar chart of thermodynamic properties of a working fluid for a heat engine which is based entirely upon actual measurements made in one laboratory, upon a fluid of a definite quality, in a program of separate investigations, each complete, each planned and executed according to a high standard of accuracy, and all extending over the entire range of conditions to be covered by the table. The resulting data have been made thermodynamically consistent, not by mutual adjustment of values or by arbitrary choice, as in the previous tables, but by perfection of experimental technique to the point where outstanding discrepancies are negligible. In this respect, the chart is unique in its class. It is now published merely as a preliminary edition, subject to revision.

Air A1-22. Compressed-Air Illness and Its Engineering Importance. Dr. Edward Levy, Consulting Physiologist, Bureau of Mines is the author of Technical Paper No. 285 on the above subject.

The effect of compressed air upon the life, health, and efficiency of workers in deep mining or subaqueous tunneling becomes of increasing importance in the study of occupational diseases and the medical problems of industries.

This report relates the experience of the author in curative and preventative work as physician to the Public Service Commission for the First District, State of New York, which supervised the building of the four pairs of tunnels constructed under the East River during the years 1914 to 1919.

Address the Superintendent of Documents, Government Printing Office, Washington, D. C. Price ten cents.

Electrochemistry A1-22. Generated Voltage of Cells at Low Temperatures. Scientific Paper No. 434 of the Bureau of Standards, for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at five cents per copy, deals with the generated voltage of dry and storage batteries at low temperatures. The practical importance of a knowledge of the behavior of these two types of batteries at low temperatures has arisen from their use in the arctics and at high altitudes. Measurements were made on dry cells and storage batteries cooled to —72 deg. cent. (—98 deg. fahr.) by carbon dioxide snow and to —170 deg. cent. (—274 deg. fahr.) by liquid air. The Gibbs-Helmholtz equation was applied to the observations, and excellent agreement between theory and observation was found. At the lowest temperatures, high values of voltage were sometimes observed, and the polarity was often reversed. A possible explanation based on the Nernst equation is given.

Glue and Gelatin A2-22. The Chemistry and Technology of Gelatin and Glue. Dr. R. H. Bogue, who has been engaged since 1915 in research on gelatin and glue at the Mellon Institute, Pittsburgh, Pa., has completed a comprehensive treatise on The Chemistry and Technology of Gelatin and Glue. This work is being published by the McGraw-Hill Book Company, Inc. Dr. Bogue's consideration of the standardization of testing methods will be of interest to mechanical engineers. A brief account of Dr. Bogue's work appeared in the July, 1922 issue of the *Journal of The Franklin Institute*, pages 75–82.

Health and Sanitation A1-22. Compressed-Air Illness and Its Engineering Importance. *See* Air A1-22.

Industrial Management A1-22. Industrial Fatigue Research. A list of the topics discussed in the Annual Reports of the Industrial Fatigue Research Board (London) contains the following:

Hours of Work and of Ventilation, Influence of, on Output in Tinplace Manufacture (1919). With Illustrations and Statistical Tables. Price 0s, 6d.
A Study of Improved Methods in an Iron Foundry. (1919) Price 0s, 2d.
Fatigue and Efficiency in the Iron and Steel Industry. (1920) With Plates and Charts. Price 3s, 0d.
Adaption of Output to Altered Hours of Work, Speed of. (1920) With Plate and Charts. Price 1s, 0d.
Individual Differences in Output in the Cotton Industry. (1920) Textile No. 1. Price 0s, 6d.
A Statistical Study of Labour Turnover in Munition and other Factories. (1921) Price 3s, 0d.
Motion Study in Metal Polishing. (1921) (Metal No. 5). Price 2s, 0d.
Time and Motion Study. (Illustrated) (1922) Price 2s, 0d.
Address H. M. Stationery Office, Imperial House, Kingsway, W. C. 2, London.

Iron and Steel A3-22. The Nick-Bend Test for Wrought Iron. The "nick-bend" test is included in nearly all specifications for wrought iron. The usual statement says that the fracture of the nicked bar shall show no crystalline areas, or at least not more than a specified per cent. The clause, as usually given in American specifications, allows the nicked bar to be broken either by pressure or by blows. Foreign specifications of this test differ widely from American practice and from each other.

An investigation by the Bureau of Standards consisted in the fracturing, under known conditions, of nicked bars of 9 grades of wrought iron furnished by 5 different manufacturers. The composition, structure, and mechanical properties of the materials were determined, and the method of fracturing varied from simple transverse bending to severe impact, these extremes being permitted by current specifications.

A paper on this subject was presented at the June meeting of the American Society for Testing Materials, by Messrs. H. S. Rawdon and S. Epstein of the Bureau of Standards.

Light A1-22. Interference Methods for Standardizing and Testing Precision Gage Blocks. Scientific Paper No. 436 of the Bureau of Standards describes interference methods by which the planeness and parallelism errors of precision surfaces can be measured, and the length of standard gages can be determined by direct comparison with the standard light waves with an uncertainty of not more than a few millionths of an inch. The errors of other gages can be determined by comparison with these calibrated standards with equal precision. The process makes the standard light waves, determined to 1 part in 4 or 5 million, the standards of length for this work. The apparatus used for calibrating standards and comparing other gages with these standards is illustrated by line drawings and thoroughly explained. The paper may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at ten cents per copy.

Panits, Varnishes and Resins A4-22. Carbon Black—Its Manufacture, Properties and Uses. This is the title of new Bureau of Mines Bulletin No. 192 by R. O. Neal and G. St. J. Perrott.

The authors point out in this paper that the present process of making carbon black recovers only a small percentage of the carbon in the gas, yet no other process in practical operation produces a material with properties similar to carbon black. Inability to secure carbon black would deal a serious blow to the printing industry, and inconvenience rubber manufacturers. On account of the diminishing supply of natural gas, development work should be conducted on more efficient methods of manufacture and production from other materials.

Carbon black is coming into extensive use in paints, since it has a higher tinting strength than any other black, consequently a given weight will obscure a greater area of surface.

Address the Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy twenty-five cents.

Petroleum and Allied Substances A8-22. Methods for Testing Petroleum Products. For a number of years a Federal Technical Committee made up of representatives of nine of the Government departments or bureaus

has been working on a set of specifications for petroleum products. This committee's work has been reviewed by the present Interdepartmental Committee on Standardization of Petroleum Specifications and its Advisory Board of seven representatives of the same number of civilian organizations, and has been finally adopted by the Federal Specifications Board. It is known as Bureau of Mines Technical Paper 305. This report covers specifications for gasoline, naphthas, burning oils, fuel oils, and lubricants. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price five cents.

Railroad Rolling Stock and Accessories A3-22. The Properties of Chilled-Iron Car Wheels. The scope of this investigation was revised and extended until it included tests to determine (1) the strains caused by mounting the wheel on its axle, (2) the strains caused by the static or wheel loads, (3) the ultimate breaking strength of flanges and strains caused by flange pressure, (4) the strains, due to temperature gradients in the wheel, caused by brake application, (5) incidental problems related to the above. Professors J. M. Snodgrass and F. H. Guldner, of the University of Illinois, conducted the experiments, on which this Bulletin No. 129 is based. In this work the University of Illinois Engineering Experiment Station had the coöperation of the Association of Manufacturers of Chilled Car Wheels.

The present bulletin gives the results of a series of strain-gage tests in connection with the items (1) and (2) just mentioned; that is, tests made to determine the strains produced within the wheel by mounting it on its axle, and by the application of wheel loads. The strain within the wheel caused by forcing it on an axle was first determined for two 33-in. 725-lb. M. C. B. wheels. The same pair of mounted wheels was then subjected to static loads ranging from 20,000 to 200,000 lb. per wheel, and the resulting strains noted. The loading effect was produced by applying the load to the axle by means of a testing machine, and allowing the wheels to transmit it to a pair of rails, the conditions being similar to those found in service. A similar set of tests was carried out with a pair of 33-in. 740-lb. arch-plate-type of wheels. Additional tests for the purpose of obtaining more complete information concerning the mounting strains were then made upon a pair of 33-in. 725-lb. M. C. B. wheels. The reporting of the results of the mounting and static tests upon the wheels just mentioned is the purpose of the present bulletin. It is intended to publish additional reports dealing with tests to determine the ultimate strength of flanges, the effect of flange pressure, and the effect of brake applications, together with the related problems of brake friction and the thermal expansion of cast iron. The report is fully illustrated and the data are shown in the form of curves and charts.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Automotive Vehicles and Equipment B3-22. Power Losses in Automobile Tires. The Bureau of Standards has undertaken a general investigation of automobile tires and inner tubes. In connection with this work a rather comprehensive program has been laid out for dynamometer tests, to study among other things the power losses or energy dissipated into heat in tires operated under different conditions of axle load, inflation pressure, speed, temperature, and tractive effort. Preliminary tests have been made to determine the influence of these factors, which, aside from matters of design, are the principal items affecting the power loss in a tire. A continuation of the work will involve problems of design and construction, the influence of "oversize" tires and of "cord tires" on power losses, mileage, and general efficiency of operation. An investigation will be made of inflation pressures as affecting the efficiency and economy of tire operation. Tests will be made to determine the effects of tire fillers, shields, puncture-proof tubes, etc., and the properties of cushion tires will be studied.

For copy of preliminary report known as Technologic Paper of the Bureau of Standards No. 213 by W. L. Holt and P. L. Wormeley. Address the Superintendent of Documents, Government Printing Office, Washington, D. C. Price five cents.

Corrosion B4-22. Corrosion of Metals by Acid Mine Waters. In the course of the general investigation of metal corrosion by mine water, being conducted by the Bureau of Mines at Pittsburgh, Pa., a study has been undertaken of the microscopy of corroded metals and alloys for the purpose of examining the preferential and differential corrosion of constituents in alloys under the action of different corroding media. The work will be done under the direction of R. J. Anderson, metallurgist, with the assistance of George M. Enos, research fellow. Address H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

Ferrous Alloys. Magnetic Properties of Pure Alloys of Iron and Carbon. *See Magnetism B2-22.*

Foundry Equipment, Materials and Methods B4-22. Molding Sand. In coöperation with the joint committee of the National Research Council and the American Foundrymens' Association, the Bureau of Standards is investigating standard methods of testing molding sands. The formulation of the fineness test is practically complete, and the cohesiveness and other physical tests are well under way.

Fuels, Gas, Tar and Coke B2-22. Blast-Furnace Coke. Its Physical Properties. Investigations now being conducted by the Bureau of Mines at the Southern experiment station, Birmingham-Tuscaloosa, Ala., cover the physical properties of blast-furnace coke, including physical tests, solubility of coke in carbon dioxide, and analyses of blast furnace hearth gas. In the study of the reactivity of coke with carbon dioxide, the effect of mesh of coke, temperature, rate of flow of carbon dioxide, and dilution with nitrogen has been further investigated. Six furnaces have been investigated in the Southern district. Experimental work is being conducted also at the Pittsburgh, Pa., experiment station of the Bureau of Mines on the influence of fineness, medium, and time of boiling, in determining the true specific gravity of coke, which determination is used in calculating the amount of cell space or porosity of metallurgical coke.

Iron and Steel B2-22. Effect of Rate of Heating in Hardening Steels. The rate of heating for hardening has rarely been accurately regulated though it is apparently of considerable importance, at least in some steels and under certain conditions where control in dimensional changes in quenching is desired. This question is, therefore, of vital importance to manufacturers of die castings and in the production of thread gages. A series of 16 samples of chrome-vanadium die steel was hardened, using various rates of heating, and these dimensional changes noted. Unfortunately, the desired uniformity of results was not always obtained, but in view of the discrepancies found in other types of tests on the same steel, it is believed that the metal did not have the required uniformity. Similar tests of different steels will be carried out during the month and upon their completion further comments concerning these changes will be made. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Iron and Steel B3-22. Resistance of Chromium Steels to Acid Corrosion. See *Corrosion B4-22.*

Magnetism B2-22. Magnetic Properties of Pure Alloys of Iron and Carbon. Experimental work has been completed by the Bureau of Standards on an investigation of the magnetic properties of a series of very pure alloys of iron and carbon. A number of alloys were prepared having carbon contents ranging from 0.018 to 1.60 per cent and containing no impurities in sufficient amounts to be of importance. Normal induction and hysteresis data were obtained for magnetizing forces up to 2500 gilberts per cm. and the results correlated not only with the carbon content but also with heat treatment. The reluctivity relationship previously used in the study of a carbon steel of eutectoid composition was found to be useful in correlating the results. A paper describing the results of this investigation is now in the course of preparation.

Metal Manufactures, Miscellaneous B1-22. Enameling of Metal Plates. During the past month the Enameled Metals Section of the Bureau of Standards has made an investigation of kitchen-ware enamels. About ten ground coats have been applied to 8-in. steel plates and coated with each of seven cover enamels, representatives of a series of enamels with varying composition. Some 600 plates have been enameled during the month. They are now being tested for resistance to impact, to thermal shock, and to acids, but the work has not yet progressed to a point where conclusions can be drawn. Some very interesting information, however, has been developed regarding the effect of variations in composition on the burning range, burning properties, and fish scaling.

Non-Ferrous Metals B2-22. Magnetic Determination of Iron as an Impurity in Brass. The presence of iron in brass is sometimes objectionable as it exerts a bad influence on the mechanical properties or interferes with cutting. For this reason, a rapid non-destructive method for its determination would be of value. In order to investigate the possibilities of a magnetic test in this connection, the Bureau of Standards has made a study of the magnetic properties of a series of samples of cast brass containing varying amounts of iron up to one per cent. It was found that the physical condition of the material as affected by heat treatment exerted a great influence on its magnetic properties, and that a quantitative determination, at least for the type of material investigated, is not feasible. There is no direct relationship between the magnetic properties and the carbon content.

Petroleum and Allied Substances B1-22. Temperature-Pressure Curves of Petroleum Products. In the course of investigations now in progress by M. B. Cooke, assistant refinery engineer, of the Bureau of Mines, into the nature of "gum-forming" constituents of gasoline, several gasolines and other petroleum products were heated in a small bomb, and pressures of considerable magnitude were developed. As the Bureau has received many inquiries for data showing the pressure that may be developed in a still when gasoline or other oil is subjected to elevated temperatures, it was thought advisable to record the pressures observed at various temperatures in the course of this work. These data were merely a by-product of the main investigation.

Gasoline and similar products are very complex mixtures, and it is difficult to determine accurately the true vapor pressures, hence the vapor pressures of the oils used in these tests have not been studied in detail, but the data obtained may be taken as representative of the pressure-temperature relations of the various oils in commercial work. Address H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

Petroleum and Allied Substances B2-22. Oil Shale Investigations. At Boulder, Colo., at Salt Lake City and at Indiana University the Bureau of Mines in coöperation with the state institutions is carrying on intensive investigations into the best methods of distilling and refining the shale oil found in these localities.

Steel, Its Treatment and Products B5-22. Wear of Steels. Experiments have been started in the study of the rate of, or resistance to wear of, steels run in contact without lubrication. The Amsler wear-testing machine is being used for this investigation. The steels included in the preliminary studies form a series that has been submitted by the Gage Steel Committee and which is being studied in detail to determine the suitability of the steels for gages. In gage work, the question of wear is of extreme importance. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Steel, Its Treatment and Products B6-22 The Mechanical Working of Invar. Invar steel, an important alloy where very low coefficient of expansion is desired, is very difficult to work mechanically. In order to see whether it could not be worked successfully, four small ingots of invar were prepared by the Metallurgical Division of the Bureau of Standards. The first attempt at forging was unsuccessful, the ingot cracking and breaking under the forging press. The second attempt was quite satisfactory as a result of very careful handling during forging operations.

It was found necessary to give very light reductions and not allow the forging temperature to drop below 1000 deg. cent. during the first reduction. This ingot was forged to a $^{3}/_{8}$-in. rod, and a portion of this was cut off and machined to a $^{1}/_{4}$-in. rod. This has been cold drawn with two intermediate annealings down to approximately $^{1}/_{16}$-in. wire. It is being carried further with the idea of determining how fine a wire of invar may be made.

Steel, Its Treatment and Products B7-22. The Effect of Manganese on the Magnetic Properties of Steel. It has been recognized for some time that manganese has an effect on the magnetic properties of steel which is of a somewhat similar nature to that of carbon. A series of iron-carbon-manganese alloys of exceptional purity have become available for a study of their magnetic properties. Several sets of specimens, each set having the same carbon content, but varying manganese, will be subjected to standard heat treatment and their magnetic properties determined. New apparatus for the testing of small specimens recently developed at the Bureau of Standards is being used in this investigation.

Steel, Its Treatment and Its Products B8-22. Effect of Rate of Heating in Hardening Steels. *See Iron and Steel B2-22.*

Ventilation B2-22. Relative Comfort Measurements by Means of Katathermometer. The katathermometer is an instrument contrived by Dr. Leonard Hill, an eminent English physiologist, and its various features have been fully described by him in his book entitled The Science of Ventilation and Open-Air Treatment. He made exhaustive experiments and concluded that the rate of cooling of the human body was the controlling factor in determining comfort or discomfort, and then set out to make an instrument that would measure this rate of cooling. The resulting instrument, the katathermometer, measures its own rate of cooling when its temperature approximates that of the human body and thus serves as an index of the rate of cooling of the body itself.

In connection with the coöperative metal-mine dust and ventilation investigations of the U. S. Bureau of Mines and the U. S. Public Health Service, some underground data have been obtained with intent to ascertain the adaptability of the katathermometer for determining the comfort of working places in mines. This preliminary study indicates that the instrument will probably be useful for making routine determinations of comfort conditions in our mines, and that it may also prove an important accessory for investigative work on problems in ventilation and kindred subjects in both coal and metal mines, although the instrument should probably be altered somewhat for maximum utility under the varied conditions in the mines of the United States.

By means of this instrument an exact numerical index of the relative comfort of a working place may be obtained, free from any personal equation, as determined by the temperature, pressure, relative humidity and motion of the air of the place. The instrument cannot take into consideration such vital elements affecting comfort as chemical impurity of air and presence of various kinds and quantities of dust, both of which may become determining factors in comfort of underground workers; nor measure the effect of undue noise, cramped positions, etc., which also may be important items in determining comfort of underground workers.

The authors of this Bureau of Mines Report of Investigation Serial No. 2355 are D. Harrington and G. E. McElroy. For further information address H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

Chemistry, Industrial D1-22. The Mellon Institute of Industrial Research. The 9th Annual Report of Director Edward R. Weidlein has just been issued and serves as a reminder of the service which this institution is prepared to render industry through its system of Industrial Fellowships.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the headquarters of the Society.

Aeronautics F1-22. Air Navigation, Theoretical and Practical. This bibliography in addition to giving a selected list of articles on aerial navigation contains selective references to allied subjects, such as Astronomy, Meteorology, Nautical Pilotage and Navigation, Cartography and Terrestrial Magnetism. Address Intelligence Branch, The Air Board, Ottawa, Canada.

Fluid Flow F1-22. Turbulent Flow of Fluids. This bibliography contains all the recent articles of importance on subject named in its title. It consists of two typewritten pages and is known as Search No. S. 3572.

Lubricants F1-22. Emulsification of Lubricating Oils. A bibliography of two typewritten pages. Search No. S. 3574.

Machine Parts F1-22. Gears. This is a fairly comprehensive bibliography of recent magazine and textbook articles on the subject of gears. It consists of five typewritten pages and is known as Search No. S. 3562.

Paints, Varnishes and Resins F1-22. Carbon Black—Its Manufacture, Properties and Uses This ten-page bibliography forms an appendix to Bulletin No. 192 on this subject recently issued by the Bureau of Mines. Address Director H. Foster Bain, Bureau of Mines, Washington, D. C.

Photography F1-22. Air Photographic Surveying and Mapping. The Intelligence Branch of The Air Board, Ottawa, Canada, has just completed three bibliographies on the general subject of aerial photography. One of them is named above and a copy may be secured by addressing the Air Board direct.

Photography F2-22. Forestry Reconnaissance and Forest-Fire Protection by Air. Address Intelligence Branch, The Air Board, Ottawa, Canada.

Photography F3-22. Air Photography, Generally. Address Intelligence Branch, The Air Board, Ottawa, Canada.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 365 and 396 to 405 inclusive, as formulated at the meeting of June 29, 1922, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 365

Inquiry: Is it permissible, under the requirements of the Boiler Code, to weld together the outwardly projecting edges of furnace door hole flanges by the autogenous process, provided the form of the circular door opening and the autogenous or fusion welding

is as shown in Fig. 19 and the staybolting around the opening does not exceed the permissible staybolt pitch as given in Par. 199?

Reply: It is the opinion of the Committee that a circular door opening, of the form shown, in which the projecting cylindrical portion of the inside sheet is provided with an outwardly turned flange, at its extreme edge, to form an abutment for the edge of the circular projecting flange of the outside sheet, and is made leak-proof by autogenously filling the space between these two flanges, will meet the requirements of the Boiler Code, provided the circumference of the outwardly turned flange on the cylindrical projection of the inside sheet exceeds the outer circumference of the flange of the outside sheet, and provided that the thickness of this cylindrical projection of the inside sheet conforms to the requirements of the following formula:

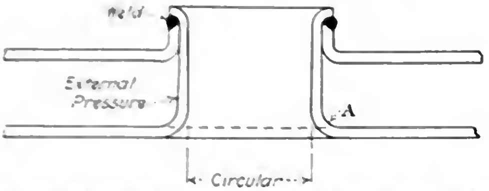


FIG. 19 CONSTRUCTION OF FURNACE DOOR OPENING WITH OUTWARDLY PROJECTING EDGES FLANGED AND AUTOGENOUSLY WELDED

$$P = \frac{5000 \times t}{R}$$

where

P = maximum allowable working pressure in lb. per sq. in.

t = minimum thickness of the plate forming the circular door opening in in.

R = the radius of the outer surface of the circular door opening in in.

Case No. 396

Inquiry: Is it permissible, under the requirements of Par. 257, to calk the heads of rivets? If so, how shall it be done and with what type of tools? Is it permissible to cut the plate or butt strap underneath the head and force the projecting metal up under the head?

Reply: It is the opinion of the Committee that it is permissible to calk the head of a rivet, if the rivet is not loose, provided the number of rivets requiring calking is not objected to by the inspector as indicating improper workmanship. Such calking must be done with a round-nosed or other type of tool which will not score or damage the plate under the head. The plate under the head should not be cut in order to force the metal up and make the head tight.

Case No. 397

Inquiry: Was it the intent, in Par. 199, to permit a value of 175 for C where copper washers were used as described in the definition for C?

Reply: It is the opinion of the Committee that the washers should be of steel to permit the use of 175 for C. Copper washers may be used provided no increase is assumed in the value of C for the strength of the washer.

Case No. 398

Inquiry: Is it permissible, under the requirements of the Boiler Code, to use a single-piece dome, with the shell drawn or pressed out of one piece, eliminating the lap seam and riveting of dome head to dome shell?

Reply: It is the opinion of the Committee that it was not the intent of the Code to prohibit the use of seamless construction otherwise built in accordance with the Rules.

Case No. 399

Inquiry: Is it permissible, under Par. 199 of the Code, to use a value of 175 for the constant C in the formula when the outside washer is omitted and instead an inside doubler plate securely riveted to the plate is used?

Reply: It is the opinion of the Committee that if three-fourths of the combined thickness of the boiler plate and doubler plate is used for the value of T in the formula, the value of 175 for C cannot be used unless outside washers are employed. It is the opinion of the Committee that if the thickness of the boiler plate is used for the value of T in the formula without adding anything for the thickness of the doubler plate, the doubler plate may be considered as the equivalent of the outside washer and the value of 175 may be used for C.

Case No. 400

Inquiry: Is it the intent of the Code that Par. 183, specifying the distance from centers of rivet holes to edges of plates, shall apply only to longitudinal joints, or is it applicable also to girth joints, manhole frames and other riveted attachments?

Reply: Par. 183 refers only to longitudinal joints.

Case No. 401

Inquiry: In Par. L-31, is it the intent that the area to be stayed is calculated from the maximum pitch squared, or the product of the actual pitches of the area supported by the stay under consideration?

Reply: The formula cited is based on the use of flat and not curved plates. In the absence of authentic data as to the reduction in stress that may be obtained due to curving the sheets, stayed curved sheets were made subject to the rules for staying flat plates. In the revision of the Code which is now under way, such allowances will be made for stayed curved plates in conformity with rules which have been developed since the last printing of the Code. For calculating the stress in staybolts the area of surface supported can of course be used. However, for spacing of stays or estimating stresses in stayed sheets, it will not be admissible to substitute the area of surface supported for p^2.

Case No. 402

Inquiry: Is it necessary, under Par. 195, where more than one manhole opening is inserted in a dished head, to increase the thickness of the head by more than $^1/_8$ in.?

Reply: It is opinion of the Committee that it is not necessary to increase the thickness of the head more than $^1/_8$ in. if more than one manhole opening is inserted, provided the minimum distance between the manhole openings is not less than one-fourth of the outside diameter of the head.

Case No. 403

Inquiry: Where a steam drum or dome is attached to a boiler, is this drum or dome to be considered a part of the boiler in applying the requirements of Pars. 277 and 278 for the attachment of safety valves?

Reply: It is the opinion of the Committee that where a steam drum or steam dome is attached to a boiler, the safety valve or valves, under ordinary conditions, may be located on this drum or dome. The area of the connection between the boiler shell and the drum or dome shall conform to the requirements in Par. 290.

Case No. 404

Inquiry: If a dished head is formed with a flattened spot or surface for the attachment of a connection or flange, is there any limit to the size of the plane or flattened spot on the head?

Reply: It is the opinion of the Committee that the diameter of the flat spot formed in the head should not exceed the value of p as given in the formula in Par. 199 or in Table 4, for the pressure and thickness of head involved.

Case No. 405

Inquiry: If a boiler constructed to the requirements of the A.S.M.E. Code for Boilers of Locomotives, is removed from the locomotive and operated for stationary or portable service, will the rules under which the boiler was constructed still apply?

Reply: The rules for the Construction of Boilers of Locomotives do not apply to portable locomotive-type boilers, such as are used for steam shovels, steam cranes, road rollers, and portable boilers used for threshing grain or cutting lumber.

If a locomotive boiler is removed from the locomotive and used in stationary or portable service, it shall be treated in accordance with Parts I or II of the Code for Stationary Boilers.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on activities and policies of the Society in Research and Standardization.

The Accuracy of Boiler Tests

To the Editor:

In the Accuracy of Boiler Tests, published in the July issue of Mechanical Engineering, Mr. Cotton's estimate of a plus or minus 3 per cent error in a "regular carefully conducted boiler test" is more or less justifiable according to what is meant by a carefully conducted test and particularly according to the length of such test. No doubt there are many boiler trials made, the accuracy of which is not closer than plus or minus 5 per cent. In fact a boiler test made with coal fuel never is and never can be accurate. Besides all the other reasons for this the difficulties of samplying and analyzing the fuel are sufficient.

While the author does not make specific recommendations toward the improvement of accuracy it is quite apparent from the paper, although not brought out very strongly in the discussion, that the primary requirement is a test of reasonably long duration. No duration however long will eliminate all of the errors but every added hour of the run, assuming uniform care and attention, reduces the proportion of total error. The one big error in a boiler trial is made when it is too short. A 48-hour run is in several respects more accurate than the average of two 24-hour runs.

The so-called heat balance is too useful to give up, but perhaps it would be wise to state only the computed items and their total as representing the "heat accounted for."

There are altogether too many boiler tests made and a large proportion of them are perfectly useless for many purposes. As pointed out by Mr. Burke, studies of temperature and flue-gas composition often give more reliable information than the evaporation. The writer recalls the instance of a coal-feeding device, the only function of which was to spread buckwheat coal over the grate. The merit of the device could have been determined by an experiment made 100 miles from any boiler and the actual tests made by using the machine under a boiler indicated several interesting things but only incidentally the functioning of the machine. It is extremely illogical and unwise to use a steam boiler as a measuring instrument. It lacks every desirable characteristic of such an instrument. It is costly, inaccurate and subject to all sorts of disturbing influences to say nothing of the human factor which always enters into its operation.

New York, N. Y. W. D. Ennis.

Test to Determine the Pressure Caused by Expansion of a "U"-Pipe Bend

To the Editor:

Recently the writer noted a request for information relative to the pressure exerted by the expansion of steam pipes when the pressure or strain due to the temperature is transmitted to the anchors.

Fig. 1 shows the method of test adopted by the writer to determine this. Preliminary calculations, however, were made as follows:

Pipe	standard full weight, 4 in. diam.
Wall thickness	0.237 in.
Sectional area of metal	3.18 sq. in.
Length of pipe in bend	23 ft.

Area in half section = 3.18/2 = 1.59 sq. in.
Lever arm of pipe = Y = O. D./2 = 4.5/2 = 2.25 in.
Lever arm of bend = 7 ft. 2 in. = 86 in.

Limiting the stress to 16,000 lb. per sq. in.

$$\text{Pressure} = \frac{16{,}000 \times 1.59 \times Y}{\text{Lever arm of bend}} = \frac{16{,}000 \times 1.59 \times 2.25}{86} = 665.5\text{ lb.}$$

This figure, however, does not disclose the number of inches of compression required to produce the stress which the test does show, as will be seen later.

The tensile stress in the pipe wall was calculated as follows:

	Sectional Area	Moment of Inertia
O. D. = 4.5	Outside = 15.904	I for O. D. = 20,129
I. D. = 4.026	Inside = 12.75	I for I. D. = 12.948
	Difference = 3.154	Difference = 7.181

Lever arm of bend	86 in.
Pressure to compress bend $2^3/_4$ in. from test	580 lb.

Whence

$$580 \times 86 = 49{,}880 \text{ in-lb.B.M.}$$

and

$$P = MY/I = (49{,}880 \times 2.25)/7.181$$
$$= 15{,}630 \text{ lb. per sq. in. tension in the bend.}$$

Fig. 1 shows the method employed in setting up for the test, which was as follows:

The bend was mounted on beam scales in such a way that only the load on the bend would be measured. Compensation was made on weight arm for the weight of the pipe and jack.

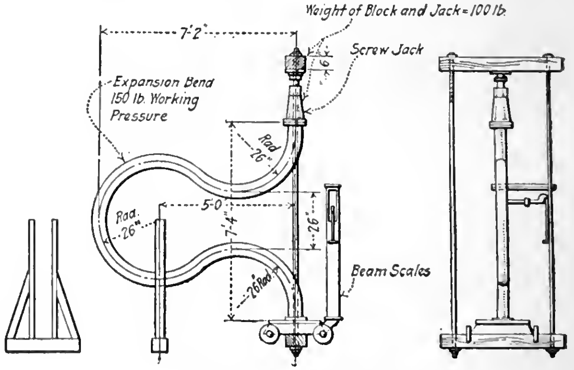


Fig. 1 Testing Device fo Expansion Bends

The compression test data obtained were as follows: The bend standing on a flange compressed $^1/_4$ in., due to its own weight, (255 lb.) and it required a pull of 49 lb. to restore it to its length of 7 ft. 4 in. between flange faces.

100 lb. compressed bend $^1/_2$ in. more, or $^3/_4$ in.
247 lb. compressed bend 1 in.
281 lb. compressed bend $1^1/_4$ in.
340 lb. compressed bend $1^1/_2$ in.
431 lb. compressed bend 2 in.
580 lb. compressed bend $2^3/_4$ in., or to 7 ft. $1^1/_4$ in.

As it is usual to stretch a bend of this kind when drawing up on the flange bolts, it may be assumed that there is little or no stress on the anchors except when cold, and that it requires approximately the same stress to extend the bend an equal number of inches, although this may not be strictly true, on account of the tendency to cripple the pipe wall on the inner radius and stretch it on the outer when the bend is made.

These tests were also intended to indicate the stress under ex-

pansion limits if the pressure was later raised to 325 lb. per sq. in. and at a temperature corresponding to this pressure and 150 deg. superheat; barring a possible decrease in the bursting strength of the pipe due to the temperature, the bursting safety factor for this pressure will be nearly 8 for 4-in. pipe and a cold-water test.

Baltimore, Md. A. E. Walden.

An Engineering Education Question

To the Editor:

The science of engineering in its various phases is the most powerful actuating lever in the world today as pertaining to the progress of civilization and the unfolding of known and unknown forces which will serve mankind, to the end that life as men now know it will only be remembered in the future as a nightmare of misdirected energy, waste, lack of order, and greed.

With the foregoing thought in mind, and those set forth in papers presented before the A.S.M.E. by Prof. C. F. Scott, T. C. Pratt, A. G. Christie, J. E. Otterson, and Dexter S. Kimball, on the subject of professional engineering education for the industries, the writer here records some impressions of the subject from the broad viewpoint of how to make the science of engineering most active in all the work of the world, for we want not only good engineers, and many of them, but we want—and must have—more men in the world's business who can engineeringly focus.

If so, how are we to stimulate a desire for engineering knowledge in our young men, and in the end produce the men with engineering knowledge, and in sufficient numbers to weave the thread of engineering science throughout the fabric of civilization in a symmetrical and predominating pattern.

It would seem to the writer that control as applied by our educational institutions to engineering education is the answer. We then may ask:

What is a sane and safe latitude for the control of an engineering education from the beginning to the end? A latitude which engineers, employers of engineers, and the public, can safely subscribe to as a means to the end of producing for America and the world the engineers upon whom will fall the task of carrying on the great development and progress, which must take place in national, civic, industrial, commercial, and transportation life as men push on to the world's greater future?

What kind of a system will best serve the universities of our commonwealth, to the end that they shall have the greatest opportunity of developing the greatest number of inventive, research, and constructive engineers?

What attitude will the educator, the engineer, and man of business take toward a means to the end of giving this country and its associates the greatest number of men who know what engineering means, and who, while not active as engineers, will think and act along engineering lines because of an engineering education?

Will educators sense the fact that an engineering course with latitude educates a man better than those leading to a L.L.B., B.A., or B.C.L., or like degrees, because it fits him better for any line he may follow in business life, and because it is obvious that the more citizens a country has who can think engineeringly, the greater and more rapid will be its advancement?

From the opinions which are appearing in the educational and technical press, it would seem that the prevailing idea on the subject of engineering education is that the harder and less attractive an engineering course is made, the better engineer it will produce. If such is the idea to be conveyed, it is eerie.

However, it seems that the majority of educators and engineers who are interested in the subject to the extent that they have something to say upon it, feel that the best results can be accomplished in the engineering course that calls for increased pressure and period—the kind of course which is most attractive to the photographic-minded student, because under a system of pressure and period it would only be the photographic-minded student who could hope to make the entrance, go through the course and be graduated, while the young man who absorbs knowledge slowly would have great difficulty in even approaching a university campus. Be it understood, however, that students with photographic minds can be developed into real engineers.

Under the plan suggested for improving engineering courses in order to produce better engineers, there is no provision made for considering the young man who may carry in his mind the rarest engineering ability, which ability cannot be cultivated by a system that assumes that the phenomenon of memory is a satisfactory proof of creative and constructive ability. However, this ability could be cultivated by a system based on time, reasonableness, patience, and encouragement.

The educational institution that would multiply the barriers to its engineering course so that only the so-called select students or high-grade men can enter, and by such barriers keep out all low-grade men, and then follow with an inflexible six-year course of study, is not rendering to America its maximum effort for the general good of the nation, and can be said to have reached the exclusive stage in education.

It is a fallacy to assume that the student who can reel off the day's work in perfect synchronism with the instructions of the professor is to be the great engineer of the future, because such is not always the case, as is shown by the history of engineers, past and present.

It may be that our educators and the engineers they have produced are developing a conviction that the profession of engineering will become debased if it is made easy to attain, but this is not so, and any line of reasoning which advocates pressure and ambition-killing periods for the young mind is wrong—wrong from a standpoint of efficiency as demonstrated through an engineering education, because efficiency in engineering as applied to the work of the world will best be served by our universities educating, or partly educating, all of the young men that it is possible to induce to take up the study of engineering. In this way there will be produced not only the greatest number of real engineers from the greatest possible field of embryo engineers but also, from the men who are not suited for the life of a working engineer, a class of non-active engineers who will find their place in the commercial world. These men will be properly educated to understand what constructive advancement means, and will be broader and more aggressive citizens, better servants of the government, state and municipal, better bankers, manufacturers and merchandizers. Again because they will know enough of the laws of engineering to make them interested in the evolution of the world along engineering lines, they will be able to help their brothers, the highly trained and natural engineers, to put into practice their ideas and aims and push civilization on more rapidly to greater heights.

It is a well-known fact that many 95 per cent men have proven "dudds" on the battlefield of engineering, and that many, yes—a great many class tail-enders, or dropped-for-failure men have to their credit great achievements. The first individuals had the photographic mind while the latter did not, and according to the education specifications proposed, would not have been accepted as students; nevertheless they have been able to meet the working specifications of the world through what they did assimilate engineeringly, and because of this they have accomplished things of importance. And let it be remembered that there are some brilliant engineers with concrete works to their credit who were not university trained, so that there is some power outside the pressure-and-period course suggested.

It would, therefore, seem that the engineers and educators of today should view this all-important question not from the standpoint that we must deal only with the easily educated young man, but rather from the standpoint that we wish to develop for our country, and the world, the largest number of engineers within our power, that we want to make engineering a democratic line of endeavor, not an exclusive one. To do this we must use the keys of reasonableness and encouragement, leaving the initiative and ambition of the student to act as the medium through which he will gravitate to his true position in life.

Chicago, Ill. W. R. Macklind.

A Correction

On page 516 of the August issue of Mechanical Engineering in Mr. T. A. Lewis's paper on Utilization of Waste Heat in the Steel Industry, the twelfth line should read "It amounts to $25,000 a year per furnace" instead of $2500.

MECHANICAL
ENGINEERING

A Monthly Journal Containing a Review of Progress and attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie
Ralph E. Flanders John T. Wilkin
O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Jurisdictional Board Asks Coöperation of Engineers

FOR over two years a quiet but effective body has been at work preventing misunderstandings that may lead to strikes in the building industry. These misunderstandings are not the major ones between the employers and the workmen but those insidious fallings out over work claimed by more than one building trade. In 1919, as the result of a plan adopted at the annual meeting of the Building Trades Department of the American Federation of Labor, a National Board for Jurisdictional Awards in the Building Industry was established. Coöperation of the contractors, architects and engineers was secured and as now organized this arbitration body is made up of three representatives of the labor unions, three representatives of contractors and employers of building-trade workers, a representative from the American Institute of Architects and one from the American Engineering Council.

The constitution and rules of procedure under which the Board has successfully carried on its work, provide, in the main, for the submission of complaints in writing through one of the organizations signatory to the plan, and a hearing after due notice to all parties in interest. A two-thirds vote of the Board is necessary for a decision, failing which, an umpire, whose decision is to be final, is selected either by the Board or the Secretary of Labor, although, thus far, it has not been necessary to resort to an umpire. Provision is also made for the appointment of committees to investigate cases that may be brought to the attention of the Board. Each of the labor bodies coming under the scope of the Board agreed that their membership shall not take up any sympathetic strikes in any case of jurisdictional dispute. Suitable penalties are provided for violation of this rule. Under the guidance of these principles the Board has considered a number of troublesome points of difference between the various building-trades unions and in general its findings have been regarded as final by the trade unions involved. In fact those who have been intimately connected with the workings of this Board are convinced that its accomplishments have fully justified its establishment. One prominent labor leader has expressed his satisfaction in a statement that the Board has accomplished more in the short period of its existence than the unions themselves in the years in which they have been joined in their Federation.

In only one instance has there been any organized attempt to obstruct the action of this Board. The carpenters refused to abide by the Board's award to the sheet-metal workers of the work of setting hollow steel doors, hollow metal window frames and sash. Great embarrassment resulted from the tactics pursued by the carpenters and as a result the carpenters' union was forced to withdraw from the Building Trades Department of the Federation. In a resolution, given in full in the June issue of Mechanical Engineering, page 405, condemning the action of the carpenters' unions of the Building Trades Department in disavowing its decisions, the Jurisdictional Board called upon all parties to the plan to show an active support, the architects and engineers by inserting in their specifications and contracts a stipulation that the decisions of the National Board for Jurisdictional Awards in the Building Industry shall be observed, the contractors by similarly requiring coöperation from their sub-contractors and the labor men by disciplining subordinate bodies that are inclined to dissent.

The attitude of the Building Trades Department of the American Federation of Labor is most encouraging, especially as at the recent Cincinnati convention it unanimously voted confidence and support of the Board's work. Furthermore it refused to readmit the carpenters' union to the Department except in accordance with the constitution of the Jurisdictional Board. There is, however, a feeling among some of the labor men that the architects and engineers are rather luke-warm toward this movement to eliminate jurisdictional strikes and that some of the contractors, among whom are many of our engineers, are not giving their support whole-heartedly. As their contribution to the elimination of waste in industry and as part of their obligations to their clients and the general public, who ultimately pay the cost of strikes and other labor troubles, engineers, both as designers and contractors, should line up with the other parties to this voluntary agreement and support with all their strength the work of the Board and use every reasonable effort to secure the coöperation of their colleagues and associates.

We take this opportunity, therefore, to emphasize again the request of the Board for engineers, architects and contractors to insert in contracts the stipulation that the decisions of the Jurisdictional Board shall be observed, than which no more direct or effective method seems practicable. It is not uncommon at the present time for architects and engineers to incorporate in their specifications that disputes as to the meaning of those specifications shall be submitted to arbitration, and even in many cases to name certain individuals in the specifications as arbitrators. Why is it not fitting that the success and standing of the Jurisdictional Board be recognized in a similar manner in matters pertaining to jurisdictional disputes?

Rudolph P. Miller.[1]

German Standards

THE writer had an opportunity to visit Germany a few months ago as a delegate of the American Engineering Standards Committee for the purpose of discussing international ball-bearing standards with the German Ball-Bearing Committee.

In this work I made the acquaintance of several of the leaders of the German standardization work and obtained an idea of the magnitude of this work in Germany.

It was only a few years ago that the "Normenausschuss der Deutschen Industrie," an organization corresponding to our American Engineering Standards Committee, was formed under the auspices of the Verein Deutscher Ingenieure, but the amount of work which it has accomplished since its formation is stupendous.

The "Normenausschuss" has already issued several hundred sheets of approved standards, and about twice as many are already published as proposed standards. This enormous output of the German organization has led many to believe that it was merely a factory, producing "paper standards," and that its work was not to be taken very seriously. A personal investigation convinced me that this is not the case, and I found that the great output of standards was merely due to the enormous efforts put forth and to the enthusiasm of the great majority of the interested parties.

---

[1] Representing American Engineering Council on the National Board for Jurisdictional Awards in the Building Industry.

This enthusiasm is due to a more or less general recognition, created under the pressure of war conditions, of the great economical value of standardization, and to the very generally accepted opinion that a standardised industry would be one of the strongest weapons in Germany's struggle for economic rehabilitation and financial reconstruction.

To give a concrete illustration of this point, I may mention that at the time of my visit, a syndicate of nineteen German and one Swedish manufacturer was executing an order for seven hundred locomotives for Russia, all of the same design, and every part in every one of them was being made interchangeable with the corresponding part in all the others, all parts having been manufactured to the same fits and tolerances. This feature will have the great advantage of permitting the Russian railroads to use any disabled locomotive as a store of spare parts for all the others. In case of future orders, the Russians will no doubt specify that all new locomotives of this class be built not only of the same design as above, but so that every part is interchangeable with the above.

Another error in our conception of German standardization is that the "Normenausschuss" is autocratic in its methods and is not in as close contact with the industries as our own standardizing bodies. I found, on the contrary, that absolutely the same methods are used there as here to arrive at national standards. The staff of the "Normenausschuss" is merely coördinating and directing the work of the various committees, and the actual establishment of standards is left to recognized leaders in the various industries.

The work of the permanent staff is greatly facilitated by the eager response from German industry, whose leaders look to standardization as one of their greatest hopes for salvation. Many of the big German manufacturers have standard departments of their own, with a number of engineers and draftsmen working permanently on national standards.

It would of course, be highly desirable to establish international standards and great efforts are being made to obtain them in certain lines, such as ball bearings. One of the greatest obstacles for international standardization, however, is the fact that America and England do not commonly use the same scheme of measurement as other countries.

There is no doubt in my mind that one of the main reasons why forward-looking Germans force their standardization work is because they want to impress German standards on the great import countries and possibly on the whole world. Holland, Switzerland, Austria, Sweden and many other European countries follow the German lead very closely. The great German deliveries in kind to France will no doubt, as far as feasible, be made according to German standards, thereby introducing them in that country.

The days may not be far distant when our manufacturers will receive inquiries from oversea countries to furnish goods according to the national German standards or specifications, as referred to above in connection with the Russian locomotives, and it behooves us to plan in time to meet such conditions. England seems to have fully realized the importance of recognition of her standards, and is trying to force the adoption of them in her colonies and dominions.

Another institution closely connected with the "Normenausschuss" deserves special mention, and that is the Committee on Industrial Processes. This committee investigates the methods used in the various industries to obtain certain results, submits them for critical comparison and standardizes the best obtainable methods. This committee, which is also sponsored by the Verein Deutscher Ingenieure, works of course in very close coöperation with the "Normenausschuss."

On account of its very efficient organization, the German "Normenausschuss" has come to play a more important role in the industrial life of the nation than originally expected. Manufacturers write to it for advice on questions of the most delicate nature, and frequently competitors exchange manufacturing secrets through some member on its staff.

In conclusion I wish to express the hope that the example of the German engineers and manufacturers may spur us to make equally large contributions in work and money to the cause of standardization, and that our leading engineers may try to realize the enormous economical importance of both national and international standards.

Oscar R. Wikander.

Beneficial Effect of Prizes

THE A.S.M.E. Committee on Awards and Prizes has been asked to write briefly as to the benefit to the Society and to Engineering of the prizes and honors which are in the gift of the Society, with the idea that it might possibly arouse greater interest in the subject and induce a larger number to compete for these awards.

The idea of the award of a prize for the greatest merit must be practically coeval with the race. Not many of us as engineers have read the poem in the original, but we all know that one of the greatest of the world's poems, the Iliad, was in a way the result of the award of a prize in a beauty contest. Leadership in savage tribes is the reward for supremacy in bravery, skill at arms or wisdom, and so we might go on indefinitely. In other words, the feeling seems thoroughly implanted in human nature that some tangible evidence of recognition of superiority is of great value in helping to bring about that superiority.

In considering the award of prizes by our Society there comes to mind the story told of Herbert Spencer, the great philosopher (who was at first an engineer), which, whether true or not, is worthy of very careful consideration. It is said that after he became famous and was recognized as one of the world's greatest philosophers, the universities of Oxford and Cambridge offered to confer on him the honorary degree of Doctor. The story goes that Spencer's reply was that, when he was a young man and struggling hard to get recognition for his work, and when such degrees from the universities would have been of great value to him, they were not forthcoming; now that he had attained a certain degree of fame without their help he objected very decidedly to having the universities plaster their label on him after all the rest of the world had already assigned him a definite position. Observation of the honorary degree lists of our own great universities would lead one to believe that in general they follow the same plan as the English universities followed with Spencer. In other words, after a man has become famous then the universities acknowledge that fact by giving him a degree. Nevertheless Spencer's declination of the honor is about the only one on record.

This does suggest, however, that the Society might very well take the lesson to heart, and endeavor to ascertain meritorious work whether the individual is already well known or not, and that in the case of previously unknown men this award of approbation would have a real value, and might, in many cases, be such an encouragement as to lead to work of the highest value later on in life.

In order that this may be the case it is necessary that all the members of the Society should take an interest in the subject, familiarize themselves with the awards which are provided and assist the Committee on Awards and Prizes by friendly suggestion, where they are not competitors themselves, and by doing their own very best work where they feel that their efforts may justly entitle them to consideration.

An annual prize is for the best paper appearing in the Society's Transactions during the year. These papers cover so wide a range of subjects that it is impossible for a single committee unaided to make a decision based on expert knowledge of these many subjects. If the members who specialize in any particular subject find a paper along their specialty which commends itself to them as of very high value it would be a favor to the Committee and helpful to the Society if they would write to the Secretary's office giving their opinion, together with the reasons for esteeming it of specially high value. The Committee can then be trusted to weigh the evidence in the various cases and make a decision, taking account of all the features which enter in such a competition, with the probability that the paper finally decided upon is undoubtedly the best of all which appeared.

With respect to the medal for specially meritorious inventions or work in engineering, it may well happen that some members may know of such cases, which, unless they advise the Committee about them, might pass unnoticed. This was exactly the case with the first award of this prize. Those who knew of the work of Mr. Carlson recognized that it was of extreme value to the country in its hour of trial and that it solved a problem which otherwise would have involved immense cost and difficulty.

The Committee believes that much greater honor will accrue to the Society from the discovery of highly meritorious work of obscure

or little-known members. rather than from conferring the prize on some famous men whose work has been heralded in the daily press until it is known to every bright schoolboy.

The Committee on Awards is willing to do a great deal of work and give its very best efforts to advancing the interests of the profession in making suitable recommendations, but it lays no claims to omniscience and must have the cordial coöperation of the membership at large if the great benefits which will result from the proper award of the prizes is to be secured.

Walter M. McFarland.[1]

Alfred D. Flinn Reports Nationwide Interest in Research

Alfred D. Flinn, secretary of the Engineering Foundation and chairman of the Division of Engineering of the National Research Council, returned August 2 from a six-weeks' tour to the Pacific Coast on which he addressed groups of engineers to enlist their aid in a nationwide plan for engineering and industrial research.

Mr. Flinn addressed meetings at Salt Lake City, Los Angeles, San Francisco, Sacramento, Portland, Oregon, Seattle, Duluth and Minneapolis. In spite of the fact that the time of year was such that the men of the profession were to a large extent scattered, a group of from fifty to seventy-five representative engineers were present at every meeting. The meetings were arranged by local sections of the National Engineering Societies, or the local engineer's club, and the audiences included officers and members of these Societies as well as others interested in problems of research.

There was evidence of interest everywhere in the work of the Engineering Foundation and the National Research Council. Men were impressed by the extent and quantity of the work already done, considering the limited resources of the Foundation, and desirous of having the work pushed further so they could have the benefit of it. The Engineering Societies Library received favorable comment for the splendid service it renders to engineers.

At Los Angeles, San Francisco, Seattle and Portland Mr. Flinn found particular interest in the proposed study of arched masonry dams. In the first three of these cities there was an active interest in the marine-piling investigation being conducted by the National Research Council. In this connection, during Mr. Flinn's time in Canada where he met and talked with individuals instead of groups, he met Prof. C. McLean Fraser of the Biological Board of Canada. Professor Fraser gave assurance of his desire to coöperate in the study of marine borers and estimated that the damage done by these small animals to the wooden piling along the British Columbia Coast alone amounts to several hundred thousands of dollars every year.

One object of the trip was to make personal contacts that might lead to interesting people of means in contributing to the support of the Engineering Foundation. Engineers themselves are not able to do this and contributions must come largely from outside sources. Personal contacts were also made with men who can be useful in committee work and who have shown a desire to help.

St. Louis Central Station to Use Pulverized Fuel

Mechanical engineers who have been following the performance of the powdered-fuel installation at the plant of the Milwaukee Railway and Light Company will be very much interested in the announcement that the new Cahokia plant of the Union Electric Light and Power Company, St. Louis, Mo., is also to have a pulverized-fuel installation.

In a statement recently issued, McClellan and Junkersfeld, Inc., engineers and constructors of this project, emphasized the fact that in the Cahokia plant pulverized-fuel equipment will permit the economical use of the low-grade Illinois coal having a heat value of approximately 10,000 B.t.u. per pound and high moisture and ash contents.

The decision of the engineers was reached after extensive tests and investigation on stokers and pulverized-fuel equipment. The plant at Milwaukee afforded an excellent opportunity for the investigation of performance with powdered coal and it placed the results on a basis comparable with those secured with the best modern automatic stoker plants.

The new plant, of which 60,000 kw. will probably be in operation next year, will have an ultimate capacity of 240,000 kw., and is to supply the rapidly increasing industrial and lighting load in St. Louis, in addition to that now being supplied from the Keokuk Dam and from an existing large steam plant.

The engineers state that improvements may be expected in the development of stokers as well as in pulverized-fuel equipment but that stokers have been under development for a long period of years, and the burning of coal in pulverized form in large quantities by central stations has been done only in the last few years. Without attempting to estimate future developments in the two classes of equipment for burning coal at least the present relative position, so far as the Cahokia Station is concerned, will probably be maintained.

The engineers call particular attention to the fact that their recommendation should not be applied to any other quality or price of fuel, plant site, plant layout, load factor or other conditions without making careful adjustment for the differences between such conditions and those which obtain with the Cahokia Station.

Two 30,000-kw. turbines, eight 1800-hp. B. W. boilers without economizers and a Lopulco system for burning pulverized fuel will be installed. The plant will be located on the Illinois side of the Mississippi River about fifteen miles from the coal mines.

DeLamater-Ericsson Collection to be Nucleus for National Museum of Engineering

At the Council Meeting in Atlanta on May 8, President Kimball announced the appointment of five A.S.M.E. representatives on the Joint Committee on the DeLamater-Ericsson Historical Collection. The personnel of the Joint Committee is as follows:

American Society of Mechanical Engineers: H. F. J. Porter, Chairman of the Committee, Sydney Bevin, Fred A. Halsey, Thos. F. Rowland, Jr., Henry R. Towne; Swedish Societies of New York: Axel S. Hedman, Johannes Hoving, Charles K. Johansen, Emil F. Johnson, Ernst Ohnell; Associated Veterans of the DeLamater Iron Works: Walter M. Parker. This Committee will collect the historical material connected with Cornelius H. DeLamater and Capt. John Ericsson during their fifty years association as the leading factors of the DeLamater Iron Works.

In the concluding paragraph of the Report of the National Museum at Washington for 1920, attention is called to the fact that "the commanding place in the world which the United States has reached in the short space of seventy-five years is due largely to the full development and utilization of mechanical power in the exploitation of her natural resources. It is this that has made it possible for the people of the United States to enjoy a standard of living far and above that under which the peoples of the rest of the world exist, and still no public sign of appreciation, either national or otherwise, is to be found anywhere. What more suitable monument could there be than a Museum of Engineering and where could there be found a more logical place for it than as a part of the great National Museum?"

The Smithsonian Institution then not only solicited the placing of the DeLamater-Ericsson Historical Collection in its National Museum but proposed the coöperation of the Committee in establishing the nucleus there of a great national engineering museum comparable to the foreign museums to record the accomplishments, in the upbuilding of this nation, of its engineers. The DeLamater-Ericsson Historical Collection will be exhibited first at the Annual Meeting of the Society in December. Later such part of it as will exhibit the contribution to civilization by the Swedish-American engineer, Captain Ericsson, will be sent to Sweden to the Tercentenary of Gothenburg to be held there from May to September, 1923. On its return, the whole collection will be placed in its permanent repository in the Smithsonian Institution in Washington, as the nucleus for the Engineering Section of the Museum.

It is desired to make this a national movement in which every engineer in the country will participate. Engineering societies and alumni associations of engineering schools are requested to communicate for further information with the Joint Committee on the National Engineering Museum, 29 W. 39 St. New York, N. Y.

---

[1] Chairman of the A.S.M.E. Committee on Awards and Prizes.

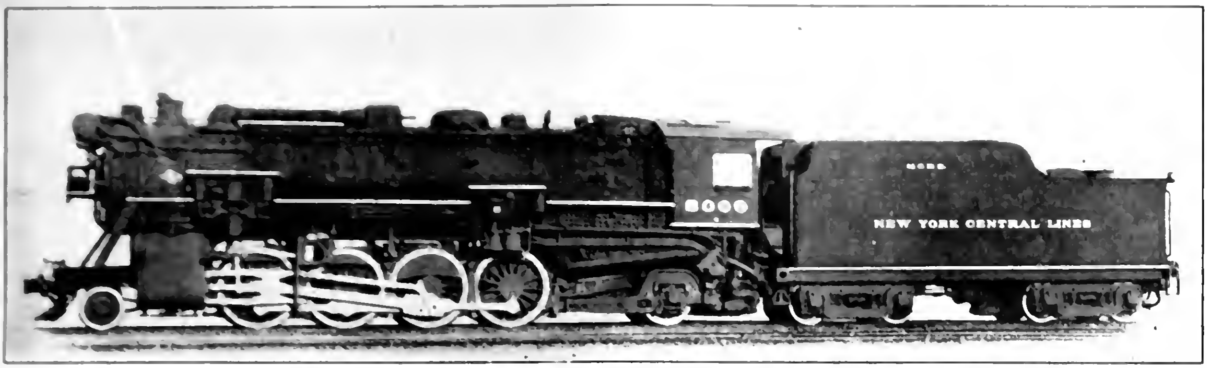


Fig. 1 The Novel Attachments, Shown Above, Contribute to Economical Operation

Remarkable Steam Locomotive Sets New Standard

Mikado for Heavy Fast-Freight Service on the Michigan Central Embodies New Devices and Principles That Insure Light Weight and High Economy

REGARDLESS of the gesture threatening electrification of railroads sometime in the future, the development of steam locomotives goes merrily on. The most recent example of remarkable progress is a new Mikado placed in heavy fast-freight service on the Michigan Central a little over two months ago. This machine embodies the results of a score of years of study and research and although no official tests have been taken, the performance has been so satisfactory that the order has been placed for one hundred and fifty according to the same detail specifications. In its initial road test, it hauled 100 heavily laden coal cars and later pulled a train of 140 cars containing more than 9000 tons of coal, this over the level division between Toledo and Detroit.

"No. 8000," as this extraordinary engine is designated, was built by the Lima Locomotive Works according to designs made under the supervision of President A. H. Smith of the New York Central Lines. To obtain a drawbar horsepower for the minimum fuel, weight and cost of repairs and to secure ease and safety of operation, the best known practices and devices have been incorporated.

The first requirement of maximum tractive effort for the minimum weight is an elimination of unnecessary weight and this has been accomplished, without sacrifice of strength, by refinements in design and by the use of alloy steels and hollow axles and crank pins. Without tender, the locomotive weighs 334,000 pounds The tender with its capacity of 10,000 gallons of water and 16 tons of coal, weighs 199,700 pounds. Maximum tractive effort of 74,500 pounds is obtainable, a booster on the trailer truck delivering 11,000 pounds. In a statement issued by the New York Central Lines, quoted recently in the *Railway Age*, attention is especially directed to the fact that, comparing No. 8000 with the heaviest Mikados in the Michigan Central service, No. 8000, with an increase in weight of only two per cent, has an increased tractive power of nearly eight per cent from the forward cylinders alone and with the booster cut in the increase is 26 per cent.

Fig. 2 The Feedwater Heater is Prominent

Perhaps the most noticeable change in this locomotive to achieve greater economy in fuel consumption is the addition of a feedwater heater. In the use of superheated steam a departure from common practice is the location of the throttle between the superheater and the cylinders and the use of superheated steam in the air pump, feedwater pump, booster engine and headlight turbo-generator. In Fig. 1 the dry pipe can be seen leading forward for connection with the superheater. The throttle box is ahead of the stack, an arrangement necessary for the use of superheat in the auxiliaries. A double arch, with eight supporting tubes, increases the effectiveness of the fire and improves the boiler circulation.

The feedwater heater is installed at the front of the engine over the headlight, high enough to return the condensate to the filter in the rear of the tender. The feedwater pump is shown on the left side of the locomotive. The boiler pressure is 200 lb. per sq. in. and the superheat at the cylinder is over 550 deg. fahr. The Type E superheater, using superheater tubes in every boiler flue, was applied. The cylinder diameter is 28 in. and the stroke is 30 in.

The cab design is such that the enginemen perform their duties with the minimum of movement and practically no physical effort. Precision power reverse gear, an Elvin stoker and a power grate shaker are installed for this purpose. The whistle is operated pneumatically. There is a water scoop on the tender.

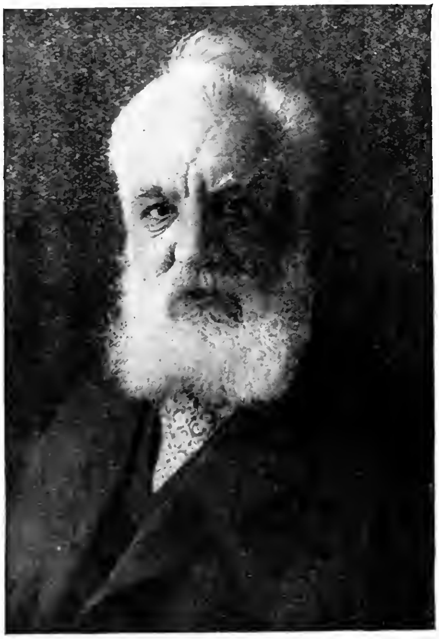
For many years, the development of steam locomotives was in size and weight but without systematic improvement in the making and using of steam. With the adoption of superheat, economy of operation was greatly improved but steam-locomotive design is still under great pressure to meet rigid requirements with definite limitations of size and weight and at the same time to equal the best results of marine and stationary practice. In this respect No. 8000, an embodiment of devices not new or radical, sets a new standard. Further, the elimination of weight and the refinements of design will lessen the dynamic augment

Steam locomotives must bear the burden of transportation in this country for some time to come and the development of this machine is a courageous movement toward better practice. The old rule demanding simplicity above all seems to have been discarded.

Alexander Graham Bell, Father of the 'Phone, Dies

ALEXANDER Graham Bell is dead. In the early morning of August 2, 1922, the great inventor passed quietly away at his summer estate in Nova Scotia. At sunset a few days later his body, clad in a homely tweed and corduroy suit similar to the one he wore in his laboratory, was laid to rest at the peak of Beinn Bhreagh Mountain overlooking the beautiful Bras d'Or lakes on whose waters he had experimented with speed boats and fast water sleds.

The inventor of the telephone was born in Edinburgh, Scotland, March 3, 1847. His grandfather, Alexander Bell, invented a system for overcoming stammering, and his father, Alexander Melville Bell, dean of British elocutionists, perfected a system of "visible speech" by which the dumb could speak. Young Bell was educated at Edinburgh and London where he acquired a smattering of music, electricity and telegraphy. His chief interest lay in the study of sound, and at the age of sixteen he was teaching elocution in the British schools and instructing deaf mutes.



Alexander Graham Bell

At twenty-two Bell was threatened with tuberculosis, a disease which had claimed his two brothers. His whole family migrated to Canada in 1870 and the next year he went to Boston University as professor of vocal physiology. His system of teaching deaf mutes won immediate recognition and his success encouraged him to open a school of his own. He went to live at the home of one of his pupils in Salem, and it was in the Sanders cellar after school hours that he started a series of inventions that were to culminate in the telephone.

In the winter of 1874, at an electrical workshop where he had taken his "harmonic telegraph," a device for sending a number of Morse messages over a single wire at the same time, Bell met Thomas A. Watson, who was employed there. From that hour Watson devoted most of his time to working out in brass and iron the ideas that came pouring out of Bell's brain. The two young men labored day and night in the workshop and in the Sanders cellar in Salem to demonstrate Bell's dream that an electric wire could carry the sound of the human voice. They worked while sane men gaped at them in pity.

In June, 1875, after months of experiments on the harmonic telegraph, something happened to convince Bell that at last he was on the right track. One of the transmitter springs of his telegraph instrument stuck, and the magnetized steel generated a current that sent a faint noise over the electric wire to Bell's receiver. This was the necessary proof that his principles were correct. Thereafter it was a question of working out details. On March 10, 1876, at a Boston boarding house, Bell, from his room on the top floor, spoke to Watson in another room, and Watson heard what was said. A week later Bell took out his first patent on the telephone.

The invention of the telephone was unique in a special sense in that it had not even been foreshadowed before its achievement. In later litigation on the Bell patent, the literature of the world was searched without finding a hint that anyone prior to Bell had even a vague thought as to how the electric transmission of speech could be effected. Possibly it was just this very fact that threw such stupendous financial difficulties in the way of the young inventor. The press reflected universal scepticism, and funds ran low for many months.

The story of the exhibit of the telephone at the Philadelphia Centennial Exposition on the day set aside for "freak novelties" has often been told, but not always in quite the way that Bell himself told it. According to Frederick P. Fish, former president of the American Telegraph and Telephone Company, to whom Bell repeated the story, the exhibit of the telephone created little attention. The various freak novelties were to be presented in order and the telephone appeared far down on the list. Sir William Thompson (Lord Kelvin) was to be present at the exhibition, and Bell was much excited at the prospect of having this eminent scientist see his invention. However, on the day of the exhibit, Sir William was delayed until it became so late that Bell thought his golden opportunity had been lost.

Finally Sir William came, and with him Dom Pedro, the Emperor of Brazil, a man of high attainment and very much interested in every phase of scientific work. Although Dom Pedro had once met Bell in connection with his work in teaching the dumb, Bell had no idea he would be remembered. But Dom Pedro grasped him cordially by the hand and when told of the invention of the telephone, asked to have it exhibited first of all. Both Sir William Thompson and Dom Pedro were greatly impressed and their outspoken enthusiasm went a long way toward attracting favorable attention to offset the universal scepticism of the public.

It was not until August, 1877, when there were 778 telephones in use, that the "Bell Telephone Association" was formed, Bell, Watson, Bell's father-in-law Gardener G. Hubbard, and Thomas Sanders, in whose cellar the invention was first started, were the members of the Company. Sanders was the sole financial backer. Bell was no business man, and after 1877 he had little active connection with the organization of the telephone industry. He married in that year one of his former pupils, went abroad to help introduce the telephone in England, returned, and with characteristic energy turned to experiments with flying machines.

Bell's inventions other than the telephone include the photophone, the induction balance, a telephone probe for the detection of bullets in the human body (for which he received an honorary M.D. from Heidelberg University at its 500th anniversary) and, with C. A. Bell and Sumner Taintor, the graphophone. It was his practice to keep complete records of his scientific researches, and the several hundred volumes containing these records cover a multiplicity of subjects from the utilization of waste heat to notes on eugenics and the biological history of a cat.

Dr. Bell had received many honors. In 1880 the French Government gave him the Volta Prix, and the engineering profession acknowledged his genius by bestowing the John Fritz Medal in 1907. He had received gold medals from The London Society of Fine Arts, the Royal Albert, the Elliott Cresson, and the Hughes Medal of the Royal Society of Arts. He was an officer of the French Legion of Honor. He founded and endowed with $250,000 the American Society to Promote Teaching of Speech to the Deaf. He was at one time President of the National Geographical Society, and was a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, and the American Association for the Advancement of Science.

The Treasure House of Aeroplane Design

McCook Field to Establish Museum of Aeroplanes and Aircraft Engines

ONE of the greatest difficulties encountered by designers of aircraft engines and aeroplanes lies in the inability to secure concise information about the various details of design. For example, the usual printed descriptions of an aeroplane engine tell about the number of cylinders, their dimensions and such main features, but when it comes to the exact location of the valves and the design of the cams, they are usually silent or indefinite. Even an inspection of the engine does not help in many cases as the desired part may be concealed from view and can be carefully studied only after the engine is dismantled. This cannot always be done for the sole benefit of the prospective designer.

The authorities of the Air Service, War Department, at McCook Field, took steps to remedy this situation for the benefit of their own engineering department as well as for legitimate use by other American engineers and manufacturers. During the war, through various agencies of the government, quite a collection of aeroplane engines of American, Allied and enemy origin was assembled at McCook Field, and this collection is to form the nucleus of the Museum of Aircraft Engine and Aeroplane Design now being installed in several hangars on the field.

The great value of this collection at McCook Field lies in the method of display adopted in place of the impressive but not always enlightening method of erecting engines on stands. Two engines have been secured for every type and one engine is placed on the stand completely assembled which gives a clear idea of its general construction and assembly. The other engine is entirely disassembled, the various parts being placed either in glass cabinets where they can be easily inspected and if necessary reached, or on shelves under the glass cabinets, these shelves containing mainly duplicate and very large parts. The designer, therefore, can easily inspect and measure any part of any of the engines shown in the Museum. There is no doubt that a few days spent in the Museum would give more information as to current practice in aircraft-engine and aeroplane design than could be obtained by any other means except extensive trips through the whole of Europe and the United States and visits to the factories. In a pocket by the side of each cabinet are placed printed descriptions, tracings, diagrams and such information as is available about each engine or plane. In addition any visitor who can show legitimate interest in this subject will be granted access to the bibliographical index files of the Engineering Division, McCook Field, in itself a veritable mine of information, often to be found nowhere else.

Fig. 1 A Disassembled Engine is Placed in the Cabinet

As it is impossible to apply the same method to aeroplanes on account of lack of space, somewhat simplified arrangements will show such details as construction of wings, landing gear, etc.

One of the most gratifying features of the McCook Field Museum is that there is no intention of making it a departmental preserve.

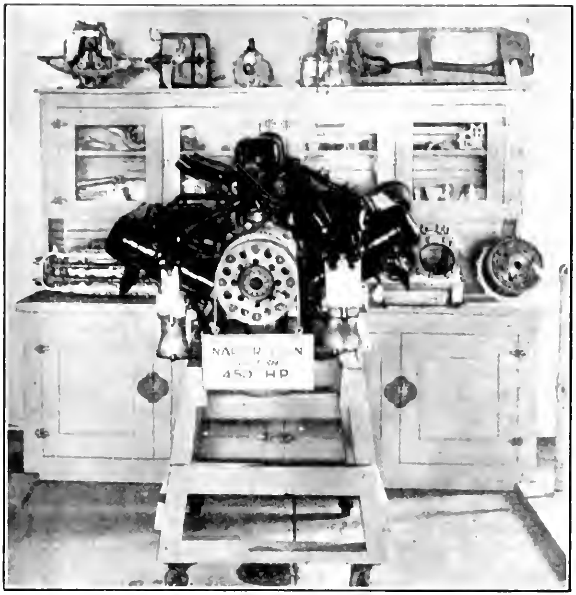


Fig. 2 The Engine and Cabinet are Available to American Designers

On the contrary, every facility of the Museum will be thrown open to any American engineer or manufacturer who can show a legitimate interest in this subject. Work is now proceeding on the construction of the cabinets and stands, and it is expected that the Museum will be opened the latter part of September.

Carbon Tetrachloride for Electric Fires

Engineers who look to the carbon tetrachloride fire extinguisher as the reliable aid in case of electric-arc fires will be interested in the recent report of the Bureau of Mines which acquitted the carbon tetrachloride extinguisher of the charge that the gases originated in the extinguisher caused the asphyxiation of a number of passengers in a New York City subway fire on July 6. A short circuit caused the fire in an express train on the Lexington Avenue Subway. The passengers were removed without casualty although it was necessary to take a number to hospitals so that they could be revived from the effects of fumes caused by the fire. At first it was thought that the carbon tetrachloride with which all subway trains are equipped caused the asphyxiation. The Report of the Transit Commission, which was assisted by the experts from the Federal Bureau of Mines, stated that the symptoms of the patients as shown in the hospital records can all be accounted for by the known effects of gases resulting from the burning of insulating materials such as rubber, varnish and paint, and that the symptoms given are not characteristic of phosgene or carbon tetrachloride poison. Furthermore, the Report states that carbon tetrachloride is a standard fire extinguisher in general use, approved by the National Board of Fire Underwriters and is particularly adapted for fires produced by short circuits in electrical equipment and apparatus because it is a non-conductor of electric current.

Engineering and Industrial Standardization

Fire-Hose Couplings

A NUMBER of conferences which have been held during the past two months have added new impetus to the campaign for an American Standard Fire-Hose Coupling. As far back as 1873 the importance of a universally adopted fire-hose coupling in the elimination of fire waste was recognized by those most directly connected with fire fighting.

At conventions of fire chiefs and the International Association of Fire Engineers this subject, received much attention, and finally a set of standard dimensions for the $2^{1}/_{2}$-, 3-, $3^{1}/_{2}$- and $4^{1}/_{2}$-in. couplings were agreed upon. In these early discussions the National Fire Protection Association, the New England Water Works Association, the American Water Works Association, and the National Board of Fire Underwriters took an active part. Later The American Society of Mechanical Engineers and the Bureau of Standards reviewed the work of the earlier committees and approved what was then generally known as the National Standard. The A.S.M.E. Committee's report was published in 1913 and the Bureau of Standard's Bulletin No. 50 appeared in 1914. Since that time a painstaking and consistent effort has been made by the National Board of Fire Underwriters to encourage the adoption of this standard coupling by the cities and towns of the United States. For those which had previously adopted a coupling whose pitch and outside diameter were slightly different from the standard this Board arranged for the development of a set of standardizing tools by a well-known firm of tap and die makers.

The Progress Report of the National Screw Thread Commission placed a stamp of approval on this fire-hose standard and completed it by the addition of a set of manufacturing tolerances. It was the discussion of these tolerances which was the immediate reason for the recent conferences. An agreement has been reached between the representatives of the National Board of Fire Underwriters, the National Screw Thread Commission, and The American Society of Mechanical Engineers. So it will probably not be long before the manufacture of standard fire-hose couplings will be placed on an interchangeable-production basis by the use of steel working gages which can be certified to by the Bureau of Standards.

It is proposed to present this standard in the near future to the American Engineering Standards Committee for approval as an American Standard.

Four New American Standards

Recent actions by the American Engineering Standards Committee have resulted in the following Standards:

SAFETY CODE FOR FOUNDRIES

This Code is a revision of that developed by the American Foundrymen's Association and the National Founders Association, joint sponsors of the new code. The revision was worked out by a thoroughly representative Sectional Committee organized under the Rules of the American Engineering Standards Committee and included four representatives of makers and owners of foundry equipment, four of governmental bodies, two of technical associations, two of insurance organizations, and a representative of foundry employees.

This new *tentative* American Standard Code No. 20 deals with foundry conditions only, omitting such subjects as building construction, exits, stairways, elevators, lighting, sanitation, etc., as these subjects are covered by other Safety Codes which have an official status before the American Engineering Standards Committee. The code consists of 124 sections which are grouped under the following twelve main divisions: entrances, floors, pits, and galleries, gangways, aisles, foundry equipment, finishing and cleaning, heating, ventilation, operating rules, protection devices, employment of females, and recommendations.

The Sectional Committee which revised the foundry safety code and recommended it for approval by the A.E.S.C. included representatives of the National Founders Association, the Association of Government Labor Officials, the U. S. Department of Labor, the American Foundrymen's Association, the National Association of Mutual Casualty Companies, the National Safety Council, the U. S. Bureau of Standards, the National Association of Manufacturers, the National Bureau of Casualty and Surety Underwriters, the American Society of Safety Engineers, and the U. S. Public Health Service.

NATIONAL ELECTRICAL SAFETY CODE

The National Electrical Safety Code of the Bureau of Standards which covers the generation, distribution and utilization of electricity for power, light and communication has been approved as American Standard No. 21.

In making public this decision, the Standards Committee announces that there is now in process of formation a thoroughly representative Sectional Committee to consider any revisions of Part 2 of this Code, Rules for the Installation and Maintenance of Overhead and Underground Electrical Supply and Signal Lines, which may be deemed necessary by any of the interested parties. There are also being organized three sub-committees to take up the unification of crossing specifications under the three following heads: Signal Lines Crossing Railways; Power Lines Crossing Railways; and Power Lines Crossing Signal Lines.

It is believed that this action, together with the organization of the representative committees to take care of the revision of the Code and to prepare the crossing specifications, constitutes one of the most important steps yet taken in securing national uniformity in these matters.

ILLUMINATING ENGINEERING NOMENCLATURE AND PHOTOMETRIC STANDARDS

This group of Standards as published by the Illuminating Engineering Society in 1918 has been approved as American Standard No. 22 with the substitution of six internationally agreed upon definitions for certain ones of the 1918 rules. The definitions which have been reworded are: luminous flux, luminous intensity, illumination, candle, lumen, and lux.

The special committee of the American Engineering Standards Committee which examined the proposal submitted by the I.E.S. and which recommended approval of the nomenclature and photometric standards included representatives of the U. S. Bureau of Standards, the American Gas Association, the American Physical Society, the International Acetylene Association, the Optical Society of America, the American Institute of Electrical Engineers, the Illuminating Engineering Society, and the National Electric Light Association.

SPECIFICATIONS FOR TESTING AND USE OF PERMISSIBLE EXPLOSIVES APPROVED

The specifications for the testing and use of permissible explosives submitted to the American Engineering Standards Committee by the U. S. Bureau of Mines has been approved by the A.E.S.C. as an American Standard. It therefore becomes American Standard No. 23.

The Special Committee of the A.E.S.C. which examined the proposed specifications and recommended them for approval by the Standards Committee included representatives of the U. S. Department of Interior, the American Mining Congress, the Coal Mining Institute of America, the Mine Inspectors' Institute of America, the American Society of Civil Engineers, the Institute of Makers of Explosives, and the U. S. Department of Agriculture.

Your Comment is Requested

Stacks. Some of our readers have proposed the standardization of the specifications on which the estimates for circular brick stacks are based. A few of the items which might be specified are: maximum wind pressure, maximum permissible stress in brickwork, amount of lining, etc. Should steel stacks also be considered?

Valves, Cocks and Faucets. During the past two months the American Engineering Standards Committee has carried on a considerable amount of correspondence with a view to determining

whether or not these products offer a field for standardization and, if so, what dimensions should be considered. The Committee needs all the guidance it can have.

Shop Drawing Sizes. Periodically the A.S.M.E. Standards Department receives an inquiry concerning the supposed A.S.M.E. standard sizes for shop drawings. There are no such standards but many firms have given considerable attention to the problem. Should this information be collected and studied by a properly organized committee for the purpose of developing a set of generally acceptable standard sizes?

BOOK NOTES

Beleuchtung der Bahnhöfe und der Bahnhofshochbauten. By Richard Sarre. Wilhelm Engelmann, Leipzig, 1922. (Handbuch der Ingenieurwissenschaften, 5. Teil, 5. Band.) Cloth, 7×10 in., 300 pp., illus. 151 M.

The primary object is to provide a discussion upon the principles and systems of lighting railway stations and railway office buildings. But since every existing method of lighting has been used for these purposes and since the principles of artificial lighting are of general application, the book is in reality a concise survey of methods of illumination and of the laws governing their use.

Les Colloides. Par J. Duclaux. Gauthier-Villars et Cie, Paris, 1922. (Actualités scientifiques.) Paper, 5×7 in., 305 pp. 10 fr.

This work does not purport to be encyclopedic. It is, rather, a concise statement of chosen facts woven into a coherent account, from a single point of view, with useless details and superimposed theories avoided. Certain modifications have been made in the new edition. The author is Director of the Laboratory of the Pasteur Institute.

Mathematical Theory of Probabilities. By Arne Fisher. Second edition, enlarged. The Macmillan Co., New York, 1922. Cloth, 6×9 in., 289 pp. $5.

The author's aim has been to treat all the modern researches upon this important branch of applied mathematics from a common point of view, based upon the mathematical principles laid down by Laplace, and to present a theory of probabilities as developed in recent years of value to the practical statistician, the actuary, the engineer and the biologist, as well as students of mathematics. The second edition is extended to nearly twice its original size by added chapters on frequency functions and their applications. Mr. M. C. Rorty contributes an introductory note indicating some of the practical applications of the theory of probabilities to business problems.

Les Progrès de la Métallurgie du Cuivre. Par Auguste Conduché. Masson et Cie; Gauthier Villars et Cie, Paris, 1922. (Encyclopédie Léauté.) Paper, 5×8 in., 254 pp., illus., 14 fr.

Considerable progress has been made in recent years in the metallurgy of copper, due in part to the technical improvement of machinery and plants, but still more to scientific investigation and to the careful utilization of the chemical reactions that occur. This book is a concise account of this progress. It provides a statement of present knowledge of the properties of copper, the effects of impurities, its alloys, and the methods of smelting and refining, with careful attention to scientific principles and to the economic factors. It also presents a typical example of the value of systematic research and scientific methods for the development of an industry.

On The Electro-Deposition of Iron. By W. E. Hughes. H. M. Stationery Office, London, 1922. (Dept. of Scientific and Industrial Research. Bulletin No. 6.) Paper, 50 pp., plates, 6s. 8½d.

Reports the results of an extensive laboratory investigation of the structure of electrodeposited iron, together with the author's conclusions regarding the influence of various factors upon this structure. The effects of temperature, current density, and movement of the cathode or electrolyte are given special attention. The conclusion is reached that the general theories entertained in regard to the crystallization of other substances hold also for deposited metal and that the dominant factor governing structure is concentration.

Pulling Together. By John T. Broderick. Robson & Adee, Schenectady, 1922. Cloth, 5×8 in., 144 pp., $1.

A discussion of current problems connected with the relations of capital and labor, with employee representation as the central theme. Dr. Steinmetz has contributed a brief introduction.

SYNTHETIC-GASOLINE PRODUCTION

(*Continued from page 595*)

B. = gravity of crude oil in degrees Baumé
n = percentage of natural gasoline of 58 deg. B. gravity in the crude
c = value of crude oil at refinery in dollars per bbl.
f = value of fuel oil at refinery in dollars per bbl.
s = value of gas oil at refinery in dollars per bbl.
a = percentage of artificial or synthetic gasoline in crude.

(1) Percentage of artificial gasoline obtainable by commercial cracking:

$$a = \frac{[100 - n]\,[35 + 1.45\,(B. - 10 - 0.3n)]}{100}$$

Total gasoline = $n + a$

(2) Cost (C_1) of gasoline per gallon when made by skimming only:

$$C_1 = \frac{c + 0.35 - f\,(0.95 - 0.01\,n)}{0.42\,n}$$

(3) Cost (C_2) of gasoline per gallon when made by cracking and skimming:

$$C_2 = \frac{c + 0.40 + a\,(0.0202 + 0.015\,f) - f\,(0.95 - 0.01\,n)}{0.42\,(a + n)}$$

(4) Cost (C_3) of gasoline per gallon when made by cracking gas oil:

$$C_3 = \frac{\$2.02 + 1.41\,s - 0.05\,f}{42}$$

Illustrations of Preceding Formulas

(1) Total gasoline from crude oils:

	Sp. Gr., deg. B.	Per Cent Natural	Per Cent Artificial	Per Cent Total
Mexia, Texas crude	37	5	68	73
Burkburnett, Texas	40	40	37	77
Ranger, Texas	38	25	49	74
Panuco, Mexico	12	5	34	39
Tuxpan, Mexico	17.5	15	32	47

(2) Cost (C_1) of gasoline by skimming only (c = $2.00 per bbl.; n = 25 per cent; B. = 37 deg.; f = $1.00 per bbl.):

$$C_1 = \frac{2.35 - 1\,(0.95 - 0.25)}{(0.42)\,(25)} = 15.7 \text{ cents per gal.}$$

(3) Cost (C_2) of gasoline by skimming and cracking, using values given in (2):

$$C_2 = \frac{2.00 + 0.40 + 47.4\,(0.0202 + 0.015) - (0.95 - 0.25)}{0.42\,(47.4 + 25.0)} = 11 \text{ cents per gal.}$$

(4) Cost (C_3) of gasoline made from gas oil with s = $1.25 and f = $1.00:

$$C_3 = \frac{\$2.02 + 1.75 - 0.05}{42} = 8.9 \text{ cents per gal.}$$

ACID-RESISTING METALS AND ALLOYS

(*Continued from page 580*)

of acid or combinations of acids other than sulphuric, namely, nitric, hydrochloric, hydrofluoric, acetic, stearic, oleic, etc., and outside of those with nitric acid, have been fairly successful. Most of the tests have been conducted with acids and solutions at normal temperature. When subjected to the higher temperatures the losses are much greater, and this makes the solution of the problem even more complex.

There are few known metals or alloys that will resist the action of nitric acid or a combination of nitric with other acids, and the general use of these few is either prohibited by their rareness and cost, or by the fact that they cannot be produced in such a way as to make them at all interesting from a commercial standpoint so far as mine pumps and accessories, apparatus for the chemical industries, etc., are concerned.

Metals and alloys which are required to be highly resistant to the effects of corrosion and erosion, and at the same time commercially practicable, must be of such a nature that they can be easily cast, rolled, drawn, and machined, so that all parts of a pump or other apparatus can be readily made from them, including piping, valves, etc., otherwise the field covered by such metals must be more or less confined and limited.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCOUNTING

Construction Projects. Accounting for Construction Projects, W. Paxton Little. Elec. World, vol. 79, no. 24, June 17, 1922, pp. 1211–1215, 18 figs. Commission regulation requirements give importance to proper accounting; actual unit-cost information needed as guide to engineers and executives; outline of specific methods that have been found successful.

AERONAUTICAL INSTRUMENTS

Air Service Tests. Air Service Tests New Instruments, S. R. Winters. Aviation, vol. 12, no. 26, June 26, 1922, pp. 755–756, 3 figs. Rate of climb indicator, bubble statoscopes and new barograph tested in balloon flights.

Sylphon Diaphragms. Sylphon Diaphragms, H. N. Eaton and G. H. Keulegan. Aerial Age, vol. 15, no. 15, June 26, 1922, pp. 370–372, 4 figs. Method for predicting their performance for purposes of instrument design.

AERONAUTICS

Government Laboratories, Aid. Government Laboratories Aid Aircraft Growth, P. M. Heldt. Automotive Industries, vol. 46, no. 26, June 29, 1922, pp. 1423–1426, 3 figs. Aeronautic session of S. A. E. develops discussion on aircraft performance formulas, government subsidies, and commercial flying. McCook field work is shown in motion pictures.

Standard Atmosphere. Standard Atmosphere, Willis Ray Gregg. Nat. Advisory Committee for Aeronautics Report no. 147, June 1922, 4 figs. Use of Toussaint's formula in determining standard atmosphere up to 33,000 ft. and tables showing values. Based in part on paper entitled An Aerological Survey of the U. S. to be published by Weather Bureau.

AIR COMPRESSORS

Centrifugal. A New Air Compressor (Ein Neuer Luftkompressor), E. Löwenstein. Deutsche Optische Wochenschrift, vol. 8, no. 22, May 28, 1922, pp. 413–414, 4 figs. Describes new compressor by Götz, having very high efficiency and requiring little power, for use in glass-blowing and technical glass industries.

AIRCRAFT

Research in America. America Makes Creditable Showing in Aircraft Research, Archibald Black. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1257–1265, 13 figs. Speed and reliability increased; helicopters; variable-pitch propeller; landing-field development; Handley Page slotted wing.

AIRPLANE ENGINES

Developing, Method of. A Method of Developing Aircraft Engines, Geo. E. A. Hallett. Soc. Automotive Engrs. Jl., vol. 10, no. 6, June 1922, pp. 457–462, 10 figs. Outline of procedure taken by Air Service before beginning actual design, and subsequent developments.

German, Siemens-Halske. A New German Aeronautical Engine, Erik Hildesheim. Aviation, vol. 12, no. 24, June 12, 1922, p. 693, 3 figs. Siemens-Halske 50–60 hp. air-cooled radial engine; first example of German post-war commercial design.

German 5-Cylinder Radial. A New Low-Power German Radial Air-Cooled Aero Engine. Flight, vol. 14, no. 23, June 8, 1922, pp. 326–327, 3 figs. Description of 60-hp. Siemens-Halske 5-cylinder, 4-stroke engine.

Metals for. Metallurgical Problems of the Airplane Engine (Le Probleme metallurgique pose par le Moteur d'Aviation), C. Grard. Aeronautique, vol. 4, no. 46, May 1922, pp. 156–165. Conditions metals must fulfill for construction of airplane engines.

Silencers. The Silent Airplane and the Silent Engine (L'avion silencieux et la moteur silencieux), Charles Dollfus. Aéronautique, vol. 4, no. 36, May 1922, pp. 145–147, 3 figs. Describes Schneebeli and Birger apparatus for reducing noise.

AIRPLANES

Aerofoils. Flow Tests on Slotted Aerofoils. Flight, vol. 14, no. 22, June 1, 1922, pp. 315–316, 15 figs. Some experiments on behavior of eddies at various points, angles and velocities as shown by means of sal-ammoniac smoke.

BaCo Skylark. The BaCo Skylark. Flight, vol. 14, no. 24, June 15, 1922, pp. 337–339, 5 figs. Description of two-seater tractor biplane fitted with 60-hp. Lawrence air-cooled engine. Constructed by Bethlehem Aircraft Corp.

Propulsion Efficiency vs. Performance. Propulsion Efficiency vs. Performance, Roy G. Miller and F. E. Seiler, Jr. Aviation, vol. 12, no. 25, June 19, 1922, pp. 716–719, 5 figs. Influence of propulsion efficiency on performance of airplanes demonstrated by some well known examples.

Performance Formulas. Airplane Performance Formulas, Edward P. Warner. Soc. Automotive Engrs. Jl., vol. 10, no. 6, June 1922, pp. 469–474, 7 figs. Process of deriving simplified formulas and consideration of elements such as minimum and maximum speeds, climbing ability, etc.

Slotted-Wing Theory. Theory of the Slotted Wing, A Betz. Nat. Advisory Committee for Aeronautics Technica Notes, no. 100, June 1922, 13 pp., 7 figs. Means of varying coefficient of lift, thereby reducing difficulties of taking off and landing and making greater flight speeds possible; suggestions for theories from which formulas may be developed. From Berichte u. Abhandlungen der Wissenschaftlichen Gesellschaft fur Luftfahrt, no. 6, Jan., 1922. See also Aerial Age, vol. 15, no. 15, June 26, 1922, pp. 366–368, 6 figs.

Two-Way. Introducing the Two-Way Airplane, John B. Flowers. Aviation, vol. 13, no. 1, July 3, 1922, pp. 9–10, 1 fig. Tentative design presented to stimulate thought in this direction and criticism of idea, by well-known aeronautical engineer.

AIRSHIPS

Wright Dirigible Engine. The Wright Dirigible Engine and Its Development for the Navy, George J. Mead. Aerial Age, vol. 15, no. 15, June 19, 1922, pp. 342–343. Six-cylinder, vertical, water-cooled engine with 1850 cu. in. displacement, weighing 1320 lb. and developing 400 hp.

ALLOYS

See ALUMINUM ALLOYS, NICKEL ALLOYS, ZINC ALLOYS.

ALUMINUM

Coating With. Coating With Aluminum (Les recouvrements par l'aluminium), Léon Guillet. Révue de Métallurgie, vol. 19, no. 5, May 1922, pp. 296–297. Describes various processes and their successful application.

ALUMINUM ALLOYS

Aluminum-Silicon. Aluminum-Silicon Alloys and Their Industrial Uses (Les alliages aluminium-silicum et leurs emplois industriels), Leon Guillet. Révue de Métallurgie, vol. 19, no. 5, May 1922, pp. 303–310, 15 figs. Reviews development of this type of alloy and discusses new types and their properties.

Aluminum-Zinc. A Study of Alloys of Aluminum and Zinc, D. Hanson and Marie L. V. Gayler. Raw Material, vol. 5, no. 5, June 1922, pp. 174–181, 29 figs. Results of experiments on work along this line; effects of age hardening. Paper read before British Inst. of Metals.

Light. Light Aluminum Alloys, Prof. F. C. Lea. Metal Industry (Lond.), vol. 20, no. 23, June 9, 1922, pp. 533–536, (includes discussions), 2 figs. Effect of various combinations on melting point and characteristics of alloys. From paper read before Inst. of Metals.

Melting and Pouring. Melting and Pouring Aluminum Alloys. Am. Mach., vol. 57, no. 1, July 6, 1922, pp. 1–4. Proper care of furnace; effect of melting and pouring temperatures on castings; how to overcome foundry difficulties.

[See also DURALUMIN.]

AMMONIA

Capacity Table. A Pound of Ammonia, John E. Starr. Refrig. World, vol. 57, no. 6, June 1922, pp. 19–20. Table showing work of a pound of ammonia when heat is received at various temperatures and discharged at various other temperautres.

Chart, Bureau of Standards. The New Bureau of Standards Ammonia Chart. Ice & Refrigeration, vol. 62, no. 6, June 1922, pp. 461–464, 2 figs. Historical facts; nature of chart, properties of anhydrous ammonia which are represented; characteristic curves to show properties; phases of cycles of operation; some common cycles of operation shown graphically.

ASHES

Use for Refiring. Ash Treatment (Ashen-Aufbereitung), F. A. Gruessner. Technische Blätter, vol. 12, nos. 8 and 9, Feb. 25 and Mar. 4, 1922, pp. 81–82 and 89–90, 3 figs. Feb. 25: Discusses processes of preparing ashes for refiring, such as magnetic separation. Mar. 4: Detailed discussion of magnetic separation.

Washing for Refiring. Utilization of Ashes (Aufbereitung von Feuerungsrückständen), G. Reder. Archiv für Wärmewirtschaft, vol. 3, no. 5, May 1922, pp. 83–87, 15 figs. Describes number of plants for washing ashes for reuse under boilers.

AUTOMOBILE ENGINES

Air-Cooled. Air-Cooled Engines Subject of Widespread Current Research, J. Edward Schipper. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1214–1218, 7 figs. Producing cooling at hottest points on combustion chamber wall. General Motors copper-cooled car near production.

Citroen, Fuel Economy. Citroen Which Lowered World's Fuel Consumption Record, W. F. Bradley. Automotive Industries, vol. 46, no. 26, June 29, 1922, pp. 1434–1435, 2 figs. New detachable head engine used in fuel trials; total valve head diameter $1\frac{1}{8}$ in.; reciprocating parts lightened; compression from 65–68 lb.; lubrication follows standard lines; 1-section connecting rods; rocker arms mounted on two separate shafts.

Diesel Type. Small Diesel Type Automotive Engine Now in Production. Automotive Industries, vol. 46, no. 24, June 15, 1922, pp. 1320–1321, 2 figs. Four-cylinder Austrian engine designed to avoid excessive compression and combustion pressures, thus

---

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

reducing strain on working parts. Hindl engine can be started by means of hand crank and operates at speed of 1150 r. p. m.

Economy and Flexibility Aims. Better Economy and Flexibility Are Chief Aims of Engine Development, Herbert Chase. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1266–1269, 4 figs. Research and development work tending towards 40 miles per gal., lower speed and higher torque, nonthrottling engines.

Lubrication. Oil-Pumping, Geo. A. Round. Soc. Automotive Engrs. Jl., vol. 10, no. 6, June 1922, pp. 309–312, 4 figs. Factors controlling rate of oil consumption, methods of lubrication, including splash and force-feed systems, oil-pumping troubles.

Oil Consumption. Oil Consumption, A. A. Bull. Soc. Automotive Engrs. Jl., vol. 10, no. 6, June 1922, pp. 313–322, 19 figs. Fundamental factors affecting oil consumption. Methods of testing.

Overhead Camshaft. Overhead Camshaft Passenger-Car Engines, P. M. Heldt. Soc. Automotive Engrs., vol. 10, no. 6, June 1922, pp. 489–498, 19 figs. Adoption of overhead valves in automobile engines, their use on American cars greatly increased.

Pistons, Light-Metal. Light-Metal Pistons for Automobile Engines. Engineering, vol. 113, no. 2945, June 9, 1922, pp. 716–718, 3 figs. Competitive tests under auspices of German Transport Ministry and Verein Deutscher Motorfahrzeug-Industrieller by Prof. Gabriel Beckee.

AUTOMOBILE FUELS

Alcohol. Alcohol Motor Fuel Research. Petroleum Times, vol. 7, no. 176, May 20, 1922, pp. 711–712. Report of four series of tests which showed that all speeds, both with high and low compression, thermal efficiency obtained with alcohol was higher than that obtainable with petrol or benzol at any compression which could be employed with them.

Detonation of, Blended. Detonation Characteristics of Some Blended Motor-Fuels, Thomas Midgley, Jr. and T. A. Boyd. Soc. Automotive Engrs. Jl., vol. 10, no. 6, June 1922, pp. 451–456, 5 figs. Effects of admixtures of various percentages of alcohol and alcohol-benzine for reducing detonating tendency of paraffin hydrocarbons.

Low-Volatile. Can Less Volatile Motor Fuels Be Used Successfully? F. C. Mock and M. E. Chandler. Automotive Industries, vol. 46, no. 25, June 22, 1922, pp. 1372–1376, 8 figs. Proper fuel preparation prior to combustion involves formation of continuously homogeneous mixture without liquid film or drops at lowest possible temperature. Advantages and disadvantages of present methods of heat application. Condensed from paper read before Soc. Automotive Engrs.

Research, Effect on Industry. Automotive Engineering Development Rests Largely on Fuel Research, Herbert Chase. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1219–1231, 16 figs. Gasoline substitutes used in other countries; cracking processes developed; work of Ricardo and Kettering.

AUTOMOBILE INDUSTRY

André Citroen Plant, France. The André Citroen Establishments. Engineering, vol. 113, no. 2945 June 9, 1922, pp. 705–708, 5 figs. Description of plant where sixty 10-hp. automobiles are turned out daily. Some details of buildings which cover 20 acres.

British Research, Economy. British Automotive Research Devoted to Securing Operating Economy, M. W. Bourdon. Automotive Industries, vol. 46, no. 24, June 15, 1922, pp. 1322–1324. Use of combined oil and air cooling for engines being studied in several quarters. Experiments proceeding to further use of light alloys in chassis construction. Reducing bus operating costs.

Canadian Plant at Ford, Ont. Producing 55,000 Cars and Trucks a Year. Can. Machy., vol. 27, no. 25, June 22, 1922, pp. 26–31, 11 figs. Outstanding features of Ford Motor Co. of Canada at Ford, Ontario.

General Motors Plant, Chicago. Making Five Types of Cars At One Plant. Can. Machy., vol. 27, no. 25, June 22, 1922, pp. 35–37, 6 figs. Outstanding features of plant where two types of Chevrolet, McLaughlin-Buick, Oldsmobile and Oakland are turned out for Canadian consumption.

Research in Iron and Steel. Better Cars and Trucks May Result from Iron and Steel Research, P. M. Heldt. Automotive Industries, vol. 46, no. 23, June 8, 1922, p. 1270. Study of chrome-molybdenum steel, high-carbon steel brake drums, resistance-to-wear investigation and heat treatment.

Research in Light Metals. Light Metal Research Will Affect Future Car and Truck Design. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1278–1279. New all-aluminum car. Rosenhain's aluminum alloy for pistons. Germans light alloys in high-speed engines. Aluminum forging and soldering.

Research in Non-Ferrous Metals. Non-Ferrous Metal Research Affects Design of Small Automotive Parts. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1259–1260. New coefficient of expansion determined for nickel; properties of monel metal; bearing flux.

S.A.E. Standard Report. New S.A.E. Standard Report of Interest to Many Manufacturers. Automotive Industries, vol. 46, no. 24, June 15, 1922, pp. 1329–1336, 10 figs. Recommendations covering bumper mountings, oil-drain plugs, spring steel, truck-axle parts, electrical equipment, tractor drawbar adjustment, bronze and aluminum sheet, bearing metals, ball studs, screw threads and serrated fittings are important to vehicle as well as to parts makers.

AUTOMOBILES

Differentials, With and Without. With and Without the Differential, G. E. Bradshaw. Autocar, vol. 48, no. 1382, April 15, 1922, pp. 611–613. Upholding argument that differentialless axle is not suitable for touring cars.

Suspension. New System of Spring Suspension for Automotive Vehicles, H. M. Crane. Soc. Automotive Engrs. Jl., vol. 10, no. 6, June 1922, pp. 463–465, 2 figs. History; Hotchkiss drive for shaft driven cars, rear-axle mountings and device developed by author.

Taxicabs, European. New European Taxicabs Are Designed for High Economy, W. F. Bradley. Automotive Industries, vol. 46, no. 24, June 15, 1922, pp. 1316–1319, 3 figs. Citroen with small four cylinder engine, 111-in. wheelbase and 46-in. track, and body seating only two passengers has proved highly successful. 3200 Renault cabs with larger engine, same wheelbase, 56-in. track, and four-passenger body are now competing.

Transmission, Mechanical Shift. Gear Transmission with a Mechanical Shift, H. O. Herzog. Am. Mach., vol. 57, no. 1, July 6, 1922, p. 17, 5 figs. on p. 16. Describes Saden gear shift, a German device; 4 speeds and reverse; operator merely selects speed desired, shift is mechanical.

Trojan Two-Stroke. The 10 Hp. Two-Stroke Trojan. Autocar, vol. 48, no. 1392, June 24, 1922, pp. 1071–1073, 9 figs. Small utility car incorporating novel two-stroke engine, epicyclic gear, and solid tires.

Waverley. The New 10–15 Hp. Waverley Car. Auto, vol. 27, no. 23, June 8, 1922, pp. 467–470, 12 figs. New and lighter model of well known London-made car with Coventry-Simplex, four-cylinder monobloc engine.

Webb Light Car. The Webb Light Car. Auto, vol. 27, no. 24, June 15, 1922, pp. 489–491, 11 figs. Description of British car of pleasing design, four-cylinder Alpha engine of 1,088 cc. piston displacement.

AVIATION

Traffic Law Proposed. Proposed Air Traffic Law, Geo. Ripert. Aerial Age, vol. 15, no. 14, June 12, 1922, pp. 320–323. Suggestions for international laws deduced from those adopted at international conventions and by various governments.

B

BEAMS

Plate. Dimensions of Plate Beams (Dimensionierung Einfach Bewehrter Plattenbalken), Leo Báron. Bauingenieur, vol. 3, no. 9, May 15, 1922, pp. 273–275. Gives new, simplified, expeditious and reliable method of calculation, and explains it by practical examples.

BEARING METALS

Babbitt. The Microstructure of Babbitt Metal, A. McArthur Johnston and R. W. Irwin. So. African Instn. of Engrs. Jl., vol. 20, no. 10, May 1922, pp. 197–211, 21 figs. Characteristics, construction, and properties of alloys recommended by Chamber of Mines Eng. Standardization Committee; nature of microstructure o feach alloy and physical properties likely to be found.

White-Metal and Red-Brass. White Metal and Red Brass Bearing Metals for Machines, Bushings, Collars, Etc. (Weissguss- und Rotguss-Lagermetalle für Maschinen, Lagerfutter, Zapfenlager usw). Zeit. für die Gesamte Giessereipraxis, vol. 43, no. 23, June 10, 1922, pp. 316–317. Composition of bearing metals, especially for machine tools; gives tables of percentages of tin, zinc, antimony, copper, lead, etc., also of their mechanical properties, elasticity, tensile strength, elongation, hardness, construction.

BEARINGS

Babbitted, Troubles. Fourteen Causes of Trouble With Babbitted Bearings, L. D. Allen. Belting, vol. 20, no. 6, June 1922, pp. 55–56, 1 fig. Points that should be investigated when bearings give trouble.

Motor. Some Pointers on Bearings, A. L. Gear. Elec. Rev. & Indus. Engr., vol. 80, no. 6, June 1922, pp. 265–270, 309–310, 13 figs. Sleeve-bearing materials, design and construction.

Steam-Engine, Lubrication of. The Problem of Lubricating Steam-Engine Bearings, W. F. Osborne. Power, vol. 56, no. 2, July 11, 1922, pp. 53–54, 1 fig. Method of lubrication; effect of characteristics of engine on selection of suitable lubrication.

BEARINGS, BALL

Advantages. On the Quality of Various Bearings and the Advantages of Ball Bearings (Note sur les qualités générales des divers paliers de transmissions, avantages des paliers à billes), H. Bursic. Révue Générale de l'Électricité, vol. 11, no. 21, May 27, 1922, pp. 792–794, 3 figs. Progress made in recent years in journal bearings and SKF ball bearings.

BELT DRIVE

Power Transmission by. Power Transmission by Belting. Machy. (Lond), vol. 20, no. 507, June 15, 1922, pp. 325–327, 4 figs. Characteristics of leather belting and charts for simplifying calculations.

Power Transmitted. How Much Power is Belt Transmitting? W. F. Schaphorst. Nat. Engr., vol. 26, no. 6, June 1922, pp. 268–269, 1 fig. Simple method of determining from easily obtained instruments.

BELTING

Cellulose. Experiments With Cellulose Belting (Versuche mit Zellstofftreibriemen), M. Rudeloff. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 19 and 20, May 13 and 20, 1922, pp. 466–469 and 491–494, 23 figs. May 13: Equipment for experiment, details of testing operation and conditions under which each test was carried out. May 20: Discusses friction in ball bearings in pulley-driven machinery; determination of useful work; records of revolution counters.

Grain Elevators. Belting Systems in Two Large Grain Elevators, D. R. Egbert. Belting, vol. 20, no. 6, June 1922, pp. 13–17, 6 figs. Reconstructed C. & N. W. elevator contains $8^1/_2$ miles of conveyor and elevator belt; New Orleans public elevator; four installations compared.

Slide Rule, Calculation by. The Improved Belt Slide Rule, Carl G. Barth. Management Eng., vol. 2, no. 6, June 1922, pp. 351–354, 2 figs. As now constructed it solves problems for three classes of belts, viz., machine, heavy countershaft, and light countershaft.

BLAST FURNACES

China. New Steel Plant is Wholly Chinese. Trans-Pacific, vol. 6, no. 4, April 1922, pp. 72–74, 1 fig. Some details of 250-ton blast furnace of Lungyen Min. Administration near Peking which is expected to make iron this spring.

Fuel Economy. The Alabama Company's No. 1 Stack Breaks Production Record on Low Fuel Consumption, H. R. Stuyvesant. Blast Furnace & Steel Plant, vol. 10, no. 6, June 1, 1922, pp. 343–346, 1 fig. Production increased 17 per cent, coke consumption decreased 30 per cent; labor force reduced 50 per cent.

BOILER FEEDWATER

Feeding Compound with. Methods of Feeding Boiler Compound With the Feed Water, W. H. Wakeman. Southern Engr., vol. 37, no. 4, June 1922, pp. 43–45, 4 figs. Description of successful application.

BOILER FIRING

Half-Gas. Improvements in Half-Gas Firing (Neuerungen an Halbgas-Feuerungen), Graafen. Braunkohle, vol. 21, no. 6, May 13, 1922, pp. 113–120 and (discussion) 120–124, 18 figs. Describes Völcker, Peretti, Bergman, and other types of firing systems.

BOILER PLATES

Strength and Elasticity. Strength and Elasticity of Boiler Plate at Elevated Temperatures, H. J. French. Chem. & Met. Eng., vol. 26, no. 26, June 28, 1922, pp. 1207–1209, 3 figs. Proportional limit maintained or increased with first temperature rise; tensile strength has slight maximum at about 250 deg. cent., but both fall off badly at higher temperatures; reduction and elongation have minimum at about 260 deg. cent., but recover their original value around 450 deg. cent.

BOILER TUBES

Safe Ends, Electric Welding. Electrically Safe Ending Boiler Tubes, J. J. Sullivan. Boiler Maker, vol. 22, no. 6, June 1922, pp. 153–154, 2 figs. Summary of results in safe ending boiler tubes and flues with Thomson electric butt welder at Nashville, Chattanooga & St. Louis Ry., Nashville, Tenn.

BOILERS

Electrically Heated. Production of Steam and Hot Water in the Electric Boiler (Dampf- und Warmwassererzeugung in elektrischen Dampfkesseln), Hindelang. Zeit. des Bayer. Revisions-Vereins, vol. 26, no. 10, May 31, 1922, pp. 84–85, 1 fig. Providing hot water to Municipal Bath and German Museum in Munich.

Fire Bridges. Arches in Central Heating Boilers (Schamotte-Einbauten in Zentralheizungs-Kesseln) de Grahl. Glasers Annalen, vol. 90, no. 12, June 15, 1922, pp. 215–221, 5 figs. Nassel fire bridge and tests made to establish its efficiency, including flue-gas analysis, determination of heat losses, etc.

Ladd-Belleville. Large Units of Modern Boiler Plants (Les grandes unités des chaufferies modernes), C. Radiguer. Révue Générale de l'Électricité, vol. 11, no. 24, June 17, 1922, pp. 897–906, 6 figs. Describes Ladd-Belleville boilers at Ford plant on River Rouge, their operation, upkeep, firing with gas and pulverized coal, etc.

[See also LOCOMOTIVE BOILERS.]

BOILERS, WATER-TUBE

Spearing, Manufacture of. The Manufacture of the Spearing Boiler. Eng. Rev., vol. 35, no. 11, May 1922, pp. 379–381, 3 figs. Facts about design, manufacture and testing of this comparatively new type.

BRASS

Forgings. Brass Forgings, C. G. Heiby. Metal Industry (N. Y.), vol. 20, no. 6, June 1922, pp. 220–221. How produced; chilled cast blanks; composition of metal; microstructure of forgings. Paper read at Convention of A.F.A.

The Development of Brass Forging, Oscar T. Roder. Forging & Heat Treating, vol. 8, no. 6, June 1922, pp. 256–259, 7 figs. Art of working brass while hot; general details of process of presses used and of die construction; composition; physical properties; microstructure of forgings and castings.

BRAZING

Dip Brazing and Heat Treatment. Dip-Brazing With 80:20 Brass and the Heat Treatment of Brazed Joints, E. V. Schaal. Chem. & Met. Eng., vol. 26, no. 24, June 14, 1922, pp. 1121–1125, 9 figs. Satis-

factory methods for dip brazing; strengths of joint and effect of heat-treatment; metallography of brazed joints; strength of bond between brass and steel.

BUSES

Trolley, Overhead Materials for. Overhead Materials and Current Collection Equipment for Trolley Bus Lines, M. W. Manz. Bus Transportation, vol. 1, no. 6, June 1922, pp. 327–330, 12 figs. Advantages of continuing use of present standards as far as practicable. Details of trolley harp, base and overhead special work design.

C

CABLEWAYS

Aerial. The Use of Electric Telphers for Conveying, in Dock Operations (Die Verwendung der Elektrohangebahn im Hafenbetrieb), Martin Bruckmann. Schiffbau, vol. 23, no. 37, June 14, 1922, pp. 1086–1092, 16 figs. Mechanical conveying by means of aerial cables, electric telphers, and cable cranes, and their operation in loading and unloading ships.

CANS

Seaming, Special Machines for. Building Special Machines for Can-Seaming, Arthur Mumper. Machy. (N. Y.), vol. 28, no. 11, July 1922, pp. 899–902, 3 figs. Highly developed type of single-purpose machine which closes ends of cylindrical tin containers.

CAR CONSTRUCTION

Side Frame. A One Piece Wrought Steel Truck Side Frame. Ry. Rev., vol. 70, no. 24, June 17, 1922, pp. 918–920, 6 figs. Symington type which is sheared and formed under hydraulic press; electric welded in final form.

CAR LIGHTING

Generator, Direct-Drive. Direct Driving Axle Generators for Passenger Cars. Ry. Rev., vol. 70, no. 25, June 24, 1922, pp. 972–974, 5 figs. Am. Ry. Assn. committee on train lighting and equipment report direct drive still in development stage. (Abstract.)

Generator, Body Suspension. Long Island Changes Generator Suspensions. Ry. Elec. Engr., vol. 13, no. 6, June 1922, pp. 190–192, 2 figs. Truck mounted machines placed on car bodies show economy by giving greater belt mileage.

CARS

Dump. Car Tippers and Automatic Unloading Cars (Wagenkipper und Selbstentladewagen), Wintermeyer. Verkehrstechnik, vol. 39, no. 23, June 9, 1922, pp. 317–320, 10 figs. Principles of construction of cars for coal, coal, ore, sand and similar material; automatic unloading to keep cars in circulation.

CARS, COAL

N. & W. Ry., 120-Ton. Coal Car of 120-Tons Capacity—Norfolk and Western Railway. Ry. & Locomotive Eng., vol. 35, no. 6, June 1922, pp. 142–145, 7 figs. Details of construction and design.

CASE-HARDENING

Distortion. Distortion Produced in Casehardening, A. A. Blue. Am. Mach., vol. 56, no. 25, June 22, 1922, pp. 915–916, 3 figs. Consistent minimum warpage in manganese steel; large holes decrease, small holes increase when carbonized; greater wall thickness produces greater effect.

Steel, Failures. Causes of Failures in Case-Hardening Steel. Iron Age, vol. 109, no. 26, June 29, 1922, pp. 1807–1808. Non-metallic impurities, chiefly dissolved oxides, responsible in many cases in which hardening process has been thought at fault.

Selective. Selective Case-Carburizing, W. P. Wood and O. W. McMullan. Chem. & Met. Eng., vol. 26, no. 23, June 7, 1922, pp. 1077–1080, 4 figs. Review of various methods of producing local cases; in general, electrodeposited copper has furnished best protection; non-metallic coating whose application and removal presents no great difficulties is described.

CAST IRON

American vs. British. American Versus British Grey Cast Iron, F. J. Cook. Can. Foundryman, vol. 13, no. 6, June 1922, pp. 26–32, 7 figs. Superior qualities of British iron shown; sulphur and phosphorus not as detrimental as generally believed; soft castings depreciate value of American machinery.

CASTINGS

Centrifugal. Centrifugal Castings, N. Lilienberg. Blast Furnace & Steel Plant, vol. 10, no. 7, July 1922, pp. 375–379, 9 figs. States advantages of making centrifugal castings in vertical molds rather than in horizontal molds as is customary; theoretical calculations necessary for method are given.

Cutting and Welding. Cutting and Welding of Castings, G. O. Carter. Iron Trade Rev., vol. 71, no. 2, July 13, 1922, pp. 107–110. Minimum interruption caused by changing of tips, altering of pressures, etc.; castings should be segregated according to size of risers. Paper read before Am. Foundrymen's Convention.

Feeding Heads, Without. The Making of Castings Without Feeding Heads, E. Ronceray. Foundry Trade Jl., vol. 25, no. 302, June 1, 1922, pp. 393–397. Suggestions of importance in practice which would obviate necessity for heads in many cases. Paper read before Inst. British Foundrymen.

Plaster Molds for. Plaster Molds for Small Castings. Machy. (Lond.), vol. 20, no. 509, June 29, 1922, pp. 398–399, 2 figs. Advantageous features for models and exacting commercial work.

CEMENT MANUFACTURE

Fusion Process. Possibilities of Fusion Process for Cement Production, S. L. Meyers. Concrete, vol. 20, no. 6, June 1922, pp. 105–107, 5 figs. This process contains fuel economy possibilities that rotary kiln with sintering methods does not.

CEMENT MILLS

Iowa. Building and Operating Iowa's First Cement Plant, W. T. Christine. Cement, Mill & Quarry, vol. 20, no. 10, May 20, 1922, pp. 25–34, 19 figs. Plant was put into operation in 1908; intricate process of cement manufacture; waste-heat boiler furnishes all power to operate plant.

CEMENT, PORTLAND

Chemical Analysis. Interpreting the Chemical Analysis of Portland Cement, J. C. Witt. Cement & Eng. News, vol. 34, no. 6, June 1922, pp. 21–23. Suggested system of recasting has not demonstrated relationship of results with physical behavior.

CENTRAL STATIONS

Superpower. The Superpower Undertaking in Styria (Austria) (Das steirische Grosskraftwerksunternehmen), Richard Hofbauer. Elektrotechnik u. Maschinenbau, vol. 40, no. 23, June 4, 1922, pp. 265–269. Discusses power works of Enns group, Mur groupe, water storage works at Teigitsch and Mixnitz, and districts they supply with power.

CLUTCHES

Magnetic. Magnetic Clutches in the Cement Industry, W. H. Costello. Cement, Mill & Quarry, vol. 20, no. 11, June 5, 1922, pp. 23–24. Transmits from 600 to 800 hp. Torque requirements; starting tube mill; shaft alignment.

COAL

Briquetting. Briquetting of Peat (Brikettierung von Rohtorf oder Kohlenschlamm durch maschinelle Druckentwässerung ohne Bindemittel), Kampers. Technische Blätter, vol. 12, no. 5, Feb. 4, 1922, pp. 49–51, 4 figs. Processes depending on extracting water by pressure.

Production Costs. Analyzing the Cost of Producing Anthracite, S. D. Warriner. Min. & Metallurgy, no. 187, July 1922, pp. 7–9. Explanation of wide difference in price to consumer from labor cost in mine.

Steaming. Coal Steaming, A. W. Binns. Power Plant Eng., vol. 26, no. 12, June 15, 1922, pp. 595–598, 8 figs. Costs, steam consumption and mechanical details.

COAL HANDLING

Equipment for Ash and. On Coal and Ash Handling Equipment, Harry R. Westcott. Power House, vol. 15, no. 10, May 20, 1922, pp. 25–29 and 42. Numerous types of apparatus for these purposes are described in outline, and suitability of one or other is indicated under differing conditions.

COKE

Non-Coking Coals. Coke from "Non-Coking" Coals. Iron & Coal Trades Rev., vol. 104, no. 2828, May 12, 1922, pp. 708–709. Process of heating non-coking coals so rapidly that resinous content is decomposed before excessive oxidation occurs.

COMPRESSED AIR

Interfactory Mail Despatch. Development of Flat Postal Tubes for Conveying Sheets of Paper to Distant Departments (Die Entwicklung der Flachrohrpost fur die Beförderung von Zetteln in Fernämtern), Carl Beckmann. Ziet. für Fernmeldetechnik Werk- und Gerätebau, vol. 3, no. 5, May 16, 1922, pp. 77–82, 21 figs. System of pneumatic conveying which does without condensers, documents being conveyed direct by air to distant parts of factory.

COMPRESSORS

See AIR COMPRESSORS.

CONCRETE

Alkali Action. The Effect of Alkali Upon Concrete, S. H. McCroy. Cement & Eng. News, vol. 34, no. 6, June 1922, pp. 17–18. Decomposition caused and explanations of it offered. No method known of preventing such deterioration, but impermeability retards it. Recommendations as to aggregate, proportioning and placing of concrete.

Lumber. Concrete Lumber Industry Is Growing, W. A. Scott. Concrete Products, vol. 22, no. 6, June 1922, pp. 29–31, 8 figs. Company in California has developed system of manufacture which is leased in assigned territory.

CONCRETE CONSTRUCTION, REINFORCED

Calculation. Reinforced-Concrete Construction Work and Calculations (Rechnung und Konstruktion im Eisenbetonbau), Robert Otzen. Bauingenieur, vol. 3, no. 9, May 15, 1922, pp. 262–266, 1 fig. Methods of calculating cross sections, stresses, etc., develops formulas and gives examples of application.

CONDENSERS, STEAM

Air Pumps for. The C. M. and M.-Delas Air Extractor. Electrician, vol. 88, no. 2300, June 16, 1922, pp. 718–719, 3 figs. Results of tests made in Paris workshops of Société Condenseurs Délas.

Tube Packing. Condenser Tube Packing. Am. Mar. Engr., vol. 17, no. 6, June 1922, pp. 25–31, 17 figs. Underlying causes of corrosion and an easy economical solution of problem.

COOLERS

Live-Steam. Live-Steam Coolers (Heissdampf-Kühlapparate). Archiv fur Wärmewirtschaft, vol. 3, no. 5, May 1922, pp. 91–92, 4 figs. Describes cooler built by Sieffert & Co., A. G., for cooling live steam to be used in manufacturing where waste-steam supply is insufficient.

CORES

Machines for Manufacture of. Production of Cores by Means of Machines (Die Herstellung von Kernen mettels Maschinen), Georg Hoffmann. Giesserei-Zeitung, vol. 19, nos. 13 and 15, Mar. 28, and Apr. 11, 1922, pp. 199–203 and 241–245, 33 figs. Mar. 28: Detailed description of American and hydraulic core machines. Apr. 11: Describes large and small types of core-making machines.

CORROSION

Iron and Steel. Corrosion of Iron and Steel—Influence of Molecular Concentration on Immersion-Test Investigations, D. M. Strickland. Chem. & Met. Eng., vol. 26, no. 25, June 21, 1922, pp. 1165–1169, 1 fig. Initial rate of corrosion most important; since solution rates change as equilibrium approaches; spent solutions often harmless, but sometimes accelerate corrosion; short tests in circulating pure chemicals logical method for comparative tests.

COST ACCOUNTING

Concrete Products Industry. Cost Accounting in Products Manufacture, Mac Hanson. Concrete, vol. 20, no. 6, June 1922, pp. 235–238, 3 figs. Relation of management to profits; valuable system which is being used and requires only few hours per week for usual product plant.

COTTON

English and American Practice. Cotton Manufacture, Sidney B. Paine. Engrs. & Eng., May 1922, pp. 149–153 and (discussion) 153–154. Conditions under which English textile industry has been developed; difference between English and American practice; suggestions toward adoption of English details which have proved profitable.

CRANES

Hammerhead, 200-Ton. Two-Hundred-Ton Fitting Out Crane at Camden Yard. Mar. Eng., vol. 27, no. 6, June 1922, pp. 383–385, 4 figs. Details of construction and operation of huge electrically operated hammerhead crane installed at South Yard of N. Y. Shipbldg. Corp.

CUPOLAS

Charging Machines. Charging Machines for Cupolas. Engr., vol. 133, no. 3470, June 30, 1922, pp. 727–728, 5 figs. Design of Thwaites Bros., Ltd., Bradford, which combines comparative low first cost and ease of installation.

Operation. Cupola Furnace Operations, Requirements in Coke and Its Influence in Enriching the Melt in Sulphur (Der hochentwickelte Kupolofenbetrieb, sein Koksbedarf und sein Einfluss auf die Schwefelanreicherung der Schmelze), Hörnig. Giesserei-Zeitung, vol. 19, no. 14, Apr. 4, 1922, pp. 215–220, 6 figs. Discusses modern cupola furnace with air preheater, and its operation.

CUTTING METALS

Cutting Fluids for. Cutting Fluids, Eugene C. Bingham. Am. Mach., vol. 56, no. 26, June 29, 1922, pp. 958–961, 4 figs. Why adhesion is important lubrication factor; relative physical properties found by tests; best oil for each operation and material. (Abstract.) Tech. Paper No. 204, Bur. of Standards.

D

DIESEL ENGINES

Air Supply. Air for Diesel Engine-Installations, W. P. Sillince. Oil Eng. & Finance, vol. 1, nos. 11 and 13, Mar. 25 and Apr. 8, 1922, pp. 370–371 and 439–440. Survey of air for combustion of fuel, for starting and maneuvering engines, for injection of fuel and to operate auxiliaries.

Compressorless. Compressorless Diesel Engines (Kompressorlose Dieselmaschinen). Schiffbau, vol. 23, no. 36, June 7, 1922, pp. 1055–1057, 7 figs. Discusses Trinkler, Haselwander, and other types, which do without compressor for feeding of fuel.

Construction and Operation. Diesel and Semi-Diesel Engines (Moteurs Diesel et Semi-Diesel), Ed Allar. Bul. des Associations Françaises de Propriétaires d'Appareils a Vapeur, vol. 3, no. 8, Apr. 1922, pp. 86–105, 5 figs. Theory, principle of combustion, construction, operation, and application.

Petroleum as Fuel. Some Characteristics of Petroleum Oils Used On Diesel Engines, Harold Moore. Oil Eng. & Finance, vol. 1, no. 14, Apr. 15, 1922, pp. 458–460 and 463–464. Number of analyses of fuel oils from various sources and their value as means of predicting behavior of new oils of similar characteristics. Paper read before Diesel Engine Users Assn.

Tosi. Internal-Combustion Engines (Les moteurs a combustion interne). Génie Civil, vol. 80, no. 25, June 24, 1922, pp. 561–564, 7 figs. Compares two-stroke and four-stroke Diesel engines, their application for marine purposes, and describes in detail Tosi Diesel four-stroke engine.

DURALUMIN

Gearing, for. Duralumin for Gearing, Robert W. Daniels. Am. Mach., vol. 57, no. 2, July 13, 1922, pp. 62–65. History of duralumin; some properties

that make it desirable for worm and other gearing, its strength and wearing qualities.

DUST

Precipitation, Electrical. Electrical Precipitation of Dust and Its Application in the Purification of Gas (La précipitation électrique des poussières), Saget. Bul. de la Societe Française des Electriciens, vol. 2, no. 12, Feb. 1922, pp. 83-100, 6 figs. Discusses precipitation in metallurgical, sulphuric acid and other plants, and advises its more general adoption.

DYNAMOMETERS

Tractor, Recording Type. The Watson Dynamometer, George W. Watson. Engineering, vol. 113, no. 2948, June 30, 1922, pp. 814-816, 10 figs. Tractive force transmitted by oil pressure in one cylinder to spring-actuated piston in smaller cylinder. Link motion controls stylus recording on paper roll actuated by speed of tractor. Time and furrow depth also recorded.

E

ECONOMIZERS

Value of. The Case for the Economizer, Julius Frith. Engineer, vol. 133, no. 3468, June 16, 1922, pp. 655-656, 3 figs. Rigid application of first principle usually shows coal economy but not always reduction of operating costs and features which influence this result.

EDUCATION, ENGINEERING

Technical Literature, Use of. Instruction of Students in the Use of Technical Literature, an Unexploited Phase of Engineering Education, E. H. McClelland. Eng. & Contracting, vol. 57, no. 25, June 21, 1922, pp. 598-600. Importance of research in present-day manufacture and available literature from which to start.

ELASTICITY

Moduli. The Modulus of Elasticity in Mechanical Construction Work (Le rôle du module d'élasticité dans la construction mécanique), R. de Fleury. Revue de Metallurgie, vol. 19, no. 5, May 1922, pp. 295-302. Its application to malleable iron, aluminum bronzes and other light metals, and construction of Diesel, aeronautical, and automobile engines.

ELECTRIC FURNACES

Design. New Electric Furnaces for Temperatures of 2500 Degrees and Over (Neuartige elektrische Öfen für Temperaturen von 2500° und darüber), E. Löwenstein. Centralblatt für Mineralogie, Geologie und Paläontologie, no. 9, May 1, 1922, pp. 283-285, 3 figs. Describes furnace built by Göttinger Elektroschaltwerk, in which high temperatures can be reached quickly, temperatures can be accurately regulated, current consumption is small; suitable for metals and minerals, and difficultly fusible earths of all kinds.

Fiat. Development of the Italian Iron Industry by Extensive Use of Electric Power in Smelting Works (Ueber die Entwicklung der italienischen Eisenindustrie durch weitgehende Anwendung elektrischer Energie im Schmelzbetrieb), Dornhecker. Stahl u. Eisen, vol. 42, no. 22, June 1, 1922, pp. 845-848, 3 figs. Discusses electric furnaces in iron foundries, especially Fiat furnace, and works of Fiat Co.

ELECTRIC LAMPS, INCANDESCENT

Dangers. Danger of Touching Unclean Incandescent Bulbs (Gefährdungsmöglichkeiten bei Berührung unsauberer Glühlampen), Stefan Jellinek. Elektrotechnische Zeit., vol. 43, no. 24, June 15, 1922, pp. 815-817, 4 figs. Discusses case of a death resulting from touching glass bulb covered with lime spots. Very considerable potentials were found by making contact with unclean bulbs.

ELECTRIC LOCOMOTIVES

British Design. Electric Locomotives, Vincent L. Raven. Ry. Gaz., vol. 36, no. 25, June 23, 1922, pp. 994-996, 2 figs. Design of shunting, freight and passenger locomotives. Foreign practice in relation to British conditions. Summary of paper read before Instn. Mech. Engr.

Mechanical Parts. Mechanical Parts of Electric Locomotives, H. A. Houston. Ry. Mech. Engr., vol. 96, no. 6, June 1922, pp. 319-322, 12 figs. Comparison with steam locomotives; details of construction of outside-frame type.

ELECTRIC PLANTS

Turbo-Alternator. Some Notes on the Design of Generating Plant, C. F. Hewitt. Elec. Times, vol. 61, no. 1599, June 8, 1922, pp. 552-553. Reliability; working conditions; thermal economy, capital cost, ease of operation and general accessibility are design factors in order of their importance.

ELECTRIC WELDING

Apparatus. Electric Welding Installations (Elettrische Schweissanlagen), Karl Midsch. Metall-Technik, vol. 48, no. 19, May 4, 1922, pp. 205-208, 10 figs. Discusses electric arc, resistance, and spot welding, and explains operations and apparatus.

Development. The History of the Development o Electric Welding, J. M. F. Wilson. Elec. News, vol. 31, nos. 7 and 11, Apr. 1 and June 1, 1922, pp. 35-37 and 40-41, 3 figs. Discusses carbon-electrode and metal-electrode systems of welding, selection of electrodes; impurities, etc.

Ship Construction. Electric Welding Applied to Steel Construction With Special Reference to Ships, A. T. Wall. Instn. Mech. Engrs. Prac., no. 2, 1922, pp. 239-288, 19 figs. Review of present application to ship construction and indication of further possibilities in steel structures.

Shipyards, Germany. Electric Arc Welding in the German Shipyard at Hamburg (Die elektrische Lichtbogenschweissung auf der Deutschen Werft, Hamburg), W. Heins. Schiffbau, vol. 23, no. 36, June 7, 1922, pp. 1062-1066, 14 figs. Gives a number of examples of handy application.

ENAMELS

Coating. Microscopic Study of Ground Coat and Cover Coat Enamel Reactions, E. E. Geisinger. Am. Ceramic Soc. Jl., vol. 5, no. 6, June 1922, pp. 322-337, 13 figs. Study showing that susceptibility of enamels to furnace gases is easily classified by cross section under microscope, examples.

ENERGY

World, Economics of. A Swedish Scientist on the World Energy Economics, Svante Arrhenius. Eng. Progress, vol. 3, no. 6, June 1922, pp. 136-138. Consideration of sources of energy which are still available and how long they are likely to last.

ENGINEERING SCHOOLS

Germany. Illuminating Institute Department of the Baden Technical High School at Carlsruhe (Das Lichttechnische Institut der Badischen Technischen Hochschule in Karlsruhe), J. Teichmuler. Zeit. für Beleuchtungswesen, vol. 28, no. 9-10, May 15-31, 1922, pp. 51-55, 9 figs. Series of articles describing building and equipment, curriculum at high school, photometry, diffusion of light, etc.

ENGINEHOUSES

Equipment. Expediting Enginehouse Work at Hoboken. Ry. Mech. Engr., vol. 96, no. 6, June 1922, pp. 301-304, 8 figs. Modern machine equipment and efficient labor-saving devices show good results at D. L. & W. enginehouse.

EXHAUST STEAM

Superheating for Textile Process Work. Textile Plant Superheats Exhaust Steam for Process Work, Power, vol. 55, no. 25, June 20, 1922, pp. 965-966, 2 figs. Easton Finishing Co's method of drying cloth in tentering machine and heating drying rolls.

EXPLOSIVES

C. P. Toluene. Report on the Manufacture of C. P. Toluene from By-Products Plants and Petroleum Distillates, W. K. Kirby. Alumini Mag. of Colorado School of Mines, vol. 12, no. 2, June 1922, pp. 5-10. Description of toluene and its production by scrubbing coal or water gas and synthetic process by cracking petroleum distillates.

Detonators, Lead Plate Test. The Lead Plate Test as Applied to Commercial Detonators, Bennett Grotta. Chem. & Met. Eng., vol. 26, no. 24, June 14, 1922, pp. 1126-1132, 12 figs. Tests and experiments demonstrating its value in grading commercial detonators according to well-defined standards; efficiency of commercial detonators.

Liquid Air. Use of Liquid Air as an Explosive (Empleo de oxigeno liquido como explosivo), Eduardo Carvajal. Revista Minera, Metalurgica y de Ingenieria, vol. 73, no. 2829, Apr. 24, 1922, pp. 230-233, 3 figs. Making of cartridges; comparative costs; method of operation.

F

FANS

Forced-Draft, Operating Characteristics. Operating Characteristics of Forced-Draft Fans, H. E. Corl. Power, vol. 55, no. 26, June 27, 1922, pp. 1012-1013, 2 figs. Recent developments due to underfeed stokers; new type of fan in which maximum hp. is only approximately 5 per cent higher than rated hp.

Output and Efficiency. The Characteristic Curves of Fans, and Their Application to Pre-determine the Output and Efficiency of Fans Working Singly and In Parallel On Various Resistances, Joseph Parker. Instn. Min. Engrs. Trans., vol. 63, part 3, May 1922, pp. 222-234, 11 figs. Brief consideration of a comprehensive view of all laws brought into operation by two fans working in parallel. See also Min. Inst. of Scotland Trans., vol. 43, Apr. 22, 1922, pp. 22-34, 11 figs.

FIRE PREVENTION

Building Materials Tests. Lessons of Fire Tests, S. H. Ingberg. Clay Worker, vol. 77, no. 7, June 1922, pp. 657-660, 5 figs. partly on p. 661. Brick as fire-resisting material and some results of tests on steel and concrete columns subjected to fire conditions. Paper read before Nat. Brick Mfrs. Assn. convention.

Reinforced Concrete Slab Tests. British Fire Tests on Reinforced Concrete Slabs. Indian Eng., vol. 71, no. 20, May 20, 1922, pp. 278-279, 5 figs. on supp. plate. Dept. of Sci. and Indus. Research four-hour tests, maximum temperature 2000 deg. fahr., followed by 5 min. water application.

FLOORS

Concrete. Hardening Concrete Floors, Edward D. Boyer. Cement & Eng. News, vol. 34, no. 6, June 1922, p. 28. Sometimes defects in workmanship make use of remedies advisable.

FLOW OF WATER

Pipe-Capacity Chart. Chart That Solves Pipe-Capacity Problems, W. F. Schaphorst. Coal Age, vol. 21, no. 24, June 15, 1922, pp. 999-1000, 1 fig. Chart from which velocity that water will travel through a pipe of given diameter may be quickly determined in cu. ft. gals. or lb. per min.

FLOUR MILLS

Machinery. The Machinery of Flour Milling. Eng. Rev., vol. 35, no. 11, May 1922, pp. 370-376, 7 figs. Economics, mechanical aids, cleaning grain, some types of mills.

FLUE-GAS ANALYSIS

Graphical, Use of. New Diagrams for Turning to Account Fuel and Flue Gas Analyses (Neue Schaubilder zur Auswertung von Brennstoff- und Rauchgasanalysen), Wilhelm Schultes. Warme, vol. 45, no. 17, Apr. 28, 1922, pp. 213-218, 7 figs. Shows how flue gas analyses of fuels of known composition can be made use of by means of diagrams and graphic calculations, diagrams for classification of fuels.

FORGING MACHINES

Germany. Recent Forging Machines and Their Application (Neuzeitliche Schmiedemaschinen und ihre Anwendung), Technische Blatter, vol. 12, no. 1, Jan. 7, 1922, pp. 1-3, 13 figs. Discusses machines, especially for research work, railroad shops, and hardware generally.

FOUNDRY EQUIPMENT

Compressed Air. Compressed Air Applied to the Foundry, R. Hoadley Tingley. Compressed Air Mag., vol. 27, no. 6, June 1922, pp. 153-158, 20 figs. Description of some of many air appliances indispensable in modern foundry practice.

[See also CORES.]

FUELS

Coal and Oils. Relative Value of Coal and Oils as Fuels, C. H. Butz. Forging & Heat Treating, vol. 8, no. 6, June 1922, pp. 262-265, 6 figs. Comparison made by means of charts based upon practical operating figures obtained from processes varying in nature from very inefficient furnace to highly efficient boiler.

Utilization on Railways. Utilization of Fuels on Railroads—6th Report of the Commission for the Utilization of Fuels (L'Utilisation des combustibles sur les chemins de fer—Sixieme rapport de la Commission d'utilisation des combustibles). Génie Civil, vol. 80, no. 20, May 20, 1922, pp. 449-453. Effect of electrification of railway lines; character and performance of steam locomotives; production and use of steam; etc.

[See also AUTOMOBILE FUELS, COAL, COKE, GASOLINE, OIL FUEL, PULVERIZED COAL.]

FURNACES, BOILER

Care and Upkeep. Views of Mechanical Engineers in Wyoming Valley as to Proper Care and Upkeep of Boiler Furnaces, D. C. Ashmead. Coal Age, vol. 21, no. 26, June 29, 1922, pp. 1083-1087, 3 figs. Anthracite boiler practice inefficient; some plants install Dutch ovens; combustion arches increase temperature and steadiness of heat; large-size fuel may ruin arches; water softening much needed; fireclay as a mortar.

FURNACES, HEATING

Fuel Economy. Fuel Economy in Heating Furnaces, K. Huessener. Blast Furnace & Steel Plant, vol. 10, no. 7, July 1922, pp. 380-383, 2 figs. New methods to obtain increased production with decreased fuel consumption from regenerative and recuperative furnaces.

G

GAGES

Gage Blocks. Interference Methods for Standardizing and Testing Precision Gage Blocks, C. G. Peters and H. S. Boyd. Scientific Papers Bur. of Standards, no. 436, May 2, 1922, pp. 677-713, 21 figs. Use of interference of light waves makes possible detection of errors within a few millionths of an inch.

Wear, Allowing for. Allowing for Gage Wear, R. Dumas and E. C. Peck. Am. Mach., vol. 56, no. 26, June 29, 1922, pp. 953-954. Discussion of desirability of having fixed tolerance or an allowance for wear; difference of American and British viewpoints.

GALVANIZING

Heat Transmission in. Heat Transmission in the Hot-Galvanizing Process, J. D. Keller. Blast Furnace & Steel Plant, vol. 10, no. 7, July 1922, pp. 371-373, 2 figs. Describing thermal features of process; rate of motion of sheets through bath should vary with sheet thickness if based on factor of heat transmission.

GARAGES

Ramp and Elevator Type. Comparison of Ramp and Elevator Type Garages, Harold F. Blanchard. Bus Transportation, vol. 1, no. 6, June 1922, pp. 331-335, 12 figs. Description of comparative capacities and convenience.

GAS CLEANING

Filtering Process. A New Process For Scrubbing Gases and Vapours, E. Stach. Eng. Progress, vol. 3, no. 6, June 1922, pp. 127-130, 7 figs. Rotary filtering process by Freytag-Messler for removing dust, tar, oil, and other impurities more completely than hitherto.

GAS ENGINES

Navy, Building for. Building Gas Engines for the Navy, S. W. Brinson. Am. Mach., vol. 57, no. 2, July 13, 1922, pp. 45-48, 9 figs. Developing engine

and special plant; equipment of shop; machining engine parts; handling work; assembling engine.

GAS PRODUCERS

Seaboard By-Product Coke Plant. Producer Gas for By-Product Ovens, Freeman D. Lohr. Gas Age-Rec., vol 49, no. 22, June 3, 1922, pp. 677–681, 8 figs. Description of new plant built to meet increasing demand for gas and decreasing market for coke.

GASOLINE

Cracking Process. Production of Gasoline by Cracking Heavier Oils, E. W. Dean and W. A. Jacobs. Petroleum World, vol. 19, no. 261, June 1922, pp. 225–226 and 228–230, 1 fig. Pressure-distillation and vapor-phase processes; experiments and methods resulting from same. See also Petroleum Times, vol. 7, nos. 180 and 181, June 17 and 24, 1922, pp. 874–875 and 915.

High-Explosive, Process for. New Process Makes High-Explosive Gasoline. Oil Trade Jl., vol. 13, no. 6, June 1922, p. 15. Wm. J. Knox perfects invention which will increase percentage of distillate recovered from crude on large scale.

GEAR-CUTTING MACHINES

Geometric Control. Geometric Control of Gear Cutter Movement, Chester B. Hamilton, Jr. Can. Machy., vol. 27, no. 22, June 1, 1922, pp. 40–41 and 48, 4 figs. Careful grinding of cutters is necessary to maintain proper shape; using mill type of cutter; machines for cutting double-helical gears are of special design.

Spur, Muir Automatic Machine. The Muir Automatic Spur Gear Generating Machine. Machy. (Lond.), vol. 20, no. 506, June 8, 1922, pp. 292–294, 4 figs. Teeth of spur gears are formed with rack-shape cutter which has vertical reciprocating motion across face of gear blank.

Fellows High-Speed Shaper. New Fellows High-Speed Gear Shaper. Machy. (Lond.), vol. 20, no. 507, June 15, 1922, pp. 329–332, 6 figs. Machine that operates with a shaping action and generates gear teeth from gear-shape cutter.

Spur, Hobbing. Cutting Spur Gears by Hobbing. Machy. (Lond.), vol. 20, no. 509, June 29, 1922, pp. 393–398, 5 figs. Setting up gear-hobbing machines; examples from practice; application of multiple-threaded hobs; cutting small pinions.

GEARS

Autopitch. A New Form of Gear. Eng. Production, vol. 4, no. 88, June 8, 1922, pp. 545–548, 24 figs. Development of new type of gear as an attempt to reach requirements of theoretically ideal one; description of extent to which attempt is successful. Abridgment of paper read before Instn. of Engrs. & Shipbuilders.

Helical and Spur. Helical Gears and Spur Gears, W. G. Dunkley. Machy. (Lond.), vol. 20, nos. 500 and 506. Apr. 27 and June 8, 1922, pp. 105–107 and 300–302, 9 figs. April 27: Effect of sliding action on uniform velocity and on relative efficiency. June 8: Contact conditions of spur gears; load distribution and periodical variations; effect of variation of load distribution on uniformity of rotation; effect of increased speed.

GLASS

Composition and Durability. An Examination and Extension of Zulkowski's Theory of the Relation between the Composition and Durability of Glasses, Wm. L. Baillie. Soc. of Glass Technology Jl., vol. 6, no. 21, May 1922, pp. 68–95 and (discussion) 95–101, 1 fig.

GRINDING

Automobile Parts. Grinding in the Automotive Industry. Machy. (N. Y.), vol. 28, no. 11, July 1922, pp. 855–862, 16 figs. Approved methods of grinding such important parts as pistons, piston-rings, piston-pins, cylinders, connecting-rods, crankshafts, camshafts, gear teeth and spline shafts.

H

HANDLING MATERIALS

Safety in. Making Material Handling Safe, Vernon C. King. Iron Trade Rev., vol. 71, no. 1, July 6, 1922, pp. 29–32, 8 figs. Greatest number of industrial accidents occur in handling of material; use of proper trucking and conveying equipment is aid to safety; discipline and morale are essential factors. Paper presented before Worcester Sec. A.S.M.E.

[See Also COAL HANDLING.]

HANGARS

Airplane. The New Airplane Hangars at the Aerial Port of Bourget, Near Paris (Les nouveaux hangars a avions du port aérien du Bourget, près Paris), Ch. Dantin. Génie Civil, vol. 80, no. 21, May 27, 1922, pp. 465–468, 13 figs. partly on supp. plate. General description of five hangars used by Messageries aériennes Co., Grands Express aériens Co., Franco-Roumaine Co., and Aérienne Française Co.; details of construction.

HARDNESS

Testing. The Ball Hardness Test, Dr. Moore. Metal Industry (Lond.), vol. 20, no. 22, June 2, 1922, pp. 510–513, 1 fig. Indentation tests being purely empirical should specify conditions. Features of Brinell test and Meyer's laws. Paper presented before Inst. of Metals

HEAT TRANSMISSION

Cylinder Walls. Heat Transmission Through Cylinder Walls of Internal-Combustion Engines (Wärme Durchgang durch die Zylinderwandungen von Verbrennungs-Maschinen), Schlachter. Motor u. Auto, vol. 19, nos. 7, 8 and 9, May 1, 10 and 20, 1922, pp. 97–100, 113–116 and 129–131, 8 figs. Discusses transmission of heat from one medium to another, and develops formula for calculation; transmission of heat from gas to metal walls; examines heat transmission on mathematical basis.

Measurement. American Heat Transmission Measurement by the Two-Plate System (Amerikanische Wärmedurchgangsmessungen nach der Zweiplattenmethode), Max Jakob. Zeit. für die gesamte Kälte-Industrie, vol. 29, no. 5, May 1922, pp. 83–87, 3 figs. Recent work carried out by Bur of Standards and Am. Soc. Heat. & Vent. Engrs.

HEATING AND VENTILATING

Cleveland Public Auditorium. Ventilating Equipment of Cleveland's Public Auditorium, M. A. Boyd. Heat. & Vent. Mag., vol. 19, no 6, June 1922, pp. 33–40, 9 figs. Methods followed in handling air supply for largest plastered structure in world.

HEATING, STEAM

Building Heating Plant. World's Largest Gas Heating Plant, S. S. Fyfe. Gas Age-Rec., vol. 49, no. 25, June 24, 1922, pp. 765–768, 3 figs. Gas-fired steam boilers at Los Angeles; heats building of 3,000,000 cu. ft., using mixed natural and artificial gas.

General Fire Extinguisher Co. Heating System of the General Fire Extinguisher Co., Chas. L. Hubbard. Power Plant Eng., vol. 26, no. 12, June 15, 1922, pp. 591–595, 10 figs. Steam is generated at high pressure and used only for heating. Power is purchased from an outside source.

HOISTING ENGINES

Steam and Air Combination. Combination Steam and Air Hoist, R. C. Demary. Nat. Engr., vol. 26, no. 6, June 1922, pp. 244–246, 5 figs. Description of twin tandem compound with Corliss-type valve gear; high-pressure cylinders which are used for compressing air.

HOISTS

Skip. Elevating Coke by Skip Hoist. Gas Age-Rec., vol. 49, no. 22, June 3, 1922, pp. 683–684 and 687, 5 figs. Taking coke from small cars to elevated bins by means of automatic device; straight-up lift eliminates consideration of belt conveyor.

HYDRAULIC TURBINES

Impellers. Minimum Number of Blades and Inlet Diagram of Modern Turbine Impellers (Die Minimalschaufelzahl und das Eintrittsdiagramm für moderne Stauturbinenlaufräder), Hugo Marschner. Zeit. des Österr. Ingenieur- u. Architekten-Vereines, vol. 74, no. 15–16, Apr. 14, 1922, pp. 67–69, 6 figs. Present turbine systems; arrangement of rotating blades, and calculation of minimum number; minimum space between blades.

Radial Suction. Radial Suction Turbines (Die Saugstrahlturbine), Hans Baudisch. Elektrotechnik u. Maschinenbau, vol. 40, no. 25, June 18, 1922, pp. 289–291, 1 fig. Calculation of useful work, losses due to friction and eddies, comparison with Kaplan turbine, etc.

HYDROELECTRIC PLANTS

France. Hydroelectric Plant of Baumont-Monteaux (Usine hydro-électrique de Beaumont-Monteux), J. Reyval. Révue Générale de l'Électricité, vol. 11, no. 21, May 27, 1922, pp. 781–790, 17 figs. A central station situated at confluence of Isère and Rhone; will supply current to industrial works; general description of parts of plant and engineering work connected with it

Hydroelectric Plant of Beaumont-Monteaux (Usine hydro-électrique de Beaumont-Monteux), Jacques Suet. Révue Générale de l'Électricité, vol. 11, no. 22, June 3, 1922, pp. 817–829, 18 figs. Describes electric equipment, including alternators, exciters, transformers, switchboard; current is stepped from 5,500 to 120,000 volts.

New Brunswick. New Hydro Plant in New Brunswick. Elec. News, vol. 31, no. 11, June 1, 1922, pp. 34–39, 9 figs. Unique installation just completed at Musquash River, near St. John; actually two plants in one; work of New Brunswick Power Commission.

Queenston-Chippawa, Canada. Arrangement for Handling 500,000-Kw. Load from Queenston Plant. Elec. World, vol. 79, no. 25, June 24, 1922, pp. 1261–1263, 2 figs. Most economical utilization of water power available and protection against interruption of service were chief factors influencing design of this new station of Hydroelectric Power Commission of Ontario.

Queenston-Chippawa Hydro Development Largest in the World. Power, vol. 55, no 26, June 27, 1922, pp. 1000–1006, 9 figs. Initial installation five 55,000-hp. hydroelectric units; 305 ft. of 327-ft. head between Lake Erie and Lake Ontario effective on turbines; water carried through concrete-lined canal designed for possible ultimate capacity of 600,000-hp.

Semi-Outdoor. Semi-Outdoor Hydro-Electric Plant with Backwater Suppressor, John A. Sirnit. Elec. World, vol. 79, no. 23, June 10, 1922, pp. 1161–1164, 5 figs. Mitchell Dam development of the Alabama Power Company will involve an entirely new principle in hydroelectric construction. Results of long series of experiments in backwater suppression.

Switzerland. Hydroelectric Plant of Fully (Valais, Switzerland) Using a Head of 1,650 m. [Usine hydro-électrique de Fully (Vailis, Suisse), utilisant une chute de 1.650 mètres], Ch. Daotin. Génie Civil, vol. 80, nos. 18 and 19, May 6 and 13, 1922, pp. 393–397 and 423–427, 29 figs. partly on supp. plate. May. 6: Describes civil-engineering features, damming of Fully Lake, pressure piping, etc. May 13: Electric generating machinery; turbine regulators; pipe lines.

I

INDICATORS

Indicator Diagrams of Compound Engine. Indicator Diagrams of Compound Engines. Power, vol. 56, no. 2, July 11, 1922, pp. 55–58, 10 figs. Classification of engine types; fixed and variable low-pressure cut-off. Other characteristics which determine proper setting of valves.

Micro, for High-Speed Engines. The Collins Micro-Indicator for High-Speed Engines. Engineering, vol. 113, no. 2945, June 9, 1922, p. 716, 3 figs. Description of instruments which within half a minute will produce on card ten successive indicator diagrams of performance of a high-speed engine.

INDUSTRIAL MANAGEMENT

Business Depression Cycle. Facts May Prevent Depressions, Ernest F. Dubrul. Iron Trade Rev., vol. 70, no. 25, June 22, 1922, pp. 1791–1794. Ignorance of business cycles brings reversals; burden rests upon management of modern industry to study basic factors; should contribute to general store by frank publicity about its own conditions.

Cost Explanation for Employees. Interpreting the Corporation to the Workers, C. M. Ripley. Elec. World, vol. 79, no. 25, June 24, 1922, pp. 1281–1282, 2 figs. Value of explaining distribution of costs to employees.

Manager's Problems. Solving the Manager's Present Day Problems, John H. Van Deventer. Indus. Management, vol. 64, no. 1, July 1922, pp. 1–3. Barriers to improved methods and how to overcome them.

Planning and Controlling, Chart for. Planning and Controlling Work in the Assembling Department of a French Shop, E. Jullien. Am. Mach., vol. 56, no. 25, June 22, 1922, pp. 932–933, 6 figs. Work plotted on revolving calendar and always under control of planning department; forms used for assembly specifications and piece-work tickets.

Psychosis of Industry. The "Psychosis" of Industry, Frank Mason Harris. Indus. Management, vol. 64, no. 1, July 1922, pp. 18–23. Application of psychoanalysis methods in relieving friction between employer and worker.

Purchase Controlled by Output Records. Making Output Records Control Material Purchases, Kenneth Coggeshall. Indus. Management, vol. 64, no. 1, July 1922, pp. 6–11, 23, 6 figs. Practical procedure for conservative purchasing with materials in stock bought at former high levels.

Shop-Record Keeping. Record Keeping on Dies, Tools and Scrap, Geo. H. Koskey. Forging & Heat Treating, vol. 8, no. 6, June 1922, pp. 279–282, 6 figs. Ideas as to data which can be kept and discussion of die bonus and die piecework.

INTERNAL-COMBUSTION ENGINES

Fuels. Research Aimed at Solution of Fuel Problem, Herbert Chase. Automotive Industries, vol. 46, no. 26, June 29, 1922, pp. 1412–1418, 5 figs. Cooperation of automotive and petroleum industries; new knock preventive announced by General Motors; lubricating problems also discussed.

The Value of Gas Engine Fuels, Letson Balliett. Min. Rev., vol. 24, no. 5, June 15, 1922, pp. 14–15. Exposition of impossible claims to increase heat values of hydrocarbon fuels; use of fuel oil in blacksmith's shop.

Combustion. Combustion Research—An Aid to Better Performance, Herbert Chase. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1253–1265, 2 figs. Internal-combustion engines; factors affecting detonation; flame propagation and related subjects examined by various investigators.

Reversing Turbine for Marine. The Starting and Reversing of Marine Internal-Combustion Engine with the Aid of Compressed-Air Turbines (Ueber das Anlassen und Umsteuern von Schiffs-Verbrennungskraftmaschinen mit Hilfe von Druckluftturbinen), Paul Praetorius. Schiffbau, vol. 23, nos. 28, 29, 30, 32, 34 and 35, Apr. 12, 19, 26, May 10, 24, and 31, 1922, pp. 851–857, 879–886, 911–915, 959–963, 1007–1012 and 1035–1040, 19 figs. Describes reversing turbine developed by author for a 60-hp. four-cylinder, four-cycle Diesel engine, points out its advantages and gives results of tests; comparison with other reversing systems.

Sproule. The Sproule Internal Combustion Engine. Oil Eng. & Finance, vol. 1, no. 81, March, 4 1922, pp. 277–279, 1 fig. Description of engine in which it is claimed that difficulties of limited flexibility, low efficiency, and lack of easy reversibility are almost completely overcome.

Still System for Marine. The Still System of Internal-Combustion Engine for Marine Purposes, F. Leigh Martineau. Steamship, vol. 33, no. 396, June 1922, pp. 414–416. Description of system which is applicable to several types of engines. Read before Inst. Mar. Engrs.

[See also AIRPLANE ENGINES, AUTOMOBILE ENGINES, DIESEL ENGINES, GAS ENGINES, OIL ENGINES.]

IRON

Metallography. Influence of Graphite on Iron, J. W. Bolton. Foundry, vol. 50, no. 11, June 1, 1922, pp. 436–443, 19 figs. Theories advanced for varying effects of graphite on cast iron and semi steel explain states in which it is found, causes are analyzed, micrographs illustrate points.

IRON INDUSTRY

Nord-Paris Co. Plant. The Works of the Nord-Paris Company. Engineering, vol. 113, no. 2945, June 9, 1922, pp. 708–709, 2 figs. Description of steel works, iron foundry, large machine shop, and auxiliary buildings covering some 50,000 sq. yd.

IRON ORE

Chromite. Chromite for the Manufacture of Ferro-Chrome, J. A. Holden. So. African Min. & Eng. Jl., vol. 33, no. 1595, Apr. 22, 1922, pp. 1120–1121, 1 fig. Rhodesian and new Calcedonian ores contrasted, varieties suitable for electrometallurgical smelting and some features of process.

Electric-Furnace Reduction. Electrothermic Reduction of Iron Ores and Pyrites (Sulla riduzione elettrotermica dei minerali di ferro e delle ceneri di pirite), Stefano Paghani. Forno Elettrico, vol. 3, no. 12, Dec. 15, 1921, pp. 168–183, 13 figs. Development of direct reduction of iron ore in electric furnace; summary description of the various furnaces and their working.

IRON, PIG

Silicon, Lower. Foundries Can Use Lower Silicon Irons, Y. A. Dyer. Iron Age, vol. 109, no. 25, June 22, 1922, pp. 1749–1750. Blast furnace-men would be relieved by lessened demand for high-silicon pig; call for high-phosphorus iron may be overdone also.

L

LEATHER

Drying Artificially. Artificial Drying of Leather, M. Hirsch. Eng. Progress, vol. 3, no. 6, June 1922, pp. 123–125, 5 figs. Arrangement for regulating admission of air according to progress of drying and proportioning recirculated and fresh air as drying proceeds.

LIGHTING

Industrial. Industrial Lighting: Ideal Requirements (Legislative and Otherwise) and Practical Solutions, L. Gaster. Illuminating Engr., vol. 15, no. 2, Mar. 1922, pp. 74–88, 8 figs. Consideration of four essentials for ideal lighting and discussion of code. Paper read before Illuminating Eng. Soc.

LIME

Plants. The New Rockland Lime Plant, Nathan C. Rockwood. Rock Products, vol. 25, no. 12, June 17, 1922, pp. 35–44, 36 figs. Six continuous-discharge, gas-fired mount design kilns of which five turn out 130 tons of lime in 24 hours.

A Plant Ahead of Its Time, Clinton S. Darling. Rock Products, vol. 25, no. 12, June 17, 1922, pp. 59–68, 32 figs. Rotary kiln for dry or semi-wet burning, with 175 ft. flame; remarkable flexibility to make every lime product at Am. Lime & Stone Co.'s plant.

LOCOMOTIVE BOILERS

Circulation, Effect on Efficiency. Effect of Circulation on Locomotive Boiler Efficiency, F. G. Lister. Ry. Rev., vol. 70, no. 22, June 3, 1922, pp. 787–790. Needed improvements in design for effecting better circulation, covered in paper presented at annual convention of Int. Ry. Fuel Assn. 1922.

LOCOMOTIVES

Fire Box, Water-Tube. Development of a Practical Water Tube Locomotive Fire Box, D. L. Kiss. Ry. Rev., vol. 70, no. 24, June 17, 1922, pp. 900–908, 16 figs. Hungarian state railways successfully operating locomotives equipped with Broton type boilers, use of water purifiers an important factor.

Design and Equipment. Current Questions of Locomotives Design and Equipment. Ry. Rev., vol. 70, no. 25, June 24, 1922, pp. 982–987, 1 fig. Am. Ry. Assn. Committee on locomotive construction considers relative merits of locomotive types and details in design. (Abstract.)

Fuel Economy. Effect of Tonnage Rating and Speed on Fuel Consumption, J. E. Davenport. Ry. Rev., vol. 70, no. 22, June 3, 1922, pp. 777–782, 10 figs. Practical interpretation of results of laboratory tests conducted in Pennsylvania Locomotive testing plant, showing heavy slow-speed trains to be most economical. Papers read before Int. Ry. Fuel Assn.

Locomotive Fuel—The Life Blood of Transportation, G. M. Basford. Ry. Rev., vol. 70, no. 22, June 3, 1922, pp. 742–785, 2 figs. Salient points in address at annual convention of Int. Ry. Fuel Assn.

Headlights, Electric. Effect of Design on Headlight Maintenance, R. Wayne Cargo. Ry. Age, vol. 73, no. 1, July 1, 1922, pp. 31–32, 4 figs. Cost of turbine-generator operation calls for careful consideration in selection of equipment.

Mallet for Pekin-Suiyuan. Heavy Mallet Locomotive for Pekin-Suiyuan. Ry. Mech. Engr., vol. 96, no. 6, June 1922, pp. 305–307, 5 figs. Largest locomotives exported or operated outside of U. S. now in service in China.

Mikado for Michigan Central. Lima Builds a New Mikado for the Michigan Central. Ry. Rev., vol. 70, no. 24, June 17, 1922, pp. 910–911. Locomotive 8000 recently placed in service weighs 334,000 lb. and exerts tractive effort of 63,500 lb. without booster.

Southern Pacific, 2-10-2. 2-10-2 Type Locomotive for the Southern Pacific. Railroad Herald, vol. 26, no. 7, June 1922, pp. 19–21, 2 figs. Description of locomotive of which 50 have recently been ordered.

Fifty More New Freight Locomotives for the Southern Pacific. Ry. Rev., vol. 70, no. 24, June 17, 1922, pp. 897–900, 5 figs. Southern Pacific motive power reflects evolution of 2-10-2 type, new locomotive equipped with Boosters and feedwater heaters.

Superheater. The New Locomotives of the Halberstadt-Blankenburg Railroad Company (Die neuen Lokomotiven der Halberstadt-Blankenburger Eisenbahn-Gesellschaft), Gustav Hammer. Glasers Annalen, vol. 90, no. 11, June 1, 1922, pp. 192–200, 10 figs. Describes new type 1E1 superheater locomotive with tender, built by Borsig, which shows reduction in fuel consumption and considerable increase in tractive effort.

The Superheater Locomotive—Its Lubrication. Lubrication, vol. 8, no. 5, May 1922, pp. 49–60, 10 figs. Important features in operation and lubrication in connection with these.

Uniflow. Recent Developments in the Unaflow Locomotive. Ry. Age, vol. 72, no. 25, June 24, 1922, pp. 1727–1730, 7 figs. Exhaust ejector effect overcomes handicap of high compression and reduces size of cylinders.

LUBRICATING OILS

Frictional Loss, Testing. A Practical Way to Test Lubricating Oils for Frictional Losses, W. F. Osburne. Power, vol. 55, no. 26, June 27, 1922, pp. 1010–1011. Readings to be taken; heat carried away from bearings; considerations other than bearing temperatures.

Storing and Handling. The Storage and Handling of Lubricating Oil, Allen F. Brewer. Indus. Management, vol. 64, no. 1, July 1922, pp. 27–30, 4 figs. Application of engineering principles to elimination of waste and obtaining maximum efficiency.

Voltol. The Production of Voltol. Eng. Progress, vol. 3, no. 6, June 1922, pp. 121–122, 2 figs. Process of making high-viscosity oil from thin cheap ones under effect of electrical glow discharges in rarefied gas.

LUBRICATION

Lubricants and. Lubrication and Lubricants, W. A. Ludwick. Steam, vol. 29, no. 6, June 1922, pp. 157–164. Consideration of straight-run mineral, blended mineral, compounded and animal oils; greases; selection of lubricants.

Petroleum. Petroleum and Lubrication, E. A. Evans. Oil Eng. & Finance, vol. 1, no. 13, Apr. 8, 1922, pp. 434–436. Consideration of true friction and proper specifications for oil to overcome same; constitution of film; carbonization; emulsion. Paper read before Inst. Mar. Engrs.

M

MACHINE GUNS

Hotchkiss Company, Levallois Works. The Levallois Works of the Hotchkiss Company. Engineering, vol. 113, no. 2945, June 9, 1922, pp. 710–711, 4 figs. Description of plant arranged for fine machine work.

MALLEABLE CASTINGS

Manufacture. Production of Malleable Castings and the Triplex Process (La fabrication de la Fonte malleable et le Procede Triplex), T. Levox. Fonderie Moderne, no. 6, June 1922, pp. 169–173. Composition and properties of malleables produced by triplex and other processes; electric production of malleable castings in continuous furnace.

MALLEABLE IRON

Manufacture. Malleable Anneals Not Packed, E. K. Smith. Foundry, vol. 50, no. 11, June 1, 1922, pp. 457–458, 2 figs. Pot with flange at both ends is developed to prevent gases from entering and attacking castings; temperature must be kept low to eliminate warping when castings are not supported.

Standardization. Standardizing Malleable Iron (Ueber die "Normung" von Temperguss), Rudolf Stotz. Giesserei-Zeitung, vol. 19, nos. 20 and 21, May 16 and 23, 1922, pp. 301–303 and 319–322, 3 figs. May 16: Dependence of tensile strength on thickness of wall and methods of production; gives figures for tensile strength from various foundries. May 23: Chemical composition and physical tests; shrinkage; etc.

MATERIALS

Testing Method. The Sliding Cone as Basis for Testing Materials (Die Rutschkegelbildung all Grundlage zc das Materialprüfwesen), Friedr. Riedels. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 23, June 10, 1922, pp. 566–571, 17 figs. Defects of present theory of stresses in materials; formulates new laws on basis of experiment, and discusses their application to testing of materials.

METALLOGRAPHY

Preparation of Metal. Preparation of Metal for Microscopic Examination, Wm. Campbell. Chem. & Met. Eng., vol. 26, no. 25, June 21, 1922, pp. 1163–1164. Preparation of specimens, development of structures for various samples.

METALS

Fatigue. Fatigue of Metals, C. E. Stromeyer. Iron & Coal Trades Rev., vol. 104, no. 2831, June 2, 1922, pp. 822–824, 2 figs. Empirical law by which fatigue limit may be obtained by direct measurement quickly and fatigue coefficient within one-half hour. (Abstract.) Paper read before So. Wales Inst. of Engrs.

Calorizing. Calorization (Note sur la calorisation), Léon Guillet. Bul. Technique du Bureau Veritas, vol. 4, no. 4, Apr. 1922, pp. 83–86, 3 figs. Discusses methods of protecting metallic articles, especially calorization or coating by means of aluminum by Schoop spraying process.

Casting. The Casting of Metals, Thomas Turner. Brass World, vol. 18, no. 6, June 1922, pp. 191–195. Consideration of melting and molding of metals as a whole with special attention to non ferrous alloys. Lecture before Inst. of Metals.

Cold Rolling and Drawing. The Process of Cold Rolling and Drawing and Its Consumption of Power (Der Kaltwalz- und Ziehvorgang und sein Leistungsverbrauch), L. Weiss. Zeit. für Metallkunde, vol. 14, no. 4, Apr. 1922, pp. 160–172, 18 figs. Develops formulas for calculating power required for cold rolling and applies results to wire drawing, giving examples.

Properties, Effect of Temperature on. The Effect of Temperature on Some of the Properties of Metals, F. C. Lea. Engineering, vol. 113, no. 2948, June 30, 1922, pp. 829–832, 11 figs. Results of experiments on critical points; tensile tests at from 40 deg. to 1000 deg. cent. tests on Armco iron; table showing properties of iron and certain steels at various temperatures; alloys of aluminum and copper. Paper read at Paris meeting of I.M.E.

METRIC SYSTEM

Arguments Against Adoption. Standardization and the Metric System (La standardizzazione e la serie metrica standard), Narciso Desirello. Industria, vol. 36, no. 9, May 15, 1922, pp. 163–167, 6 figs. Concludes that metric system, although perfect theoretically, is entirely inadequate for practical use and modern industrial exigencies.

MILLING MACHINES

Horizontal. A New Horizontal Milling Machine (Neue Wagerecht-Fräsmaschinen), M. Naumann. Ziet. des Vereines deutscher Ingenieure, vol. 66, no. 20, May 20, 1922, pp. 486–490, 33 figs. Describes new universal type built by Saxon Milling Machine Works, Chemnitz, and gives particulars of operation.

MINE LOCOMOTIVES

Germany. Mine Locomotive Conveying in the Ruhr District (Der Stand der Grubenlokomotivdörderung im Ruhrbezirk), O. Gunderloch. Glükauf, vol. 58, nos. 20, 21 and 22, May 20, 27 and June 3, 1922, pp. 589–592, 616–622, and 653–657, 25 figs. Describes various types of benzol, wired electric, electric accumulator, and compressed-air locomotives; their management and cost of operation.

MOLDS

Ingot, Production. Production of Molds for Steel Works (Ueber die Herstellung von Stahlwerkskokillen), A. Richold. Giesserei-Zeitung, vol. 19, no. 15, Apr. 11, 1922, pp. 239–241. Thickness of wall and relation to size of ingot.

MOTION PICTURES

Films. Chemical Production and Treatment of Films (Die chemische Herstellung und Behandlung von Filmen), S. Halen. Kunststoffe, vol. 12, no. 10, May 2, 1922, pp. 73–76. Discusses production from nitrocellulose, copper oxide, ammonia cellulose, viscose, cellulose hydrates in caustic alkali, etc., also sensitizing of gelatin layer.

MOTOR BUSES

Design. What Constitutes a Perfect Motor Bus? G. A. Green. Automotive Industries, vol. 46, no. 25, June 22, 1922, pp. 1364–1371, 14 figs. Controlling design factors are safety, comfort, and minimum operating cost. They can be obtained with low center of gravity, wide frame, track and spring centers and effective braking. Short turning radius is necessary, together with clear vision for driver. (Excerpt.) Paper read before Soc. Automotive Engrs.

Design and Operation. Motor Bus Design and Operation, G. A. Green. Bus Transportation, vol. 1, no. 7, July 1922, pp. 369–375, 13 figs. Construction of single-deck and double-deck vehicles; factors involved in minimum operating cost; maximum accessibility requires separate unit form of chasis construction. (Abstract.) Paper read before S.A.E.

MOTOR TRUCKS

Parts Inspection. Rigid Inspection One of Rules at this Plant. Can. Machy., vol. 27, no. 25, June 22, 1922, pp. 47–48, 2 figs. Practice at Nat. Steel Car Corp., Hamilton, Ont. Parts purchased from outside sources are tested before leaving place of manufacture; further test given at Hamilton factory; jigs and fixtures are extensively used.

N

NICKEL ALLOYS

Chromel. Chromel Castings, Bars, Wire and Ribbons, E. F. Lake. Brass World, vol. 18, nos. 5 and 6, May and June 1922, pp. 158–161 and 165–167, 9 figs. Nickel-chromium alloy with higher chromium content than is found in others; its uses.

Nickel-Chromium Casting. Cast Nickel-Chromium Alloys, E. F. Lake. Foundry, vol. 50, no. 11, June 1, 1922, pp. 452–454, 6 figs. Metals are melted

in induction, arc and crucible-type electric furnaces; purity found to be essential, iron added to one of alloys; occluded gases a menace in melting.

O

OIL ENGINES

Cold-Starting Crude. The Brotherhood Cold-Starting Crude Oil Engine. Engineering, vol. 113, no. 2946, June 16, 1922, pp. 746–748, 12 figs. Horizontal 4-cycle type started by compressed air on regular fuel. Will operate after starting on any grease that can be pumped.

OIL FUEL

Burning Efficiency. How to Burn Fuel Oil Efficiently, Jos. W. Hays. Refrigeration, vol. 30, no. 2, Apr. 1922, pp. 31–36. Correct conditions of furnace, atomizing burner, air supply and operation.

OIL INDUSTRY

California. Oil Industry in California, Henry M. Payne. Eng. & Min. Jl.-Press, vol. 113, no. 25, June 24, 1922, pp. 1099–1103, 3 figs. Extensive records by state of operations; "peg models;" standard methods employed.

Records, Forms for Keeping. Forms for Keeping Records. Oil Field Eng., vol. 24, no. 5, May 1922, pp. 130–136. Suggestions for preparation of sheets on which to keep records, and summary of information that should be collected

OIL SHALES

Esthonian. The Chemical Properties of Esthonian Shales. Petroleum Times, vol. 7, no. 178, June 3, 1922, pp. 777–778. Some facts about most successful development in this field and unusually rich properties of shale.

Kukkersite, the Oil Shale of Esthonia, F. H. Cunningham. Petroleum World, vol. 19, no. 261, June 1922, pp. 255–259. Facts about occurrence and development of one of richest oil shales known.

OPEN-HEARTH FURNACES

British Practice. British Open-Hearth Furnace Practice. Iron Age, vol. 110, no. 2, July 13, 1922, pp. 75–78, 2 figs. Higher temperatures and more rapid working aimed at in proposed design of a 100-ton furnace; reduction of heat losses great desideratum.

Design Improving. Improving Open-Hearth Design, Willis McKee. Iron Trade Rev., vol. 70, no. 26, June 29, 1922, pp. 1865–1868, 5 figs. Blow-torch principle insures better combustion; proposal to introduce gas into uptakes without regeneration; improved design is resulting in greatly increased output, better steel and longer life of furnace.

Valves. Gas and Air Valves for Open Hearth Furnaces, Wm. C. Bulmer. Blast Furnace & Steel Plant, vol. 10, no. 6, June 1, 1922, pp. 302–306, 4 figs. Discussion of development of various types of valves for which each inventor claims some superiority.

ORDNANCE PLANTS

U. S. Navy. Naval Gun Factory at Washington, Sidney G. Koon. Iron Age, vol. 110, no. 2, July 13, 1922, pp. 87–90, 3 figs. Exceptionally massive machine tools for production of heaviest naval ordnance; subsidiary work of great importance.

OVENS

Electric, Enameling. Electric Ovens Are A Good Investment, West S. Scott. Elec. Rev. & Indus. Engr., vol. 80, no. 6, June 1922, pp. 275–277, 4 figs. Flexibility and ease of heat control, freedom from gases and low maintenance are among advantages of various examples discussed.

OXY-ACETYLENE CUTTING

Cutting Machines. Oxy-Acetylene Cutting Machine, I. William Chubb. Am. Mach., vol. 56, no. 25, June 22, 1922, pp. 929–931, 5 figs. Mechanically guided torch cuts intricate shapes at great speed; gas pressure and rate of torch travel regulated to suit work.

Machine, Efficiency of. Efficiency of Machine Cutting, Fred J. Maeurer. Acetylene Jl., vol. 23, no. 12, June 1922, pp. 587–595, 25 figs. Cutting with oxy-acetylene torch can be made to approach very closely maximum theoretical efficiency. Paper read before Am. Welding Soc

Underwater. The Underwater Torch Makes Good. Pacific Mar. Rev., vol 19, no. 6, June 1922, pp. 337–339, 5 figs. Temperature of 6000 deg. fahr. enables diver to cut metals at any depth to which he can descend.

OXY-ACETYLENE WELDING

Foundries. Oxy-Acetylene Cutting and Welding in Foundry, G. O Carter. Can Foundryman, vol. 13, no 6, June 1922, pp. 36–39. Piped oxygen and acetylene installations are recommended for large foundries Many uses, such as cutting steel risers and welding gray iron.

P

PAINTS

Exposure Tests. Miscellaneous Exposure Tests, Henry A. Gardner. Educational Bur., Paint Manufacturers' Assn of U. S, no. 153, June 1922, pp 282–313, 12 figs. Durability tests on paints applied by spray gun vs. hand brush; three-year exposure results on Atlantic City panels; and tests on metal power paint, titanium oxide pigment and antimony oxide pigment.

PAPER MANUFACTURE

New Paper From Old. Making New Paper From Old Paper Stock, Sidney D Wells. Paper, vol. 30, no. 14, June 7, 1922, pp. 7–10. Deinking processes for old newspapers and use of bentonite as peptizing agent.

PAPER MILLS

Machines, High-speed. Developments in High Speed Machines. Paper, vol. 30, no. 12, May 24, 1922, pp. 7–11. Effect of late developments in making paper by high-speed processes.

PIPE, CAST-IRON

Centrifugal Process. Cast Iron Water Pipe Made by de Lavaud Process. Can. Foundryman, vol. 13, no. 5, May 1922, pp. 26–27, 33, 2 figs. Melted metal poured into revolving mold is deposited by centrifugal force against wall of mold; makes dense grained homogeneous casting.

Failure, Causes of. Causes of Failure in Cast Iron Pipe, F. A. McInnes. Eng. & Contracting, vol. 62, no. 24, June 14, 1922, pp. 563–564. Quality of pipe line; permissable sulphur content; importance of analyses of iron.

PIPES

Coating for Cast Iron and Steel. The Right Kind of Coating for Pipe, Wm. R. Conard. Fire & Water Eng., vol. 71, no. 25, June 21, 1922, pp. 1107–1108 and 1122, 1 fig. Suggestions for durable and efficient coating that will insure longer life for cast-iron or steel pipe. From paper read before Convention of Am. Water Wks. Assn.

Tar Coating for. Present Day Tars for Pipe Coatings, Wm. R. Conard. Can. Engr., vol. 42, no. 22, May 30, 1922, pp. 560–561. Dr. Angus Smith's solution; standard specification for pipe coatings; quality of tar used at present time; objective for research work. Paper read at Annual Mtg. Am. Water Wks. Assn.

PISTON RINGS

Quantity Production. Quantity Production of High-Grade Piston Rings (Massenerzeugung höchstwertiger Kolbenringe), C. Irresberger. Stahl u. Eisen, vol. 42, no. 22, June 1, 1922, pp. 841–845, 12 figs. Demands made on piston rings; sand and permanent molds for casting; centrifugal casting process; etc.

PISTONS

Aluminum. Aluminum Pistons (A propos des Pistons en aluminium), Frank Jardine and Ferdinand Jehle. Technique Automobile et Aérienne, vol. 13, no. 117, 1922, pp. 54–59, 9 figs. Design and operation; measurment of temperature, tolerance, etc.

PLANERS

Foundations. Second-Story Planer Foundations, A. E. Robinson. Am. Mach., vol. 56, no. 25, June 22, 1922, pp. 917–919, 4 figs. How American Tool Works supports its planer department upstairs; concrete slabs for foundations; methods of leveling and straightening long planer beds.

PLATES

Rectangular, Stress in. Method for Approximate Static Calculation of the Bending Stress of Rectangular Plates (Verfahren zur angenäherten statischen Berechnung biegefester rechteckiger Platten), Ludwig Hotopp. Beton u. Eisen, vol. 21, nos. 6 and 8, Apr. 5 and May 9, 1922, pp. 95–97 and 116–119, 8 figs. Discusses distribution of stresses and gives examples and calculations.

POWER PLANTS

Chile. The Power Works of Chuquicamata (Los talleres y fuerza motriz de Chuquicamata). Ingenieria Internacional, vol. 8, no. 2, Aug. 1922, pp. 89–94, 3 figs. Production of power for mines and metallurgical works; a central heating station which burns oil and uses salt water.

Management. Power Station Management. J. S. Thomson. Iron & Coal Trades Rev., vol. 104, no. 832, June 9, 1922, pp 817–818. Sixteen economic areas suggested for England, most of power must come from thermal efficiency; gas and electric typical stations; automatic operations; steam considerations; electrical details.

Paper Mills. The Provincial Paper Mills, Power Plant, T. H. Fenner. Power House, vol. 15, no. 11, June 5, 1922, pp. 19–23, 8 figs. Interesting features of boiler room and facilities for enlargement of plant.

Wheeling Steel Corporation. Wheeling Steel Corporation Construct New Power Plant, Thos. G. Estep. Blast Furnace & Steel Plant, vol. 10, no. 6, June 1, 1922, pp. 329–337, 11 figs. Detailed description of modern power station constructed at Whitaker-Glessner plant, Wheeling, W. Va.; many unusual features mark plant.

PRESSES

Power, Crankshaft Design. Designing Power Press Crankshafts, Wm. J. Smith. Eng. Production, vol. 4, no 87, June 1, 1922, pp. 509–513, 5 figs. Details of calculations and formulas involved.

PULVERIZED COAL

Boiler Firing. Progress in Pulverized Fuel Firing, F. J. Crolius. Blast Furnace & Steel Plant, vol. 10, no 6, June 1, 1922, pp. 337–339. Code recommended for adoption by Carnegie Steel Company in handling of pulverized coal, presented; many points of unnecessary danger have been eliminated.

Danger of Explosion in Pulverized Coal Firing, (Die Explosionsgefahr bei Kohlenstaubfeuerungen), Mathtiass. Technische Blatter, vol. 12, no. 22, June 3, 1922, pp. 225–227. Direct and indirect methods of firing; safety regulations to avoid explosions.

Powdered Fuel under Steam Boilers. Iron & Coal Trades Rev., vol. 104, no. 2, 832, June 9, 1922, p. 858. Summary of results of five boiler tests with pulverized Illinois coal, made by Milwaukee Elec. Ry. & Light Co.

Combustion. Dangers of Coal Dust (Die Gefahren des Brennstaubes), A. B. Helbig. Feuerungstechnik, vol. 10, no. 17, June 1, 1922, pp. 188–190. Discusses in detail process of combustion and shows that with ordinary care there is no danger of explosion.

Fire Hazards. Fire Hazards in Plants Using Pulverized Coal, L. D. Tracy. Blast Furnace & Steel Plant, vol. 10, no. 7, July 1922, pp. 395–399. Various cases where fires and explosions originated from improper handling of pulverized coal; many hazards connected to apparatus used for pulverizing.

Stationary Boilers. Use and Abuse of Powdered Fuel for Stationary Boilers, John E. Muhlfeld. Blast Furnace & Steel Plant, vol. 10, no. 6, June 1922, pp. 353–355. Any great advance in combined boiler and furnace efficiency will depend largely upon full utilization of radiant heat.

PUMPING PLANTS

Land Drainage. Pumping Plants for Land Drainage, L. C. Craig. Can. Engr., vol. 42, no. 21, May 23, 1922, pp. 525–527. Reclaiming land in Mississippi River valley; electrically driven centrifugal pumps often used for drainage work; advantage of Diesel engines.

PUMPS

Endless-Chain. The "Aquatole" Endless-Chain Pump. Engineering, vol. 113, no. 2948, June 30, 1922, pp 827–828, 9 figs. Installation of Aquatole liquid lifter which has capacity of 20,000 gal. per hr. with driving pully speed of 350 r.p.m.; efficiency of 55 per cent is attainable and ease of setting up and variety of liquid that can be handled are desirable features.

Gasoline, for Aircraft. The "Sylphon" Petrol Pump. Flight, vol. 14, no. 24, June 15, 1922, p. 344, 2 figs, Eliminates troubles arising from glands and their packing, and gives maximum discharge pressure at high speeds and sufficient delivery of fuel at any speed.

Hydrautomat. The Hydrautomat. Elec. Times, vol. 61, no. 1600, June 15, 1922, pp. 573–574, 2 figs. Invention whereby water is lifted through open and closed tanks by small water stream.

Valveless Reciprocating. A Valveless Reciprocating Pump. Colliery Guardian, vol. 123, no. 3206, June 9, 1922, pp. 1420–1421, 4 figs. New type which effects operation of opening and closing inlet and outlet ports by means of alternate axially reciprocating and rotary-oscillating movements of piston or cylinder itself.

PUMPS, CENTRIFUGAL

Efficiency. Centrifugal Pumps—Notes on Efficiency, E. T. Keenan. Southern Engr., vol. 37, no. 4, June 1922, pp. 39–40, 2 figs. Factors bearing on efficiency of turbine and volute pumps.

Electrically Driven. Centrifugal Pumps and Pipe Lines (Om Centrifugalpumper og Rörledninger), Rich. Holm. Ingeniören, vol. 31, no. 29, May 20, 1922, pp. 181–185, 10 figs. Discusses electrically driven pumps, power required, effective working, friction, etc.

Submersible Motor. Submersible Motors. Practical Engr., vol. 65, no. 1842, June 15, 1922, pp. 371–372, 2 figs. Extreme portability, lightness and compactness; suction lift of 30 ft.; when pump is working submerged no suction hose or priming is required; advantages of this device.

R

RADIATORS

Casting Parts. Carting of Radiator and Boiler Parts (Fortschritte in der Radiatoren- und Gliederkessel-Giesserei), Carl Irresberger. Giesserie-Zeitung, vol. 19, nos. 12 and 13, Mar. 21 and 28, 1922, pp. 185–189 and 204–205, 14 figs. Mar. 21: Operations connected with casting of radiators. Mar. 28: Patterns, forms and casting of boiler parts.

RAILWAY CONSTRUCTION

Leipzig, Germany. The Rearrangement of the Leipzig Railway Facilities (Die Umgestaltung der Leipziger Bahnanlagen durch die Preussische und Sächsische Staatseisenbahnverwaltung), H. Rothe, H. Mirus, H. Christoph, H. Schmitz and H. Schlunk. Zeit. für Bauwesen, vol. 71, nos. 4–6, 7–9, 1921, pp 168–198, 259–299 and vol. 72, nos. 1–3 and 4–6, 1922, pp. 37–76 and 131–156, 267 figs. partly on supp. plates. General notes on plan of entire railway installation in and around Leipzig; union passenger and freight stations, including description of plan of lines; interlocking machines; light and power supply, water supply and drainage installations; passage of city streets through terminal zone, including laying of new street and construction of iron viaduct.

RAILWAY ELECTRIFICATION

Austria. The Work of Electrification of the Austrian State Railways at the Beginning of 1922 (Der Stand der Arbeiten in die Elektrisierung der österreichischen Bundesbahnen zu Beginn des Jahres 1922), Paul Dittes. Elektrotechnik u. Maschinenbau, Special Number June 1922, pp. 1–34, 57 figs. Canal construction work in progress at Lake Spüller; extension of Rutz works; turbine equipment and electric

installation of both works; details of transmission masts and transmission lines, current feeds of locomotives; etc. See also Zeit des Österr Ingenieur-u. Architekten-Vereines, vol 74, no. 23 24, June 9, 1922, pp. 99–106, 4 figs.

Chilean State Railways. Electrification of the Chilean State Railways. Engineer, vol 133, no. 3470, June 30, 1922, pp 711 714, 11 figs Utilization of great water power resources for reducing working expenses, increasing traffic capacity and obviating dependence on coal supply from other countries; technical features of problem.

English Main Line. The Electrification of English Main Line Railways, Henry Fowler Instn Mech Engrs. Proc., no. 3, 1922, pp. 317 330 Discussion of paper presented at joint meeting of Instn Mech. Engrs., Instn. Civil Engrs., and Instn Elec Engrs

Japan. Electrification of the Chichibu Railway of Japan, C. A. Bereaw. Ry Rev., vol 70, no 24, June 17, 1922, pp 911 912, 2 figs. Five 41 ton locomotives shipped by Westinghouse Co., represent first shipment of electric locomotives from America for operation on steam railroad electrification in Japan.

Switzerland. Conclusion of the Work of Electrification of Rhaetian Railway (Der Abschluss der Elektrifizierungsarbeiten der Rhätischen Bahn) W. Dürler Schweizerische Bauzeitung, vol. 79, nos. 14, 15, 20, 21 and 22, Apr 8, 15, May 20, 27 and June 3, 1922, pp. 180–183, 194 198, 249–254, 267–269 and 279–281, 26 figs. Apr 8 and 15: Discusses power plants at Thusis and Küblis, and their equipment, transmission lines, distributing system, transformers, etc May 20: Describes the various types of electric locomotive and gives particulars as to their wiring and connecting. May 27: Data of trial runs of locomotives, and heating of trains. June 3 Discusses workshops and enginehouses and their equipment

RAILWAY MOTOR CARS

Advantages of. What is the Future for Automotive Rail Cars? L. G. Plant Ry. Rev., vol 70, no. 24, June 17, 1922, pp 930–934, 3 figs. Modern features which are recommended for light local passenger service. From paper read before Soc. Automotive Engrs.

Diesel-Electric. Diesel-Electric Motor Cars for Railway Service. Ry Mech. Engr., vol. 96, no. 6, June 1922, pp 314–315, 2 figs. Successful operation in Sweden has led to introduction of 250-hp cars

Gasoline. Some Recent Developments in Gasoline Passenger Rail Cars, W. L. Bean. N. Y. R. R. Club Proc., vol. 32, no. 7, May 19, 1922, pp. 6713–6726 and (discussion) 6726–6744, 6 figs. Considerations which may assist in reducing charges by substituting for light steam trains.

Developments in Gasoline Passenger Rail Cars, W. L. Bean. Ry. Age, vol. 73, no. 1, July 1, 1922, pp. 17–20 (includes discussion), 3 figs. Design, power requirements and operating results of self-propelled cars. (Abstract.) Paper read before N. Y. R. R. Club.

120 Hp. Gasoline Motor Features New Rail Car Design. Ry. Rev., vol. 70, no. 24, June 17, 1922, pp. 934–937, 8 figs. Low maintenance and adaptability to wide range of rail requirements objective in latest automotive development.

New Features. New Features in Service Railway Motor Coach. Ry. Mech. Engr., vol. 96, no. 6, June 1922, pp. 337–338, 3 figs. Unique type of truck with cushioned wheels; high seating capacity combined with light weight.

Pittsburgh and Shawmut. Operation of Motor Cars on the Pittsburgh & Shawmut, D. C. Morgan. Ry. Rev., vol. 70, no. 24, June 17, 1922, pp. 928–929, 3 figs. Costs less to operate than local steam train; affords better and more frequent service. Paper read before N. Y. R. R. Club.

RAILWAY OPERATION

Train Control. Schweyer Automatic Train Control. Ry Elec. Engr., vol. 13, no. 6, June 1922, pp. 187–189, 3 figs. Intermittent, non-contact, inert roadside element type.

The Sprague Train Control System. Ry. Signal Engr., vol. 15, no 6, June 1922, pp. 226–230, 9 figs. Description of display system of auxiliary control by magnets.

RAILWAY REPAIR SHOPS

Albuquerque, N. M. A. T. & S. F. Ry. Shop Improvements at Albuquerque. Ry. Rev., vol. 70, no. 24, June 17, 1922, pp 889–896, 16 figs. Engineering and mechanical features of improvement program of largest locomotive erecting shop in West, involving expenditure of about $10,000,000.

Car Equipment Scheduling. Scheduling of Car Equipment Through Repair Shops. Ry. Rev., vol. 70, no 25, June 24, 1922, pp. 965–970, 6 figs. Am. Ry. Assn. Committee urges scheduling of heavy freight and passenger car repairs on same principle as recommended for locomotive repairs in 1922 report.

Glass Walls in. Santa Fe Ry. Has Large Steel-Frame Shop with Glass Walls. Eng News-Rec., vol. 89, no. 1, July 6, 1922, pp. 12–15, 9 figs. Glazing outside structural framing; T-columns carry 250-ton crane, folding rack doors; repair pits and floor track construction.

Grinding Practice. Railway Shop Grinding Practice in England. Ry. Mech. Engr., vol. 96, no. 6, June 1922, pp. 325–327, 3 figs. Interesting machines developed for grinding locomotive cylinders, car journals and mounted crank-pins.

Locomotive. Modern Management of Locomotive Boiler Repair (Neuzeitliche Betriebsführung in der Lokomotivkessel-Ausbesserung). Glasers Annalen, vol. 90, nos. 10 and 11, May 15 and June 1, 1922, pp. 169 181 and 200–205 and (discussion) 205 207, 36 figs. May 15: Management of staybolts and rivets, and operations connected with them. June 1: Record keeping of boiler repairs, and their management.

Passenger-Car. The Design of Passenger Car Repair Shops. Ry. Mech. Engr., vol. 96, no. 6, June 1922, pp. 332–336, 1 fig. Requirements for various departments outlined and typical layouts proposed by A.R.E.A. Committee.

Power Plants. Some Factors in the Design of Railway Power Plants. Ry. Rev., vol. 70, no 25, June 24, 1922, pp. 991–995, 5 figs Am. Ry. Assn. Committee on modernization of stationary boiler plants advocates welding pipe lines and reports on relative merits of steam turbines and uniflow engines. (Abstract.)

RAILWAY SIGNALING

Automatic. New Signaling on the Big Four, C. F. Stoltz. Ry. Signal Engr., vol. 15, no. 6, June 1922, pp. 221–224, 6 figs. A. C. floating battery installed for operation of 68 miles of double track automatics shows economy in operation.

Automatic Block. Automatic Block System in Operation at the Grande Ceinture (Block-System automatique en service sur la Grande Ceinture), Bernard. Révue Générale des Chemins de Fer et des Tramways, vol. 41, no. 6, June 1922, pp. 457–467, 10 figs. Describes Lartigue signaling system in use in Paris, its construction and operation, which so far has worked satisfactorily.

Operation, Economy in. Introducing Economies in Signal Operation, Sidney L. Baxter. Ry. Signal Engr., vol. 15, no. 6, June 1922, pp. 231–232, 4 figs. Storage batteries replaced by primary battery, electric lights installed, and maintenance force reduced.

Wires and Cables. Railroad Signal Wires and Cables, Wm. A. Del Mar and F. A. Westbrook. Ry. Signal Engr., vol. 15, no. 6, June 1922, pp. 233–239, 15 figs. Methods of installation and causes of deterioration of rubber insulated conductors.

RAILWAY STATIONS

Waterloo, England. The New Waterloo Station, London & South Western Railway. Ry. Gaz., vol. 36, no. 23, June 9, 1922, pp. 919–936, 25 figs. Description of rebuilding of largest station in British Isles and facilities provided.

RAILWAY TERMINALS

Mississippi River-and-Rail. New River-and-Rail Terminals on the Mississippi. Eng. News-Rec., vol. 89, no. 1, July 6, 1922, pp. 18–20, 3 figs. Truck conveyor bridge and car incline with cradle provide for varying river level; two concrete docks with cranes.

Detroit. Pennsylvania to Complete Entrance into Detroit. Ry. Age, vol. 72, no. 25, June 24, 1922, pp. 1717–1718, 1 fig. Project includes local freight terminal, classification yard and 25 miles of new line.

RAILWAY TRACK

Elevation. Aurora Track Elevation Expedites Traffic. Ry. Age, vol. 73, no. 1, July 1, 1922, pp. 7–11, 8 figs. Burlington's grade separation project is supplemented by plan for increasing facilities.

RAILWAY YARDS

Freight. New Haven Builds Freight Yards at Providence. Ry. Age, vol. 72, no. 24, June 17, 1922, pp. 1467–1470, 4 figs. New terminal forms important unit in broad improvement program to effect operating economies.

REFRIGERATING MACHINES

Condensers, Free-Air. Influencing the Pressure of Free-Air Condensers, M. Hirsch. Ice & Refrigeration, vol. 62, no. 6, June 1922, pp. 457–459, 4 figs. Descriptive article with charts on subject; formula for measuring difference of vapor tension between water surface and moisture contained in surrounding atmosphere; empirical curves for regulation of water and air.

REFRIGERATING PLANTS

Ice-Cream. Modern Ice-Cream Plant, Frank D. Chase. Ice & Refrigeration, vol. 62, no. 6, June 1922, pp. 454–456, 5 figs. Diagrams and description of modern ice-cream plant; factors to be considered; taking advantage of law of gravity; anticipation of provision for future; sanitation; ventilation and welfare requirements.

Overhauling. Overhauling the Refrigerating Plant, J. J. Grover. Southern Engr., vol. 37, no. 4, June 1922, pp. 46–49, 4 figs. Pointers regarding what to do when getting ready for season's run.

REFRIGERATION

Absorption Process. Refrigeration for the Power Plant Engineer. Power House, vol. 15, no. 12, June 20, 1922, pp. 31–32, 34, 2 figs. Absorption process of refrigerating; aqua ammonia; general construction and details of parts of machine; few words on operating features.

Absorption System. Outline of the Absorption Refrigerating System, D. L. Fagnan. Power, vol. 55, no. 25, June 20, 1922, pp. 977–979, 2 figs. Discussion of functions of several parts; cycle of events in system; operating procedure to be followed.

RELATIVITY

Theory. Criticism of the Theories of Relativity (Critiques des théories de la rélativité), P. Juppont. Génie Civil, vol. 80, nos. 19, 20 and 21, May 13, 20 and 27, 1922, pp. 430–431, 443–446 and 468–473, 2 figs. May 13: Discusses relativity and postulates, force, action and reaction, temperature, entropy. May 20: Relativists' solutions of these problems; inadequacy of relativity; Lorentz contractions. May 27: Shows that Einstein's theory is not a physical theory Physical mechanics, mechanical force and power.

RESEARCH

Malleable Iron. Malleable Castings Research Laboratory Iron Age, vol 109, no 26, June 29, 1922, pp. 1819 1820, 2 figs. Freedom from routine tests permits concentration on work to advance state of art.

ROLLING MILLS

Efficiency. Effective Work of the Rolling Mill (Die Nutzarbeit des Walzvorgangs), G. Liss. Stahl u. Eisen, vol. 42, nos. 18, 19, 20, 21 and 23, May 4, 11, 18, 25 and June 8, 1922, pp. 689 697, 735 741, 768 772, 806 816 and 891 896, 21 figs. May 4 and 11: Discusses deformation generally; velocity of changing forms per second per unit of volume in various rolling processes; power factor depending on temperature and velocity; etc. May 18: The external mechanical process during rolling, spreading and elongation, shaping, pressure and friction of rolls. May 25: Discusses resistance to deformation as dependent upon block temperature. June 8: Effect of velocity of changing form; determination and comparison of effective work.

Electrically Driven. Steel Rolled for Less on Electric Mills than with Steam Drive, G. E. Stoltz. Elec. World, vol. 80, no. 1, July 1, 1922, pp. 7–10, 2 figs. Records show that steam mills can often be replaced by electric mills with marked advantages; accurate cost accounting is possible with electric mills, and labor and maintenance costs are reduced.

Ship-Plate. The Dominion Iron and Steel Company's New Ship-Plate Rolling Mill, H. E. Rice. Can. Min. Inst. Trans., vol. 23, 1920, pp. 167–178, 5 figs. Description of $5,000,000-installation with its Lauth type 110-in. by 36-in three-high plate mill driven by 4,000-hp. 82 r.p.m. special motor.

S

SAFETY

Electric Power Stations. Safety as Applied to Operating Equipment of Large Electric Power Station, E. W. Gorry. Safety Eng., vol. 43, no. 6, June 1922, pp. 261–268. Provisions at plants and sub-stations of United Elec. Light & Power Co. and new Edison Company. Paper read before A.S.S.E.

Safety is Built into the Design of the New Hell Gate Electric Power Station, E. M. Van Norden. Safety Eng., vol. 43, no. 6, June 1922, pp. 257–260. Precautions resulting from knowledge of conditions existing at other stations where trouble has been experienced. Paper read before A.S.S.E.

SAND BLAST

Apparatus. Development of Sand Blast Apparatus in Germany and America (Die Entwicklung des Sandstrahlgebläsebaues in Deutschland und Amerika), W. Kaempfer. Giesserei-Zeitung, vol. 19, no. 19, May 9, 1922, pp. 289–292, 15 figs. Discusses the various types of apparatus and their operation.

SAND, MOLDING

Properties for Steel. Study Properties of Steel Sand. Iron Trade Rev., vol. 71, no. 2, July 13, 1922, pp. 103–106, 8 figs. Facing mixtures must possess highly refractory qualities to resist intense heat of steel at pouring temperatures; determining standards for measuring permeability and strength.

SCRAP

Railway, Reclamation of. Scrap Reclamation on the Chesapeake and Ohio, E. A. Murray. Ry. Mech. Engr., vol. 96, no. 6, June 1922, pp. 308–311, 8 figs. Methods used and savings effected in reclaiming locomotive, car and other parts at Huntington shops.

SEPARATORS

Magnetic. New Magnetic Separator for Low Magnetic Ores (Neue Magnetscheider für schwachmagnetische Erze), H. Bernhardt. Technische Blätte vol. 12, no. 10, Mar. 11, 1922, pp. 105–106, 4 figs, Discusses drum separators for large and small size of grain, and describes their operation.

SHIP PROPULSION, ELECTRIC

Machinery on SS San Benito. The Electric Propelling Machinery of the "San Benito." Engineering, vol. 113, no. 2946, June 16, 1922, pp. 749–752, 13 figs. Developing 2,500 s.hp. with propeller speed of 100 r.p.m. Turbo-alternator rated at 2,040 kw. at 3000 r.p.m. has 9-stage turbine operating on 190 lb. steam with 200 deg. fahr. superheat.

SHIPS

Conversion to Oil-Burning. Cunarder "Berengaria" Converted to Oil-Fuel Burning. Mar. Engr. & Naval Architect, vol. 45, no. 537, June 1922, pp. 236–240, 18 figs. Work of conversion by W. G. Armstrong, Whitworth & Co. Ltd., Walker-on-Tyne; White low-pressure oil-burning system by White Patent Oil Fuel Co.; largest boiler repair contract ever carried out on Tyne; general reconditioning and overhaul.

Gyrostabilizer. The Latest Sperry Gyro-Stabilizer Installation. Mar. Engr. & Naval Architect, vol. 45, no. 537, June 1922, pp. 218 219, 2 figs. New 120-ton stabilizer to be installed on American passenger liner "Hawkeye State;" general principles; some particulars of rolling experiments recently carried out on Italian destroyer.

SHOVELS

Rotary. The Clere Mechanical Rotary Shovel (Pelle mécanique rotative, système Clere), E. Weiss.

Génie Civil vol 80, no 21, May 27, 1922, pp. 477–479, 8 figs Describes Clere system for mechanical excavating loading, etc

SPRINGS

Accidents to, Securing Against. Securing Springs Against Accident Autocar, vol 48, no. 1389, June 3, 1922 pp 939–940, 2 figs. Description of some of devices employed to prevent fractured spring leaf from entirely deranging steering.

Laminated, for Automobiles. Laminated Springs for Automobiles, T H Sanders. Machy. (Lond.), vol. 20, nos 501, 503, 505, 507 and 508, May 4, 18 June 1 15 and 22, 1922, pp 125–128, 185–188, 249–253 317–321 and 345–348, 28 figs. Discussion of design of modern manufacturing appliances and processes and effect of standardization on production.

STEAM

Consumption. Steam and Steam Consumption (Wasserdampf und Dampfverbrauch), A. Hinz, Gluckauf, vol. 58, no 24, Jone 17, 1922, pp. 705–739, 18 figs. partly on supp. plate. Discusses structure of i-diagram (heat content and entropy) for steam, and Mollier table, and shows possibility of their application in number of examples for determination of theoretical consumption of steam per unit of performance.

Production and Use. Economies in Steam-Raising, T W. Harper. Gas Jl., vol. 158, no 3075, Apr. 19, 1922, pp. 154–156. Lancashire versus water-tube boilers; boiler settings and flues; feedwater and scale; fuel and grate; waste-heat utilization; superheaters; steam distribution. Paper read before North British Assn Gas Managers.

Production and Utilization. Commission for the Utilization of Fuels—5th Report (Commission d'Utilization du Combustible—Cinquième Rapport), V Krammerer. Annales des Mines, vol. 1, no. 5, May 1922, pp. 348–391. Production and utilization of steam; transportation of steam; steam power and pressure; application of steam in industries.

Work of the Fuel Utilization Commission, V. Kammerer (Travaux de la Commission d'Utilisation du Combustible) Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 134, no 1, Jan 1922, pp. 50–78 Report on production and utilization of steam, including transmission, motive power, use of steam for manufacturing and heating purposes, etc. See also Chaleur et Industrie, no 24, Apr. 1922, pp. 1175–1182.

Supersaturated Condition. The Supersaturated Condition as Shown by Nozzle Flow, Prof. A. L. Mellanby. Engineering, vol. 113, no. 2948, June 30, 1922, pp. 832–835, 11 figs. Investigation of flow quantities exceeding those calculated on assumption of isentropic expansion of saturated steam. Paper read before Inst. Mech. Engrs.

STEAM ACCUMULATORS

Ruths. The Ruths Steam Accumulator on the Basis of the Patents of the Vaporackumulator Company in Stockholm (Der Ruths-Dampfspeicher auf Grund der Patente der Aktiebolaget Vaporackumulator in Stockholm). Kali, vol. 16, no. 12, June 15, 1922, pp. 234–238, 1 fig. Advantages of principle of steam accumulation for regulation of steam pressure; claims as stated in 17 German patents.

STEAM ENGINES

Uniflow. The Uniflow Steam Engine Industry. Power, vol. 55, no. 25, June 20, 1922, pp. 960–964, 8 figs Characteristics of this high-efficiency type which is thought to have kept steam-engine development from stagnation.

Uniflow Lubrication. Lubricating the Uniflow Engine Practical Engr., vol. 65, no. 1811, June 8, 1922 pp. 363–364. Errors in common practice indicated relieving excessive compression; selection of oil, speed and friction.

STEAM POWER PLANTS

Amsterdam. New Steam Plant at Amsterdam. Power Plant Eng., vol. 26, no 13, July 1, 1922, pp. 639–645, 10 figs Description of steam-turbine plant with an ultimate capacity of 200,000 hp.; boiler room; electric generating equipment; control equipment.

STEAM TRAPS

Selection and Use. Steam Traps Their Selection, Installation and Upkeep, E. Smiley. Power, vol 56, no 2, July 11, 1922, pp 45–48 General consideration and method of distinguishing actual leakage of steam from vapor formed by re-evaporation

STEAM TURBINES

Exhaust Type. The Exhaust Steam Turbine, W. R. Woolrich Nat. Engr., vol 26, no 6, June 1922, pp. 250–252, 3 figs Why this type has proven economical in conjunction with steam engine, vacuum as factor in economy; performance data.

Flow Phenomena and Design. Flow Phenomena and the Design of Large Steam Turbines (Stromungsvorgänge und Aufbau grosser Dampfturbinen), G. Zerkowitz. Zeit des Vereines deutscher Ingenieure, vol 66, nos 22 and 23, June 3 and 10, 1922, pp 533–536, 561–565, 15 figs. June 3 Incomplete expansion; means for reducing wear of turbine parts. June 10 Limits of efficiency; effect of great lengths of blades on flow of steam, etc.

STEEL

Arc-Deposited. Properties of Arc Deposited Steel, O. H. Eschholz. Iron Age, vol 109, no 26, June 29, 1922, pp 1803–1805, 7 figs Cast and hammer forged metal under static and dynamic stress as produced by direct current and steel electrodes.

Electrolytic Building Up. A Successful "Putting On" Tool for Steel Parts, David R. Kellogg. Elec. Jl, vol. 19, no 6, June 1922, pp. 249–251. Satisfactory method for depositing metal where it has been removed by wear or inaccurate workmanship.

Fatigue. Fatigue in Annealed and Tempered Carbon Steels (Über die Ermudung gegluhter und verguteter Kohlenstoffstähle), W Muller and H. Leber. Zeit des Vereines deutscher Ingenieure, vol. 66, no. 22, June 3, 1922, pp. 543–546, 8 figs. Experiments with steels of various carbon content, relation between fatigue and tempering and mechanical properties of steel.

Identification by Spark. Steels and Their Sparks Metal Industry (Lond.), vol. 20 no 23, June 9, 1922, pp. 549, 551–552, 10 figs. Determining character of steel by examination of sparks given off when sample is held against abrasive wheel.

Stainless. Stainless Steels and the Making of Cutlery R. G. Hall. Am. Soc for Steel Treating Trans vol 2, no 7, Apr. 1922, pp. 561–565 and (discussion) 566–568, 6 figs. Manufacture of stainless-steel blade, while not materially different in shape or size from that of ordinary carbon steel blade, is shown to be a great deal more costly.

STEEL CASTINGS

Foundry For. Makes Valves in New Foundry, H R Simonds. Foundry, vol 50, no 11, June 1, 1922, pp. 431–435, 13 figs. Description of steel foundry built by Chapman Valve Co for manufacture of steel castings.

Manufacture. The Production of Light Steel Castings, H. Spencer Kipling. Metal Industry, vol. 20, no. 21 and 22, May 26 and June 2, 1922, pp. 493, 495 and 525–526. Suggestions for overcoming metal difficulties of making castings for this type.

STEEL, HEAT TREATMENT OF

Carbon- and Chromium-Molybdenum Steel. Effect of Heat Treatment on Mechanical Properties of a Carbon-Molybdenum and A Chromium-Molybdenum Steel, H. I French. Am. Soc. for Steel Treating Trans., vol 2, no 9, June 1922, pp. 769–797 and (discussion) 797–798, 17 figs. Summary of results of previous tests and comparison of treatments for production of high resistance to impact and best combination to strengthen ductility.

Cooling and Heating. The Proper Heating and Cooling of Steel, John A. Succop. Can. Machy., vol. 27, no. 22, June 1, 1922, pp. 42–44, 4 figs. Less trouble experienced with small masses; all portions of piece should be subjected to same temperature; human element weakest link; temperature and time most important factors. Paper read before Am. Soc. for Steel Treating.

Annealing Overstrained Steel. The Efficiency of Annealing Overstrained Steel, I. H. Cowdrey. Am. Soc. for Steel Treating Trans., vol. 2, no 9, June 1922, pp. 802–808, 3 figs. Tests made to determine extent to which treatment of overstrained steel is successful.

Magnetic Properties, Influence on. The Influence of Heat Treatment Upon the Magnetic Properties of Steel, Lancelot W. Wild Am. Soc. for Steel Treating Trans., vol. 2, no. 8, May 1922, pp. 696–704, 6 figs. Intensity of magnetization, permeability, residual induction, and coercive force. Bibliography.

STEEL, HIGH-SPEED

Tests, Physical. Physical Tests on High-Speed Steels, A. H. D'Arcambal Iron Age, vol 110, no 1, July 6, 1922, pp. 1–5, 7 figs Transverse and tensile tests of two grades compared; effect of these properties on service of tool.

STEEL MANUFACTURE

Direct Process. A Direct Method of Steel Manufacture, A. E. Bourcoud Iron Age, vol 109, no 20, May 18, 1922, pp 1319–1351, 3 figs. Discussion of Bourcoud process and possibility of using oil, lignites and other fuels; data on costs. (Abstract.) Paper presented at meeting of Am. Iron and Steel Inst.

Tropenas Converter. Tropenas Converter for Making Steel, S. R. Robinson Blast Furnace & Steel Plant, vol. 10, no. 5, May 1922, pp 282–284. General description of this process, details of converter and information regarding cupola change. This process is very similar to the bessemer process.

STEEL WORKS

Electrification. The General Effect of Electrification on the Operation of Steel Mills, W Sykes Blast Furnace & Steel Plant, vol. 10, no. 6, June 1, 1922, pp. 306–312. Some interesting figures on operation of mills at Mark Plant are included, writer believes electric power is more economical than steam power.

Calumet Steel Company Electrify Mills, L. H. Hook and F. R. Burt. Blast Furnace & Steel Plant, vol 10, no. 6, June 1, 1922, pp. 313–316, 1 figs Rotary converter adjustable speed sets as applied to rail rerolling mill; twelve stands of rolls are now electrically driven.

France. The Hagondange Works [Les Usines d'Hagondange (Moselle)], I Siegle. Révue de Métallurgie, vol. 19, no. 6, June 1922, pp 313–351, 27 figs Describes iron works of Union des Consommateurs de Produits metallurgiques et industriels, mines operated by company; blast furnaces worked, their operation; steam production and use, compressed air; electric current; Thomas converters, rolling mills; workmen's dwellings.

France. The Unieux Foundry and Steel Works (Les Forges et Aciéries d'Unieux). Outillage, Tome 260, no 20, May 20, 1922, pp 652–655, 13 figs. partly on supp. plate. Describes works established by Jacob Holtzer, situated in Ondaine Valley, near Firminy, France, and its equipment

STOKERS

Chain-Grate. A New Chain Grate Stoker. Mar. Engr. & Naval Architect, vol. 45, no 537, June 1922, pp. 246–247, 1 fig. Mechanical method of coal firing; self-cleaning features; application of chain-grate to marine boilers.

Selection. What to Know When Selecting Stoker Equipment, J. G. Worker. Power, vol. 55, no. 17, Apr. 25, 1922, pp. 647–650. Combustion characteristics of principal coals; types of stokers best suited to burn them.

STORAGE BATTERIES

Lead Hydrate. Some Reflections on the Lead Hydrate Accumulator, W. R. Cooper. Electrician, vol. 88, no. 2298, June 2, 1922, pp. 654–656, 1 fig Examination of claims made for new type and consideration of characteristics.

STREET RAILWAYS

Toronto's Rolling Stock. Toronto's Progressive Rolling Stock Elec. Ry. Jl., vol 59, no. 21, May 27, 1922, pp. 867–870, 10 figs. Toronto Transportation Commission has added 250 new cars to its passenger rolling stock and has remodeled more than 350 other cars.

Turnstile Cars. Improvement in Turnstile Cars. Elec Ry. Jl, vol. 59, no. 19, May 13, 1922, pp. 787–789, 6 figs. One-man operation with double-truck cars in Utica and Syracuse has increased steadily until now Utica has 100 per cent operation. Improvements in turnstile arrangement are described

STRESSES

Allowable, Safety and. Factors of Safety and Allowable Stress, C. D. Albert. Am. Mach., vol. 57, no. 2, July 13, 1922, pp. 54–57. Meaning of allowable stress; factors of safety for live and dead loads; effects of fatigue, shock, and uncertainy as to actual conditions existing.

Torsional. Torsional Stresses (Die Lehre der Drehungsfestigkeit), Constantin Weber. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 249, 1921, 70 pp., 170 figs. Discusses phenomena of torsion, stresses occurring, conditions of equilibrium, internal change of form; develops formulas and makes calculations; application to various cross-sections.

Two-Dimensional. Some Special Cases of Two Dimensional Stress or Strain, C. E. Inglis. Engineering, vol. 113, no. 2945, June 9, 1922, pp. 732–733, 8 figs. Mathematical consideration in six special cases in plates.

SUBWAYS

Safety and Operating Developments, London. "Safety" and "Operating" Developments on the Underground Railways. Ry. Gaz., vol. 36, no. 22, June 2, 1922, pp. 891–894, 6 figs. Arrangements to cut off current from affected section in 20 to 25 seconds; controller governed by brake system; other features.

T

TAR

Preparation and Uses. Preparation and Uses of Tar and Its Simple Crude Derivatives, W. W. Odell. Bur. of Mines, Dept. of Interior, Technical Paper 268, 1922, 84 pp., 13 figs. General treatise on utilization of tar and usual methods of working up tar into some of its simple or easily prepared derivatives.

TANKS

Steel, Manufacture of. Role of Steel Tanks is Important, J. D. Knox Iron Trade Rev., vol. 70, no. 25, June 22, 1922, pp. 1795–1797 and 1806, 3 figs. Manufacturing methods are relieved of details by standardizing product; fabrication involves 24 distinct operations; how large oil tanks are erected; instructions for tank installation.

TELESTEREOGRAPHY

Belin System. Telegraphic Transmission of Photographs. Nature, vol. 109, no. 2743, May 27, 1922, pp. 687–688, 1 fig. Latest developments in which good results have been obtained by French wireless station near Bordeaux and naval station in United States.

TESTS AND TESTING

American Society. American Society for Testing Materials. Iron Age, vol 110, no. 1, July 6, 1922, pp. 13–18 Annual convention discusses steel castings and pig and cast iron; sulphur in steel; symposiums on impact testing and fatigue of metals.

TEXTILE INDUSTRY

British and American Practice. British and American Textile Manufacturing Practice, Wm. D. Hartshorne. Engrs. & Eng., May 1922, pp. 143–148, 6 figs. Characteristic qualities of wool fiber; comparison of its treatment and results of differences.

TIDAL POWER

Utilization. Utilizing the Power of the Tides and the Motion of the Sea Waves (Utilizzazione della forza delle maree e dell'urto delle onde del mare). Elettricista, vol. 1, no. 10, May 15, 1922, pp. 73–74, 2 figs. Various schemes for generating power; describes plant at Rennes, in France.

TIMBER

Creosoted, Fire Hazard. Are Many Creosoted Timber Structures Destroyed by Fire? Ry. Maintenance Engr., vol. 18, no 5, May 1922, pp. 167–169. Facts which show that advantages derived from preservative treatment far outweigh any possible hazzards from that source.

TIRES, RUBBER

Damaged, Inspection of. The Inspection o

Advance copies of the new enlarged and completely rewritten edition of Engineering Bulletin M-1, descriptive of Cadman Bearing Metals, were sent to a few prominent engineers. Here are their replies:

A Professor of Mechanical Engineering

"Your treatment of the subject is both interesting and logical. The bulletin contains more practical information than any text book with which I am familiar. I should like to have several additional copies for use in my classes, if you can spare them."

The Chief Engineer of a Power Company

"Your bulletin M-1 is valuable and I must frankly confess that I can now, for the first time, actually visualize what takes place in a bearing."

The Chief Engineer of a Company manufacturing Electrical Machinery

"Engineering Bulletin M-1 is the first trade publication I have received in which the subject is discussed rationally. It is of real scientific interest."

The Superintendent of Motive Power of a Railroad

"Your Engineering Bulletin M-1 is of interest. Please quote prices on your metals."

The Chief Engineer of a Company Manufacturing Gas Engines

"We have been using your metal for about twenty-five years in our heavy duty bearings, and have never had a complaint. I consider your bulletin a valuable addition to engineering literature and can heartily endorse all you say."

The Superintendent of a Steel Plant

"We have been using your metal for more than twenty years, and I am glad to learn why it gives so undoubtedly superior service to babbitts made in the usual way."

This new edition of Engineering Bulletin M-1 will gladly be sent to Consulting, Operating and Designing Engineers. Use the coupon.

(Clip the coupon or simply enclose your card in an envelope)

A.W. Cadman Manufacturing Co.
Pittsburgh Pa.

Master Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletin M-1, samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:.................................... Position:......................

Company Name:...

Address:..

Damaged Tires. India Rubber Jl., vol. 63, nos. 22 and 24, June 3 and 17, 1922, pp. 20, 22–24 and 5–7. Description of some of most common forms of tire damage and working out proper system for inspection.

Motor-Bus, Selection and Care. Selection and Care of Motor Bus Tires, W. H. Gillilan. Bus Transportation, vol. 1, no. 6, June 1922, pp. 323–326, 8 figs. Some suggestions for reducing tire mileage costs through careful operation.

Research. Temperatures and Friction Losses Determined by Tire Research. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1232–1236, 9 figs. Tire temperature increases as inflation pressure decreases; rolling resistance of fabric tire fifty per cent greater than that of cord. Influence of wear on rolling resistance not proved.

TOLERANCES

Standardizing. Standardizing Tolerances and Allowances in Machine Fits. Am. Mach., vol. 57, no. 2, July 13, 1922, pp. 70–71. Suggestions by A.S.M.E. Sextional Committee on plain gages as compiled from practice of many well-known manufacturers.

TRACTORS

Development. Market Research Essential to Development of Tractor Design, E. A. White. Automotive Industries, vol. 46, no. 23, June 8, 1922, pp. 1210–1213, 7 figs. Tractor must meet farm needs; it is essentially a power generator for soil preparation and belt work. Government and agricultural schools active in tractor research.

Testing, Standard Code for. Standard Code for Testing Tractors. Agricultural Eng., vol. 3, no. 5, May 1922, pp. 82–83 (includes discussion). Report of Subcommittee on Tractor Ratings presented at annual meeting of Agricultural Engrs.

Tread. Relation of Lug Equipment to Traction, R. U. Blasingame. Agricultural Eng., vol. 3, no. 5, May 1922, pp. 79–81, 1 fig. Excerpts from report of E. R. Hewett on principles of wheeled farm tractor, and some results of tests on same subject by state agricultural colleges. Paper read before annual mtg., Am. Soc. Agricultural Engrs.

TRANSPORTATION

Paris. Société des Transports en Commun de La Region Parisienne. Engineering, vol. 113, no. 2946, June 16, 1922, pp. 740–745, 10 figs. History; description of company which now operates 127 tramway lines over 637 miles and 41 bus lines over 159 miles.

TUBES

Seamless. The Manufacture of Seamless Steel Tubes. Iron & Coal Trades Rev., vol. 104, no. 2832, June 9, 1922, p. 819, 1 fig. Consideration of three processes, piercing, rolling and cold drawing. Features of each.

Seam Welding, Automatic. Automatic Seam Welding in Making of Tubes, J. L. Anderson. Can. Machy., vol. 27, no. 21, May 25, 1922, p. 31. Material must be of suitable composition; finger arrangement prevents all twist or curl when strip stock is entering rolls; compressing metal after weld is made.

Automatic Seam Welding and the Manufacture of Tubes, J. L. Anderson. Am. Welding Soc. Jl., vol. 1, no. 3, Mar. 1922, pp. 26–34, 1 fig. Describes simple process which makes possible production of this class of tubing at fraction of cost of seamless steel tubing.

Steel, Charts for. Nomographic Column Charts Air Service Information Circular, vol. 4, no. 304, Feb. 15, 1922, 8 pp., 6 figs. Presents charts constructed at different times since April 1920, but never before published, and explains method of using them.

TUNNELS

Converting Into Open Cut. Converting a Tunnel Into an Open Cut on a Busy Line, W. S. McFetridge. Ry. Age, vol. 72, no. 22, June 3, 1922, pp. 1275–1277, 6 figs. Bessemer & Lake Erie adopts interesting measures to effect this improvement without delaying traffic.

TURBINES

Air. The New Turbinair Hoist. Practical Engr., vol. 65, no. 1812, June 15, 1922, pp. 373–374, 3 figs. Novel, small yet powerful motor whose only movable parts are two double helical or herringbone gears meshing together and running on ball bearings.

V

VALVES

Emergency Closing. The Importance of Emergency Closing Valves, P. W. Knauf. Power House, vol. 15, no. 10, May 20, 1922, pp. 23–24, 35, 6 figs. Importance of quick and safe closing-off of high-velocity steam and method of accomplishing same.

Emergency Closing Valves, P. W. Knauf. Refrig. World, vol. 57, no. 5, May 1922, pp. 22–24, 6 figs. Necessity for and types of valve for boiler end of steam pipes.

Gate, Electrically Operated. Electrically Operated Gate Valves, C. E. Reese. Gas Age-Rec., vol. 49, no. 20, May 20, 1922, pp. 619–622, 10 figs. Discussion of power-operated valves and review of development of Dean control system for operation of gas, air, steam, water, oil, tar and ammonia gate valves.

Electrification of Gate Valves, Payne Dean, New England Water Works Assn. Jl., vol. 36, no. 2, June 1922, pp. 264–270 and (discussion) 270–272, 5 figs. Importance of quick and positive control in preventing property loss by flooding and how valve operating system works.

VENTILATION

Pipes, Friction Factors. Friction Factors in Ventilating Pipe, W. S. Weeks, W. P. Goss and G. H. Warren. Eng. & Min. Jl.-Press, vol. 113, no. 23, June 10, 1922, pp. 1001–1002, 1 fig. Results of series of experiments at Univ. of Cal ; little difference between metal and wood pipe.

VENTURI METERS

Anomalous Test Results. Anomalous Results in Venturi Flume and Meter Tests, William J. Walker. Eng. News-Rec., vol. 88, no. 19, May 11, 1922, pp. 797–798, 1 fig. Discussion of peculiar variations of venturi coefficients of discharge. Wave formation, air and other theories.

Application. Venturi Meters (Über Venturimesser), R. Kirchner. Fördertechnik u. Frachtverkehr, vol. 15, no. 11, May 26, 1922, pp. 150–152, 10 figs. Principle and law of venturi tube, its application to measurement of water, steam, gas and air; flow formulas, accuracy, etc.

VIBRATIONS

Measurement. Apparatus for Studying the Vibrations Produced in Buildings by Traffic (Apparei destiné a l'étude des vibrations produites dans les édifices par la circulation des véhicules), Paul Prache. Bul. de la Société l'Encouragement pour l'Industrie Nationale, vol. 134, no. 3, Mar. 1922, pp. 177–186, 7 figs. Holds that a disagreeable element is acceleration and describes principle and operation of accelerometer for measuring vibrations.

VISCOSIMETERS

Fuel-Oil. Fuel Oil Viscosimeters, Winslow H. Herschel. Chem. & Met. Eng., vol. 26, no. 25, June 21, 1922, pp. 1175–1177, 4 figs. Standardization and calibration of Saybolt Furol viscosimeter and calibration of Redwood Admiralty type.

W

WASTE HEAT

Utilization. Utilizing the Waste Heat of Flue Gases for Heating and Drying on a Large Scale (Rauchgas-Abwärmeausnutzung für Grossraumheizung und Trocknungsanlagen), Otto Brandt. Wärme- und Kälte-Technik, vol. 24, no. 11, June 1, 1922, pp. 125–127, 5 figs. Use of waste heat for preheating furnace air, feedwater heating, heating of buildings, etc.

WATER

Analysis. Processes of Analyzing Water (Sur les procédés d'analyse des eaux), F. Touplain. Chimie & Industrie, vol. 7, no. 4, Apr. 1922, pp. 634–639, 3 figs. Discusses sampling, physical and chemical methods; concludes that present methods need revising.

Hardness Testing. Determination of the Hardness of Water Used for Technical Purposes (Uber die Härtebestimmungen in technischen Wässern), G. Weissenberger. Zeit. für angewandte Chimie, vol. 35, no. 30, Apr. 14, 1922, pp. 177–179. Discusses various rapid methods and apparatus required.

WATER MAINS

Stresses, Calculation. Comparison of Approximate and Exact Calculation of the Distribution of Stresses in Pipes (Über den Vergleich der näherungsweisen und exakten Berechnung der Spannungsverteilung in einer Röhre), Friedrich Willheim. Zeit. des Österr. Ingenieur u. Architekten-Vereines, vol. 74, no. 25–26, June 23, 1922, pp. 117–119, 1 fig. Calculation for pipes uniformly loaded in one direction, such as water mains and pressure piping.

WATER POWER

Applications. Water-Power Applications Total 20,473,548 Hp. Elec. World, vol. 79, no. 21, May 27, 1922, pp. 1072–1073, 1 fig. Federal power commission has received 303 applications for preliminary permits and licenses, and of these had granted 74 up to and including April 17, 1922.

Development in Southeast U. S. Power Development in the Southeast, Chas. G. Adsit. Mech. Eng., vol. 44, no. 5, May 1922, pp. 291–294, 300, 5 figs. Utilized and undeveloped waterpower resources of 5 southern states discussed. Present state of Muscle Shoals project and future possibilities described.

Germany. The Importance of Reservoirs in the Utilization of Water Power in Germany (Die Bedeutung von Sammelbecken fur die Ausnutzung der Wasserkräfte in Deutschland), W. Soldan. Zeit. des Vereines deutscher Ingenieure, vol 66, nos. 17, 18 and 19, Apr. 29, May 6 and 13, 1922, pp. 413–417, 441–442 and 471–473, 8 figs. Discusses utmost use of water power by regulation of flow, fluctuations in German rivers, construction of dams and weirs, etc. Examples of German works where power installation and water storage are coördinated to best advantage.

WATER PURIFICATION

Illinois Plants. Water Purification Plant Operation in Illinois, M. W. Cowles. Eng. & Contracting, vol. 62, no. 24, June 14, 1922, pp. 569–572. Preliminary treatment, coagulating chemicals, mixing raw water with coagulant solution, filtration plants.

WELDING

Boilers. Boiler Welding, Edward H. Heidel. Am. Welding Soc. Jl., vol. 1, no. 3, Mar. 1922, pp. 13–25, 20 figs. Notes on autogenous welding of locomotive boilers; electric or gas welding of firebox, side and door sheets, door collars, stoker tubes, etc.; electric welding of flexible sleeves; cutting of staybolts.

Frogs and Crossings. Welding Frogs and Crossings with Manganese Steel, H. R. Pennington. Eng. & Contracting, vol. 57, no. 7, Feb. 15, 1922, pp. 152–154, 2 figs. Qualities and methods of use in welding operations. Paper read before Am. Welding Soc.

[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; OXY-ACETYLENE WELDING.]

WELDS

Cast-Iron, Dependability of. The Dependability of Cast Iron Welding, G. O. Carter. Acetylene Jl. vol. 23, no. 11, May 1922, pp. 535–538, 8 figs. Preheating and annealing; correct preparation of casting, by having complete casting at red temperature. From paper read before Am. Welding Soc.

Testing Standards. Standards for Testing Welds. Eng. World, vol. 20, no. 5, May 1922, pp. 297–300, 13 figs. Report of Committee on Standards Tests for Welds of Am. Bureau of Welding, a joint advisory board of Am. Welding Soc. and Eng. Div. of Nat. Research Council, on Welding Research and Standardization.

WINDING ENGINES

Germany. Winding Arrangements and Winding Cables in the Dortmund Shafts (Die Fördereinrichtungen und Förderseile in den Schächten des Oberbergamtsbezirks Dortmund während der Jahre 1915 bis 1919), H. Herbst. Glückauf, vol. 58, nos. 18 and 19, May 6 and 13, 1922, pp. 527–534 and 556–562, 12 figs. May 6: Discusses various types in use and gives statistical data concerning them. May 13: Discusses failure of cables and gives tabulated statement of these.

WIND TUNNELS

Motor Regulator. Langley Field Wind Tunnel Motor Regulator, D. L. Bacon. Aviation, vol. 12, no. 8, Feb. 20, 1922, pp. 226–227, 1 fig. N.A.C.A. develops motor regulator which practically solves problem of constant propeller speed in wind tunnel. N.A.C.A. Technical Note No. 81.

WIRE DRAWING

Chromel Wire. Drawing Chromel Wire, E. F. Lake. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 793–797, 7 figs. Methods of drawing special alloy wire; uses and physical properties of alloy; manufacture of dies.

Drawing Chromel Wire. Machy. (Lond.), vol. 20, no. 508, June 22, 1922, pp. 350–354, 7 figs. Methods of drawing special alloy wire, uses and physical properties of alloy, and manufacture of dies.

WIRE MANUFACTURE

England and France. Wire Manufacturing in England and France, Kenneth B. Lewis. Blast Furnace & Steel Plant, vol. 10, no. 6, June 1, 1922, pp. 323–325. General comparison of wire drawing practice of England and France with that of United States; reasons for differences in method of manufacture given.

WOOD

Testing Apparatus. New Apparatus for Testing Wood, Especially Wood for Aeronautics (Appareils nouveaux pour l'essai des bois), Pierre Breuil. Génie Civil, vol. 80, nos. 19 and 20, May 13 and 20, 1922, pp. 417–422 and 446–449, 17 figs. May 13: Describes Amsler system and apparatus, the Breuil volume meter, and various tests carried out. May 20: Machines for testing wear of woods; Amsler machine for testing propellers.

WOODWORKING INDUSTRY

Shavings and Dust Removal. The Removal of Shavings and Dust in the Woodworking Industry (Förderung von Spänen und Staub in der Holzindustrie), Otto Brandt. Fördertechnik u. Frachtverkehr, vol. 15, no. 1, Jan. 6, 1922, pp. 13–16, 6 figs. Points out its importance from standpoint of industry and worker's health. Desiderata for installation of chip-conveying and dust-removal plants. Results of investigation of chip-conveying plant.

X-RAYS

Metal Penetration. Metal Penetration by X-Rays (Beiträge zur Metalldurchleuchtung mittels X-Strahlen), Ludwig Zerzog. Giesserei Zeitung, vol. 19, nos. 10 and 11, Mar. 7 and 14, 1922, pp. 156–160 and 171–176, 41 figs. Mar. 7: Describes technical process of taking photographs, and gives a number of examples of successful exposures. Mar. 14: Gives various illustrations of application to reinforced-concrete plates, gear wheels, copper tubes, etc.

Z

ZINC ALLOYS

Binary. Studies on the Constitution of Binary Zinc base Alloys, W. M. Peirce. Min. & Metallurgy, no. 182, Feb. 1922, p. 64. Author endeavors to correlate and complete data on constitution of alloys of zinc with other common metals, dealing exclusively with zinc-rich alloys in which zinc content is between 90 and 100 per cent. (Abstract.) See also Am. Min. & Met. Engrs. Trans., no. 1133–N, Feb. 1922, 26 pp. 52 figs (Complete papers.)

ZIRCONIUM

Uses. New Possible Uses of Zirconium (Neue Verwendungsmöglichkeiten für Zirkon), Raphael Eugen Kirchner. Chemiker-Zeitung, vol. 46, no. 50, Apr. 27, 1922, p. 380. Discusses zirconium steel, crucibles, carbide, etc.

MECHANICAL ENGINEERING

Volume 44 October, 1921 No. 10

The Hydraulic Turbine in Evolution

New Problems Created by Turbine Evolution—Analysis of Flow in a High-Speed Turbine—Correlation of the Marine Propeller with the Hydraulic Turbine

By H BIRCHARD TAYLOR[1] AND LEWIS F. MOODY,[2] PHILADELPHIA, PA.

IF WE view the present stage of development of the hydraulic turbine against its historical background, there are many indications that we are in the midst of a transition period. There was a similar time of transition in 1890 to 1900 when the turbine was being developed to meet the requirements of electrical generation, and as pointed out in the paper by one of the authors presented last year,[3] one phase of that transition period was an increase in complexity marked particularly by the adoption of multi-runner units. Another transition occurred about 1911 to 1912, marked by a return to greater simplicity and the readoption of the single-runner vertical machine.

For almost ten years the hydraulic turbine remained nearly stationary in its development, accepted practice settled upon a nearly standardized design, and there seemed to be room for little further improvement in efficiency, speed, or mechanical design. Nevertheless within the last two or three years a surprising number of new lines of progress have been opened up and the turbine, and with it other features of water-power engineering, is again in a healthy state of change.

Notable progress has been accomplished by a number of engineers in the extension of the range of available speeds, so that extremely high specific speeds are now obtainable with satisfactory efficiency. The authors have for a number of years been devoting particular attention to this high-speed field and the possibilities which the extension of the field has opened up. This paper will describe some of the lines of development which have been followed and some of the problems involved in applying the new turbine forms which have been developed.

PROBLEMS CREATED BY TURBINE EVOLUTION

As an indication of what has been accomplished, Figs. 1 and 2 show in preliminary form the design of an installation now under construction involving a turbine runner which is within a few inches of the same diameter as that installed at the great Cedars Rapids plant on the St. Lawrence containing the largest runners in existence today. The turbine shown in these figures, however, is of very nearly twice the specific speed which was available at the time the Cedars turbines were designed. It should also be recalled that the specific speed adopted in the Cedars plant represented a notable step in advance at the time that installation was completed, namely, 1914. This ability to use double the speed which was available eight years ago represents a material saving in the cost of the turbines, generators and power-house structure.

Not only is the weight and cost of the generator reduced in even greater ratio than the saving in the turbine, but the reduction in weight of parts to be handled by the power-house cranes reduces the weight of the station superstructure, and it is also possible in installations now carried out to effect considerable savings in the amount of excavation necessary for the power-house substructure, to mention only a few of the principal factors affected by the recent progress. The turbine of Figs. 1 and 2 is of the diagonal-propeller type. As shown in Fig. 2, instead of employing the usual continuous "speed ring" at entrance to the guide vanes, the design involves the use of separate stay vanes. In addition to the stay vanes at entrance, a second series of stay vanes are used in the spreading draft tube, as shown in Fig. 1. Fig. 3 shows a 16-in. turbine of the same type tested in the I. P. Morris Laboratory.

Although great progress has been made in the attaining of higher speeds, another question remains to be investigated, and that is the extension of the application of these high-speed turbines to higher heads.

For a long time it was common practice to select the type of turbine for any installation by taking the value of specific speed from a so-called "experience curve" which was plotted between the variables: head and specific speed. Thus it was assumed that for any given head available for a projected plant, the specific speed adopted should not be higher than the limit shown by such a curve. But the specific speed permissible for any installation is not a function solely of the head on the plant but it is also dependent upon the elevation of the turbine runner with respect to the surface of tailwater. About all that can be said for the "experience curve," is that by its use, turbines can be selected for any given installation which will be capable of being set at some arbitrary height above the tailwater consistent with customary practice. This method, however, of selecting specific speeds for any projected plant is not of much value even as a rough approximation and should not be relied upon, since it neglects so many factors of importance, among them being the possibilities opened up by the latest advances in this field of engineering. For example, there are probably many plants where the elevation of the runner above tailwater has been placed at an arbitrary distance, where it would have been possible by lowering this elevation to permit the adoption of considerably higher speeds and at the same time to reduce the risk of corrosion and vibration.

Referring, for instance, to the type of turbine shown in Figs. 1 to 3, it may be pointed out that there is no strong necessity when this turbine is installed to place the runner above high tailwater level. The probability of emergencies arising which would require the shutdown of the unit for examination or repair is very slight in large modern installations of the high class of design and workmanship now available. It is therefore not likely that it will be necessary to gain access to the runner during times of abnormal height of tailwater. Moreover, in the new forms of high-speed turbines when built in the large sizes of units now being adopted, it is not necessary to provide a manhole for entrance to the draft tube below the runner, since this space is readily accessible through the wide openings between the runner blades. It is therefore possible in many plants to place the runners close to the normal tailwater elevation without likelihood of any serious inconvenience.

As mentioned in the paper of last year, moreover, a further departure from customary practice has been proposed by one of the writers, involving the placing of the runner below tailwater. This suppression of the runner may be accomplished either by providing tail-race gates to permit access to the runner, or by adopting the inverted arrangement of the turbine. As a matter of interest and to show some of the possibilities of this plan, Fig. 4 is given, representing a proposed arrangement of the Taylor inverted turbine. One of these turbines was tested with one runner in both the inverted and conventional positions in order to satisfy the skeptical that the performances would be identical—as they were.

---

[1] Vice-President, The Wm. Cramp & Sons Ship and Engine Building Co. Mem. Am.Soc.M.E.

[2] Assistant to Vice-President, The Wm. Cramp & Sons Ship & Engine Building Co. Mem. Am.Soc.M.E.

[3] The Present Trend of Turbine Development, by Lewis F. Moody, MECHANICAL ENGINEERING, vol. 43, no. 4, April, 1921, p. 235.

Abridgment of a paper presented at a meeting of the Philadelphia Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Philadelphia, March 21, 1922.

Analysis of Flow in a High-Speed Turbine

In order that the questions raised by the use of the new turbine types under an increasing range of heads may be considered more in detail, the following method of analyzing the flow through a high-speed turbine is given.

In some aspects the high-speed turbine has approached the marine propeller, but while some forms of high-speed turbines resemble a marine propeller rather strikingly in appearance, there are essential differences in action. In the marine propeller the water approaches the propeller in directions parallel to the axis of rotation; in the high-speed turbine of Fig. 3, the water enters the turbine with radial inward components of velocity directed toward the axis and also with an increasing tangential or whirl component about the axis. The radial component is turned into a diagonal direction, and in this type this turning then proceeds continuously as the flow passes through the runner until the discharge becomes axial and finally outward, away from the axis. The flow as it progresses through the turbine can be thought of as containing three kinds of rotation, or whirl, which take place simultaneously about three different axes.

In the complete form of the turbine, such as shown in Figs. 1 and 2, the water enters the turbine through a volute casing in which it takes up a motion of rotation about the turbine axis, which is increased as the water passes through the stationary guide vanes and approaches the axis. This rotation may be called the "primary whirl." As shown in the paper of last year, this whirl, while partially abstracted by the runner, still persists in reduced degree in the draft tube. It has apparently been the effort of some designers to adapt their runners to remove all whirl from the water and to discharge the water without rotation, and many of the draft tubes now used or proposed are adapted to handle only non-whirling flow; and many of such draft tubes—especially the formerly prevalent elbow type—are very defective in operation with any kind of flow. It was demonstrated in the previous paper, however, that when a runner discharges into a draft tube which is capable of regaining the energy of whirl, the most efficient condition of operation of the runner is attained when the water is discharged in an oblique direction, containing a definite tangential velocity component about the axis. It therefore follows that a high-speed runner when equipped with a whirl-regaining draft tube will operate most efficiently at a higher speed and that its efficiency will then be higher than is possible with other types of draft tube. Indeed, if runners of the speeds now being used are installed with improperly designed draft tubes, serious loss of power and efficiency may be looked for, as well as vibration and unsteady operation.

In analyzing the action of this "primary whirl" which the water possesses in some degree throughout its passage through the turbine, the law of constancy of moment of momentum may be applied to all spaces in which the water can whirl freely without the influence of directing vanes or obstructions. In accordance with this law, the tangential velocity in such spaces will vary inversely as the radial distance from the axis. We may start to apply this principle to the flow in the volute casing of the turbine and may form the walls of the volute to conform with such a mode of flow.

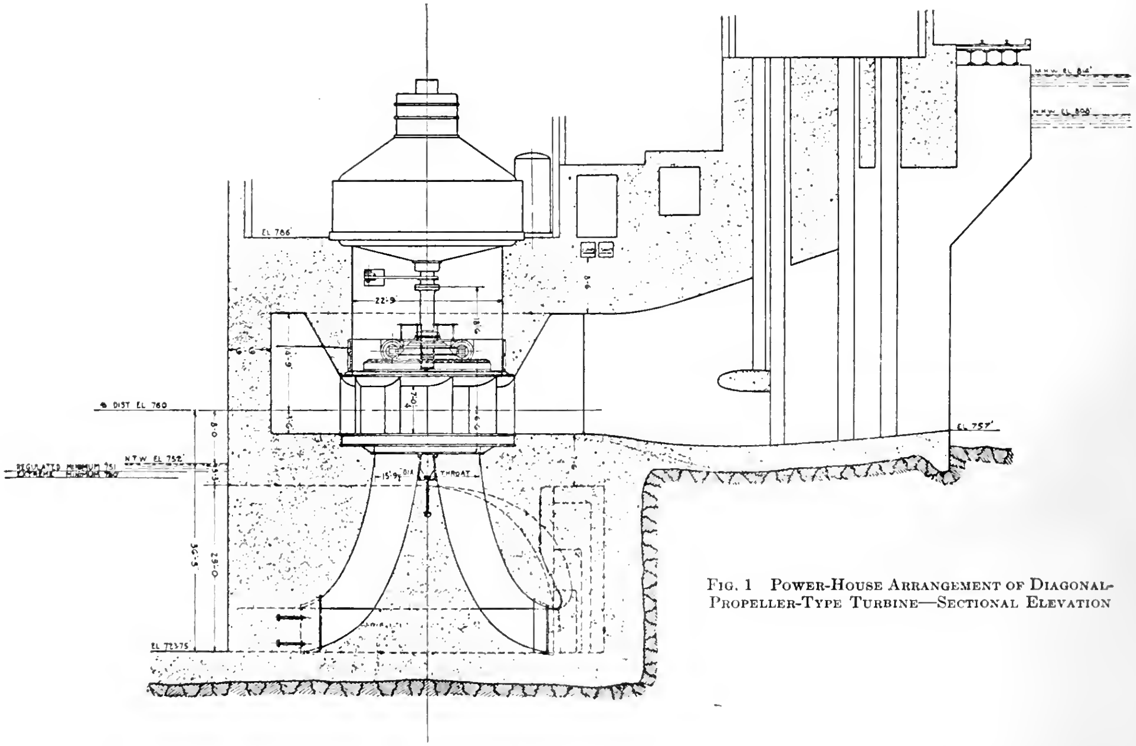


Fig. 1 Power-House Arrangement of Diagonal-Propeller-Type Turbine—Sectional Elevation

In designing the volute casing in this manner, the cross-sectional area of the volute passage will decrease in passing around the circumference of the turbine at a rate sufficient not only to provide for the decrease in quantity of flow remaining in the volute at each section, but also to provide for a continually increasing velocity. When applying this law to the velocity at any section, it may be taken as inversely proportional to the radius to the center of gravity of the section. In a casing designed by this method the walls will conform to the natural path of the water, and there is no reason to expect any greater loss of head in such a casing than that corresponding to the friction loss in an equivalent length of straight pipe.

After the water leaves the guide vanes, it passes inward toward the axis, its velocity continuing to increase in inverse proportion to the radius; and since more and more of its pressure head is converted into velocity head, its pressure decreases. If the freely whirling water is permitted to approach the axis closely, low pressures will occur, appreciably lower than atmospheric in many cases. Thus, we shall have even on the entrance side of the runner pressures of low absolute value, sometimes but little above the pressure in the draft tube; and this is evidenced in actual operation in some designs by the drawing of air through stuffing boxes into the transition space in advance of the runner.

Since points of low pressure are conducive to cavitation, or the formation of voids in the water stream, with tendencies toward

eddy formation, the formation of air pockets, and danger of corrosion and vibration, it is, of course, desirable to avoid any such low-pressure regions. An undue reduction in pressure in advance of the runner can be avoided by the admission of the water to the runner before it has approached too closely to the axis, the further reduction in pressure which the water must experience on its way to the draft tube then taking place within the runner during the process of transferring energy from the water to the runner. A reduction in pressure in advance of the runner is aggravated when the turbine is operating at part gate if it is equipped with the usual wicket gates, since at part gate the water leaves the guide vanes with increased velocity in a more tangential direction and with lower pressure, and the pressure starting at a lower value near the guide vanes drops more rapidly toward the axis. It may easily happen, particularly at part gate, that pressures may exist in the inner portion of the entrance space to the runner which are equal to, or even less than, the pressure in the draft tube. The new diagonal form in runner blade is adapted to prevent an undue pressure reduction of advance of the runner blades by providing a considerable diameter for the inflow edge of the blade where it joins the runner hub.

Another consideration which leads to the adoption of a diagonal-flow runner in preference to the purely axial-flow type is that as the stream elements at the upper portion of the guide vanes approach the axis the velocity of the water increases in inverse proportion to the radius. The velocity of the entrance edges of the runner blades, however, decreases in direct proportion to the radius, so that if the flow is carried too near the axis it may readily occur that the water will be traveling faster than the runner, requiring a backward angle of the runner blade and leading to complicated curvature and inefficient action. There is no necessity for the close approach to the axis, and by carrying the runner blades diagonally across the entrance passage an efficient runner has been produced and one having great mechanical strength due to the length and form of the blade section where it joins the runner hub.

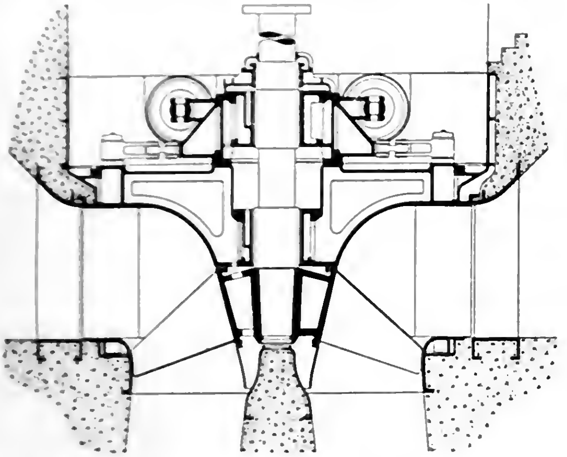


Fig. 2 Sectional Elevation of Diagonal-Propeller-Type Turbine

Since the primary whirl persists, although in reduced amount, at discharge from the runner, it is desirable, when structurally feasible, to provide in the draft tube a central core continuous with the runner hub. The provision of this core avoids the tendency toward the formation of a central cavity within the flowing stream with the resulting production of eddies, turbulence, and unsteady flow.

The second kind of whirl in the turbine occurs in meridian planes, that is, planes containing the turbine axis, and constitutes a rotation about axes perpendicular to these meridian planes. This rotation sets up an increase in pressure toward the upper and inner surface of the entrance space to the runner, and an increase in velocity and decrease in pressure at the lower distributor plate and runner tips. This "secondary" whirl therefore reduces the velocity of the stream elements leaving the upper part of the guide vanes and correspondingly reduces the velocity attained at entrance to the runner by these elements which enter the runner nearest to the axis; the stream elements leaving the lower end of the guide vanes are increased in velocity by this secondary whirl, but as these elements move inward toward the turbine axis only a small distance, their velocity is not further increased by any great amount.

The primary and secondary whirls, therefore, tend to some extent to neutralize each other in their effects of causing unequal distribution of the velocities and pressures in different portions of the stream. After turning the water from an inward direction to the axial, it then becomes desirable to turn the water outward and to conduct it away from the axis as an excellent means for regaining as much as possible of the energy of whirl with which it leaves the runner, while at the same time regaining the energy corresponding to the meridian component of velocity. The deflections from radial inward flow to axial flow and from axial to radial outward flow can very well be made continuous in a turbine designed to occupy small space in an axial direction. Fig. 3 shows such a design in which the secondary whirl is maintained and gradually reduced in magnitude as the flow attains the outward direction, without any abrupt changes in curvature of path.

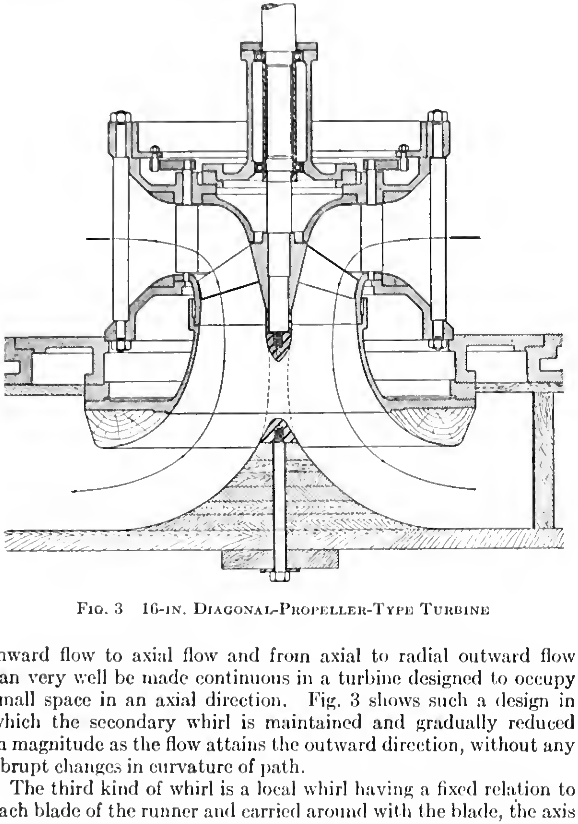


Fig. 3 16-in. Diagonal-Propeller-Type Turbine

The third kind of whirl is a local whirl having a fixed relation to each blade of the runner and carried around with the blade, the axis of this whirl being transverse to the general direction of flow and lying approximately in a revolving meridian plane. Consider the flow behind a blade, Fig. 5. The water adjacent to the rear surface of a blade will follow a curved path so that it may change in direction to correspond with the deflection produced by the blades and thus develop torque on the runner. The curvature of the path of successive stream elements will decrease at points receding from the blade, and at some distance from the blade the curvature will disappear. The flow behind each blade therefore contains a whirling motion approximating in some degree to a rotation about an axis normal to the plane of the figure. This axis may be taken as the center of an arc coinciding with the rear surface of the blade. If we apply to this local whirl the laws of a free vortex and suppose the velocity relative to the blade to vary inversely as the radial distance from the axis of rotation, we will have a picture of the flow sufficiently close to what probably occurs behind a blade to furnish us some useful conclusions. Such a local vortex at each blade would result in a local reduction of pressure on the back surface of the blade, and it is shown in the complete paper that the probable amount of such local pressure reduction is approximately equal to—

$$h_p - h_{pb} = \int_{r_b}^{r} \frac{w_b{}^2 r_b{}^2 dr}{gr^3} = \frac{w_2{}^2}{2g}\left(1 - \frac{r_b{}^2}{r_c{}^2}\right)$$

where h_p is the pressure head at any point in the stream, h_{pb} and r_b are the pressure head and radius at the back surface of the blade, r_c a radius dropped perpendicularly upon the center line of the preceding blade, and w_2 the relative velocity at the rear surface of the blade. This represents the amount by which the local pressure on the surface of each blade falls below the average pressure at the top of the draft tube. The actual amount of this reduction will vary greatly with the form, length, and spacing of the blades in any particular runner.

As any tendency of the water to leave the vane surface is believed to be conducive to cavitation, with resulting risk of corrosion and vibration, it is considered highly important to provide enough margin of pressure in the draft tube below the runner to take care of this local pressure drop, so that an adequate intensity of absolute pressure will still remain at the vane surface. This consideration requires that the runner be placed at an elevation above tailwater not exceeding a value consistent with the Bernoulli formula applied to the draft tube, with due allowance for the above local pressure drop.

One useful method of determining the allowance for the local pressure reduction is by referring to marine-propeller practice. Conservative practice in marine-propeller design dictates that the tip speed of the propeller should be kept below a fairly definite limit based on experience with actual propellers which have developed serious vibration or corrosion. If we express the local pressure drop in terms of velocity head corresponding to tip speed rather than to relative velocity, these velocities being not greatly different in propellers and high-speed runners, and if we assume that vibration and corrosion are due to cavitation produced when the local pressure at some point in the propeller or runner has been reduced to an extent sufficient to overcome the static pressure of the atmosphere and the depth of immersion of the top of the wheel, we can obtain an expression of the form—

$$\text{Local pressure drop} = (\text{a coefficient}) \times \frac{(\text{tip speed})^2}{2g}$$

in which the coefficient is determined by inserting in this formula the total static pressure at the top of a propeller and the corresponding tip speed which has been found to give safe protection against cavitation for ordinary forms of blades.

Although the allowance to be made in any given turbine installation depends on many factors, as already pointed out, the above will give a general idea of the magnitude of the effect of the local whirl or vortex at each blade.

One of the things to be avoided is an undue reduction in blade surface, particularly for turbines operating with inadequate margin of pressure in the draft tube. Insufficient blade area is not only conducive to cavitation at normal load, but gives rise to unsteady or unstable operation at part load. Evidently the driving torque on the runner is derived from the pressure difference between the face and back of blade, resolved into the tangential direction. If the angle of inclination of the blades is small with respect to the tangential direction and the blade area small, a high intensity of pressure increase is required on the blade face, and a high intensity of decrease on the back. A small number of narrow blades therefore magnifies the problem outlined above.

A comparison of the performance curves of a four-bladed, axial-type runner with those of a six-bladed diagonal runner shows that the axial runner has marked instability at small gates, while the curves of the diagonal runner are smooth and of normal form.

Reports have come to the authors of serious vibration in several high-speed installations. We may conclude from some of the considerations pointed out above that such vibration may be due to one of the following causes, or a combination of them: a defective

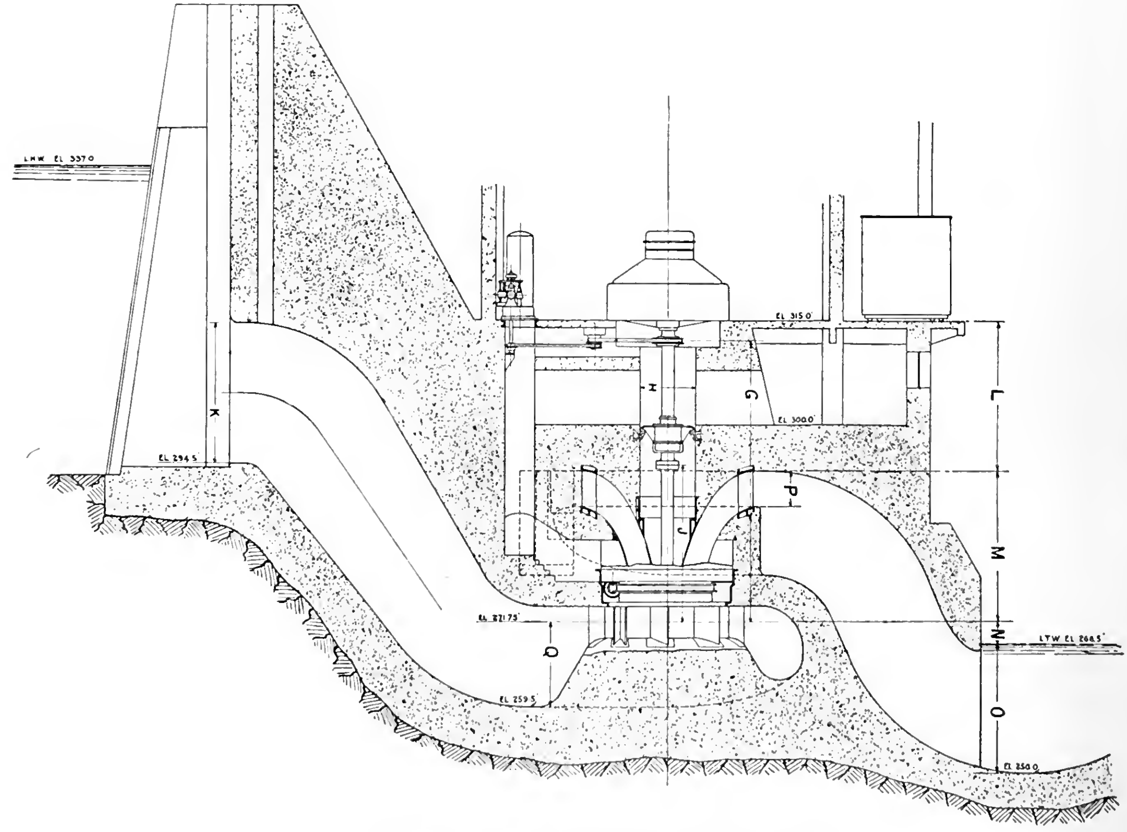


Fig. 4 Proposed Arrangement of Taylor Inverted Turbine

form of draft tube, excessive draft head, local cavitation, or unstable flow in the runner.

The high specific speeds now available involve other limitations besides those already mentioned. If extreme values of specific speed are adopted, a sacrifice in part-gate efficiencies must be accepted, but if the speed selected is within moderate bounds, very satisfactory performance curves are available. Fig. 6 shows a comparison of performance curves of a number of runners, all of 16 in. throat diameter, tested in the I. P. Morris Laboratory. Curves *A* and *B* are for runners of the so-called "Francis" type, or the usual mixed-flow, high-speed type of recent popularity. The runner corresponding to curve *B* is a model of the 16-ft.-diameter runners at Cedars Rapids, a larger model of which (of about twice the size of this one) gave 90 per cent efficiency at Holyoke; so that all of the results in Fig. 6 can be considered equivalent to some four or five per cent increase in a larger model. Curve *C* shows the performance of a runner of slightly over 100 specific speed (foot-pound system used throughout), and the excellent part-gate results will be noted. This is a diagonal-propeller-type turbine with a six-bladed runner operating with a spreading draft tube. Curve *D* corresponds to a turbine of the same type but of considerably higher specific speed (144), and its performance is also excellent. Curves *E* and *F* are for the same runner as *D*, but overspeeded, giving specific speeds of 180 and 225, with poorer performance, particularly at part gate. Curve *G* is for a four-bladed axial-type runner, with very poor part-gate results.

As it is believed that there is a tendency in a narrow-bladed runner for an eddy to form behind each blade at part gate and sometimes even at normal gate, one of the authors has proposed the use of secondary blades close to the main blades but slightly in advance of them, for the purpose of directing the flow more efficiently along the back of the main blade, and by this means eliminating instability and vibration and improving the part-gate efficiency, etc. Fig. 7 shows a four-bladed axial-flow runner equipped with such secondary blades, the two blades being in contact in the position shown. The secondary blade is of diagonal-flow form. It was found by tests that the addition of the secondary blades or "intervanes" reduced the specific speed, but increased the efficiency by 8 per cent and that it prevented unstable flow and vibration and inproved the part-gate efficiency. It was found that the best angular position of these blades was about 10 deg. in advance of their position of contact with the main blades. The field of usefulness of the idea has yet to be determined; it is merely presented here as a suggestion of interest.

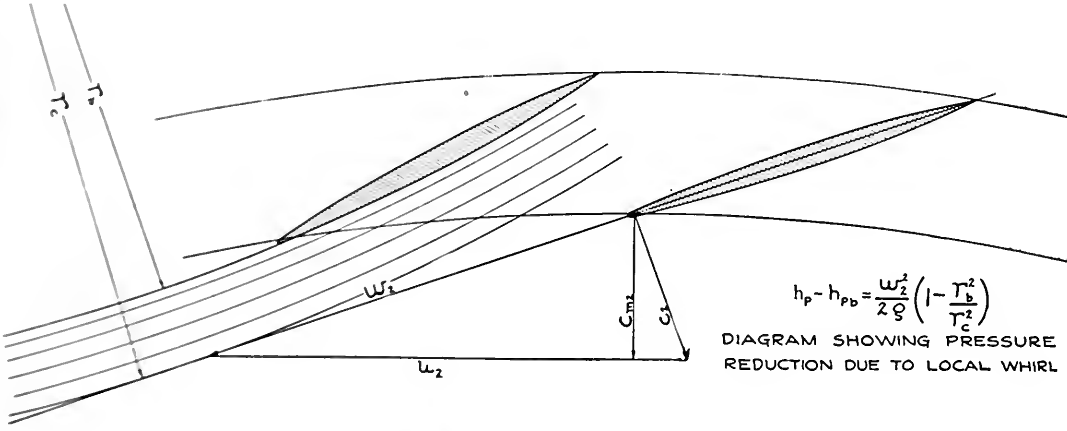


Fig. 5 Diagram of Local Vortex Behind Runner Blade

In order that the reader may appreciate the magnitude of the problems involved in applying the new turbine forms to large modern developments, it may be mentioned that the turbine of Figs. 1 and 2 will develop 28,000 hp. under 56 ft. head at a speed of $138^1/_2$ r.p.m.; and that this requires a tip speed of the runner of nearly 80 miles per hour or $1^1/_3$ miles per minute, more than the speed of the Broadway Limited. For comparison, the peripheral speed of the 55,000-hp. runners of the Queenston-Chippawa Development, operating under 305 ft. head, is only 67 miles per hour, and the circumferences of the 37,500-hp. runners of the Niagara Falls Power Company (214 ft. head) move at a rate of less than "a mile a minute."

Correlation of the Marine Propeller with the Turbine

We have already alluded to the similarity in general appearance of some of the new forms of high speed turbine to the marine screw propeller, and we have applied to turbines some of the conclusions from marine practice. It has probably occurred to many that there must be similarities in action between the new turbines and propellers; and although we have pointed out above several essential differences in the action of these devices, it has seemed to the authors that it would be worth while to investigate the performance of the propeller in its relation to the action of the turbine, to see whether it would not throw some light on the future possibilities open to us in the direction of further increases in specific speed, and on the probable forms to be looked for in turbines capable of developing higher speeds. We think that the results of this investigation are worth presenting here.

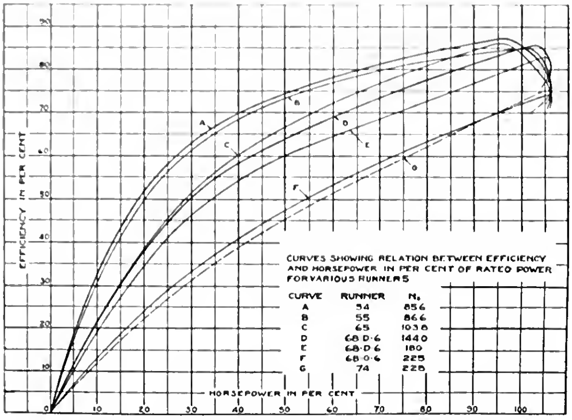


Fig. 6 Comparative Performance Curves of 16-in. Turbines of Different Specific Speeds

One difference between the turbine and the propeller is that the latter works in open water and is not enclosed. This difficulty can be met without introducing the probability of serious error by supposing the flow through the propeller to take place within definite imaginary boundaries, surrounded by water which does not partake of the action (See Screw Propellers for Hydraulic and Aerial Pro-

pulsion, second edition, by Rear-Admiral Charles W. Dyson, Fig. 1-A). A second difference—and one of considerable importance—is that the water enters the propeller with a high relative velocity and although the propeller increases this velocity and discharges the water at a still higher velocity, the relative discharge velocity is only moderately in excess of the speed of advance of the propeller. This excess represents an absolute sternward velocity, the head corresponding to which is a loss of energy corresponding to the "outflow loss" in a turbine. If the propeller should be considered, however, as operating as a turbine or pump, the head due to the entire relative velocity of discharge would represent a loss, unless the necessary step is taken of providing the device with a diffuser or draft tube to decelerate the velocity to a small value and to regain an adequate proportion of its energy. When operating as a propeller, therefore, there is on great need of a diffuser or draft tube; but the propeller cannot fairly be considered to be applicable as a turbine unless it is also supposed to be fitted with a draft tube. This change must be taken into account in giving the efficiency—the propeller ought to be credited with the loss of the entire head due to the absolute velocity of discharge, and charged with the loss which would be incurred in a draft tube of most approved form when handling the whole relative discharge velocity, the result being the efficiency of the equivalent turbine. If V is the speed of advance of the propeller through still water, c the absolute velocity of discharge, c_u its tangential component and c_m its axial or meridian component, the outflow loss of the propeller is—

$$\frac{c^2}{2g} = \frac{c_u^2 + c_m^2}{2g}$$

and that of the equivalent turbine is—

$$f\frac{(V + c_m)^2 + c_u^2}{2g}$$

in which f is the proportion of the velocity head lost in diffusion—which will here be taken as 20 per cent, corresponding to an ordinarily efficient draft tube.

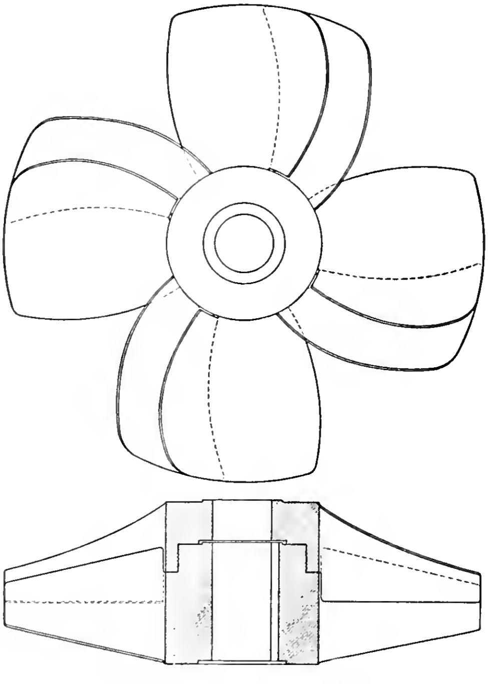


Fig. 7 Moody Intervane Runner

The first quantity which it is necessary to calculate is the head, a quantity which does not appear in the ordinary propeller calculations. Defining the head as the energy per pound of water passing through the wheel, we can distinguish three values of head: the transmitted or equivalent head H_e, that is, the head corresponding to the mechanical horsepower transmitted by the propeller shaft, and from the wheel to the water, or in a turbine from the water to the wheel; the lost head, made up first of internal losses in the wheel due to surface friction of the blade surfaces, impact or eddies, which we shall include in the term L, and the outflow loss L_1, which we have already seen is equal to $c^2/2g$; and finally, the delivered head H_1, corresponding to the horsepower realized in the thrust of the screw acting through the distance per second equal to the speed of advance. Evidently—

$$H_e - L - L_1 = H_1 \text{ and } \frac{H_1}{H_e} = e_1$$

where e_1 = propeller efficiency.

It is shown in the complete paper that $H_1 = T/WA$, where T is the axial thrust, lb.; W the weight of water per cu. ft.; and A the disk area of the propeller $= \pi R^2$, where R is the blade-tip radius.

To visualize the relation of H_e, H_1 and lost head the diagram of Fig. 8 (a) is given, in which H_1 is shown as the portion of H_e remaining after deducting the losses L and L_1.

For completeness, we have shown in the same figure diagrams (b) and (c) representing the relation of heads in the propeller working as a pump and a turbine respectively. The only modification in changing from (a) to (b) is that instead of a total rejection of the outflow loss $c^2/2g$, the pump, equipped with a diffuser, loses the fraction f of the entire discharge velocity head relative to the system—

$$f\frac{(V + c_m)^2 + c_u^2}{2g}$$

When operating as a turbine, however, as represented at (c) the equivalent head (or in this case the effective head) H_e corresponding to the energy transmitted by the shaft is that portion of the total initial head H_3 which remains after deducting the losses L and L_2. In all three modes of operation, we can suppose the same quantity of water to be passing through the wheel, the same power being transmitted by the shaft, and therefore the same equivalent head H_e being involved. (We can suppose the blade angles to be adjusted to keep Q the same.) Since the velocities are the same, L is constant throughout, and L_2 is the same at (b) and (c).

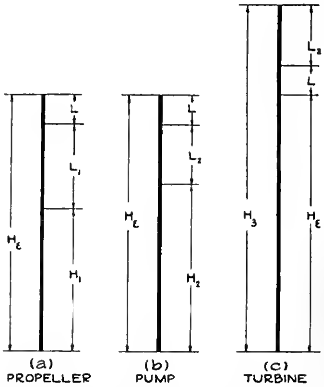


Fig. 8 Diagram Showing Relation of Heads in Propeller, Pump and Turbine

The efficiencies for the three cases are

$$(a)\ e_1 = \frac{H_1}{H_e}; \quad (b)\ e_2 = \frac{H_2}{H_e}; \quad (c)\ e_3 = \frac{H_e}{H_3};$$

and the specific speeds as a pump and turbine, respectively are—

$$(b)\ N_{sq} = N\frac{\sqrt{Q}}{H_2{}^{3/4}}; \quad (c)\ N_{sq} = N\frac{\sqrt{Q}}{H_3{}^{3/4}} \text{ and } N_s = N\frac{\sqrt{\text{S.Hp.}}}{H_3{}^{5/4}}$$

(N_{sq} indicating the specific speed based on quantity of discharge, used in pump practice and N_s the ordinary specific speed as used in turbine practice, expressed in the foot-pound system.)

The remaining steps to complete the calculation of the above results are the determination of c_m, c_u, L_1 and L_2.

In figuring either the moment of momentum or the kinetic energy of the discharge, we can assume for simplicity that the result is the

same as if the whole flow were concentrated at about seven-tenths the radius of the wheel, giving —

$$c_u = \frac{gM}{WQ\ (0.707)\ R}$$

where M is the torque or moment of tangential forces; and from—

$$c_m = \frac{gT}{WQ}$$

we obtain —

$$L_1 = \frac{c^2}{2g} = \frac{c_u{}^2 + c_m{}^2}{2g}$$

For the propeller tests used c_u is found to be small. We then have, referring to Fig. 8 (a)—

$$L = H_e - L_1 - H_1$$

$$L_2 = f\frac{(V + c_m)^2 + c_u{}^2}{2g}$$

(using 0.20 for f), and —

$$H_1 = H_e + L + L_2$$

from which we immediately obtain e_s and N_s.

The method of calculation formulated above has been applied numerically to the series of propellers tested by Admiral Taylor,[1] and the specific speed and efficiency corresponding to operation as a turbine have been computed for various values of slip for those models which gave the higher values of efficiency. The results are given in Fig. 9, which is a chart showing the relation between efficiency and specific speed for three ranges of specific speed, namely, the range corresponding to the turbines of the usual or so-called Francis type; the range so far covered by the high-speed propeller type; and finally the values calculated according to the above method for marine propellers operating as turbines. The turbine efficiencies shown on the chart, some of which are from recent tests, were all secured on 16-in. turbines tested in the I. P. Morris laboratory. It happens that Admiral Taylor's propeller tests were also made on wheels of 16 in. diameter, so that all of the results plotted are properly comparable. While the turbine performances plotted, which are indicated in solid lines, are actual test results, the curves computed from propellers, and shown in dotted lines, are inferred or theoretical values derived from the test results by the method indicated in the above analysis.

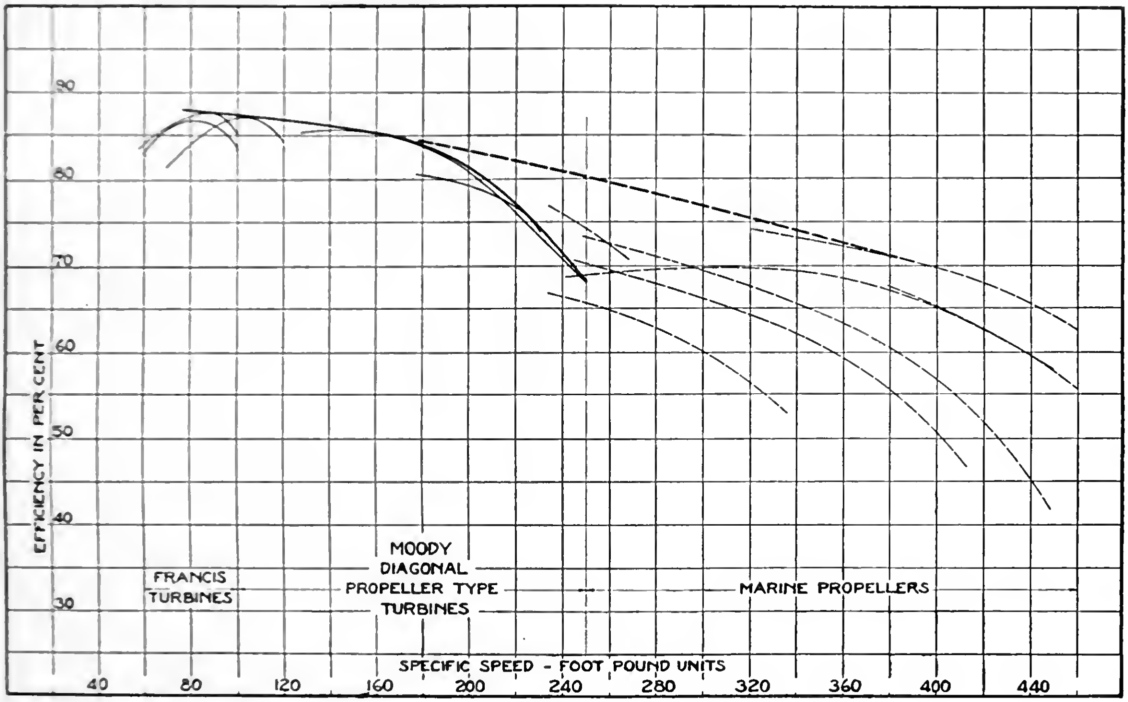


Fig. 9 Chart of Efficiency and Specific Speed for High-Speed Turbines

While there are a number of reservations which should be kept in mind in comparing the turbine and propeller performances to take account of some of the differences pointed out above, such, for example, as an allowance for the difference between the friction of a solid confining wall and the loss due to the turbulence of a flowing stream passing through still water, it is, however, believed that the relations presented in the chart are of considerable interest and significance. It will be noted that the general trend of the envelope representing the highest efficiencies at various specific speeds is very similar to the form of curve presented in the paper of last year by one of the authors, in which the theoretically possible efficiency was computed for various specific speeds. From the internal losses in the propeller due to blade friction, etc., the value of the coefficient f_2 used in last year's paper can apparently be somewhat reduced for the propeller-type turbines, giving a generally higher range of possible efficiences.

In addition to computing the efficiencies corresponding to various specific speeds derived from the propeller tests, the velocity head of the water at discharge from the runner and the allowance for local cavitation have also been computed and from these has been worked out the elevation at which the runner should be set with reference to tailwater in order to permit the propeller to operate as a turbine at the specific speeds shown. These results are presented in Fig. 10, which is a chart showing the relation of runner elevation to specific speed corresponding to three different values of the head on the plant selected by way of illustration. The chart shows, therefore, the probable effect of further increases in specific speed on the turbine setting. In order that these speeds may be safely realized, the values computed as above call for the turbine to be set at elevations not higher than those shown on the chart. These runner elevations are based on what the authors believe to be conservative practice within the field so far developed in actual turbines and similarly computed for the higher specific-speed field corresponding to the marine propellers. Under the higher heads and specific speeds it

---

[1] D. W. Taylor: Some Recent Experiments at the U. S Naval Basin. Paper before Society of Naval Architects and Marine Engineers, Nov. 17–18, 1904.

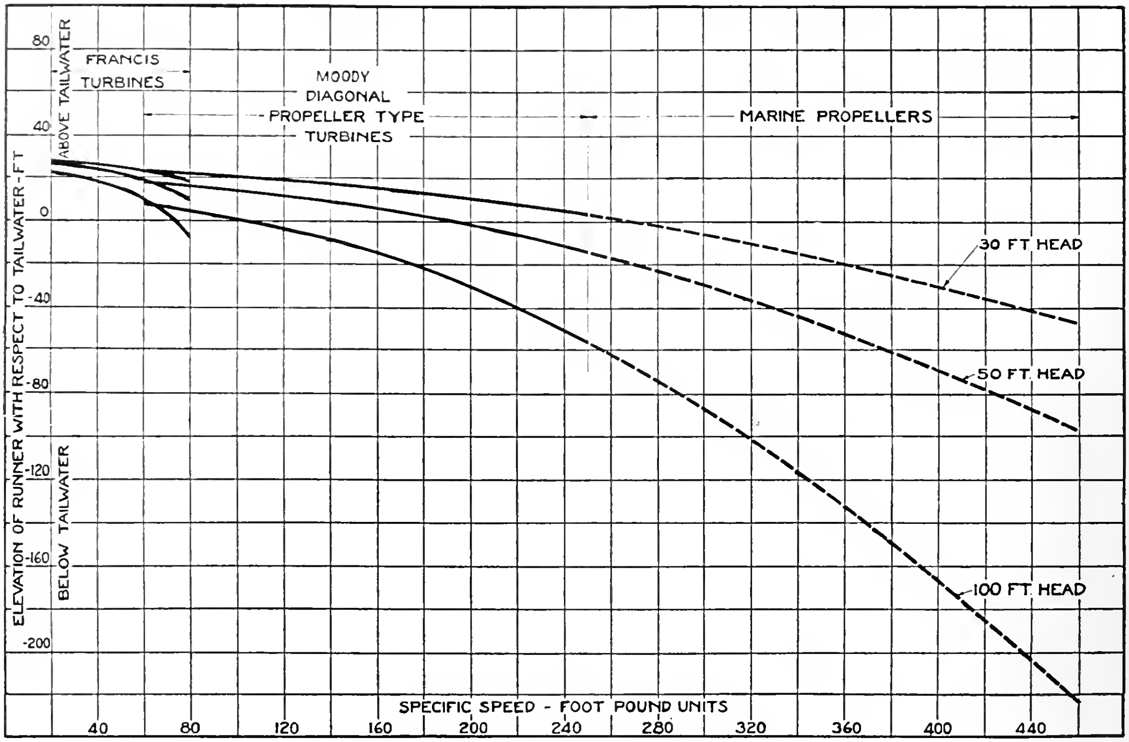


FIG. 10 CHART OF RUNNER ELEVATION AND SPECIFIC SPEED

will be noted that it would be necessary to place the runner far below tailwater and for the moderate conditions the runner would have to be placed close to the tailwater level, and in many cases somewhat below it. As has been previously shown, this is not impracticable.

It is believed that the above investigation of propeller performance throws some new light on the relation of turbine performance to that of pumps. It is also thought to be of interest to view the full range of turbine performance shown by Fig. 9, as indicated by the values of specific speed, with the corresponding values calculated for other classes of power machines. Table 1 has therefore been computed, indicating in a general and approximate way the comparative fields occupied by various machines, including hydraulic and steam turbines, pumps, air compressors and blowers, and the performance of marine propellers according to the above calculations for operation in ship propulsion, and as turbines and pumps.

TABLE 1 FIELDS OCCUPIED BY VARIOUS CLASSES OF MACHINES, COMPARED ON BASIS OF SPECIFIC SPEED

Class of Machine	Range of Specific Speeds Based on Power $N_s = N \frac{\sqrt{HP}}{H^{5/4}}$		Range of Specific Speeds Based on Quantity $N_{sq} = N \frac{\sqrt{Q}}{H^{3/4}}$
	Ft-lb. units	Metric units	Ft-lb. units
Hydraulic Turbines:			
Impulse turbines; single-nozzle Pelton wheels.	up to 8	up to 35	up to 25
Multiple-nozzle Pelton wheels or extreme low-speed Francis reaction turbines.	8 to 11	35 to 50	25 to 35
Reaction turbines, Francis type	11 to 95	50 to 425	35 to 300
Do., propeller type.	95 to 225	425 to 1000	300 to 750
Pumps:			
Centrifugal (per stage).	. . . . .	. . . . . .	35 to 350
Screw or propeller type.	. . . . . .	. . . . . .	350 to 600
Air compressors and centrifugal blowers.	. . . . . .	. . . . . .	100 to 900 (*a,b*)
Cone- and propeller type fans. .	. . . . . .	. . . . . .	900 to 4000 (*b*)
Steam Turbines:			
Last stage.	about 0.13	about 0.60	50 to 90 (*a*)
Marine Propellers:			
Operating as propellers.	. . . . . .	. . . . . .	2600 to 3700
Operating as pumps (inferred performance).	. . . . . .	. . . . . .	1600 to 3000
Operating as turbines (inferred performance).	240 to 440	1070 to 2000	800 to 1600

(*a*) Based on values from article by K. Baumann entitled, Some Recent Developments in Large Steam-Turbine Practice, in *Engineering* (London), April and May, 1921. (*b*) Based on values from article by M. C. Stuart entitled, Centrifugal Fan Calculations by the Specific-Speed Method, in *Jl. Am. Soc. Naval Engrs.*, vol. 28, no. 3, August, 1916.

For the purpose of comparing prime movers, and pumps or compressors, the specific speed based on quantity has been used, as was done in the paper (The Present Trend of Turbine Development) delivered last year. The values given in the table are necessarily approximate, and are merely expressed in round numbers, since there are no exact limits to the specific speeds developed by a given class of machines, and the values stated meerly indicate those corresponding to the field of normal design.

The values shown on the chart of Fig. 9 seem to hold out much promise for further increases of very appreciable amounts in turbine speeds, for they show sufficiently high efficiencies to make the use of considerably higher speeds feasible, particularly in low-head plants where a saving in cost of machinery often justifies a sacrifice in efficiency. While the chart suggests the possibility of increases in speeds, the authors believe that the application of such increases should be made with caution and particularly that the extension of the use of these high-speed turbines to higher heads should be limited to the range of specific speeds for which high efficiencies have been actually developed by tests. Low efficiency points to the presence of eddies and disturbances in the turbine and should be regarded as a danger signal. Even when efficiency is not a vital consideration in itself (which is seldom true), low efficiency provokes other troubles which may be serious. In the authors' judgment therefore, the utilization of still higher speeds, which from the above investigation would appear to be attainable, should be made contingent upon the development of high efficiencies.

Semi-steel is the name popularly applied to the metal resulting from the use of mild steel added to the pig irons and scrap melted in the cupola or furnace. The percentage of steel used varied from 15 to 40 per cent, the lower figure for light work and the higher proportions for heavier castings. It is stronger than usual gray cast iron as regards transverse, tensile, compression and impact tests. It is superior in regard to elasticity, toughness, resistance to shock and wear. It has proved satisfactory for such castings as cylinders, pistons, gear wheels and castings called upon to withstand wear and friction. J. Cameron, in *The Engineer* (London), Aug. 11. 1922, p. 149.

High-Pressure Steam-Heating Lines

Effect of Throttling Through a Reducing Valve or Steam Motor—Economy of Generating Steam at High Pressure and Transmitting It Through a Small Line with Large Line Drop

By EDGAR BUCKINGHAM,[1] WASHINGTON, D. C.

A LETTER recently[2] referred to the writer contained the following requests for information: "We should be pleased to have such advice and references as to permit of our estimating the economy in steam production on a large scale which would be occasioned by generating and delivering steam for vulcanization at 45 lb. per sq. in. as compared with generating at 190 lb. per sq. in. and delivering at the lower pressure mentioned by throttling through a reducing valve." "Would not a steam engine or turbine, for example, functioning as a reducing valve between 190 and 45 lb. per sq. in. deliver a considerable power output without appreciably reducing the heat-supplying power of the low-pressure steam as compared with the ordinary reducing valve?" "When steam is used for purely heat-supplying purposes, does the use of a reducing valve over a considerable pressure range involve any real efficiency loss, or does the superheat due to throttling bring the available energy practically back to its original status?"

The engineer to whom the reply was sent wrote: "The conclusions you have reached are indeed surprising, and I trust that you will find the opportunity to prepare them for publication." Without knowing whether the conclusions in question are really novel, the writer submits the substance of his reply in the hope that if these deductions from very elementary principles are known by experiment to be incorrect, the facts may be brought out, for the public benefit, by some one who knows what the facts are.

THE NATURE OF THE THROTTLING PROCESS

The throttling process does not in itself cause any change in the "total heat" of the steam; and if the steam is to be used solely for heating purposes, i.e., only as a carrier for heat, the use of a reducing valve has no direct effect on the economy of the process, although there may, of course, be indirect effects on boiler efficiency and line losses, caused by the difference between generation and transmission at high pressure and at low.

The simplest way to look at the matter is as follows: We start with water at 45 lb. per sq. in. gage (60 lb. per sq. in. abs.) and the corresponding boiling point which is 292.7 deg. fahr. We put heat into this water in the boiler; convert it into steam at any pressure we please above 45 lb. per sq. in.; run it through a transmission line to a different place; condense it to water at the original temperature and pressure; and finally feed it back into the boiler.

During this process, aside from the insignificant work of the boiler-feed pump, no outside work is done either on or by the steam. Frictional work against the line resistance is merely dissipated into heat which stays in the steam, and does not count as outside work. A sudden large drop through a reducing valve is precisely equivalent to a great amount of line resistance concentrated in a short length of line. No *outside* work is done, and the kinetic energy generated at the valve is dissipated into heat which stays in the steam and dries or superheats it.

Since, therefore, the steam, in going round its closed cycle and returning to its original state of water at 45 lb. per sq. in. gage and 292.7 deg. fahr., does no outside work and has none done on it, the total amount of heat put into it must also be zero; otherwise the steam could not return to its initial state.

It follows that the heat put into the water in the boiler (plus the small heat equivalent of the work of the feed pump) is equal to the sum of the heat loss to the outside and the heat given up in the condenser—in this case the vulcanizer. This remains true no matter what the upper pressure may be, so that the economic questions to be considered in deciding on what pressure to use, relate to boiler efficiency, heat losses, and overhead.

If the steam is generated at an unnecessarily high pressure, which requires reduction before the steam is admitted to the vulcanizer, the reducing valve may be replaced by a steam engine or turbine. This will give a certain amount of outside work and the heat remaining in its exhaust to be given up in the vulcanizer, will be correspondingly diminished. If the bearing losses of the motor all stayed in the steam, the reduction in the heating value of the steam by its passage through the motor would be exactly the heat equivalent of the work delivered by the motor outside the bearings. Bearing losses which do not go back into the steam as reheat are equivalent to so much heat lost to the outside. They are to be added into the heat loss from the motor, which is itself merely one element of the heat loss from the whole system.

CALCULATIONS DEALING WITH THROTTLING IN THE LINE

To illustrate quantitatively, we will suppose that the vulcanizer requires 1,000,000 B.t.u. per hour, which are to be given up by steam at 45 lb. per sq. in. gage condensing at its saturation temperature of 292.7 deg. fahr. We shall consider three cases: (*a*) generation and transmission at 45 lb. per sq. in. gage; (*b*) generation and transmission at 190 lb. per sq. in. gage, with throttling to 45 lb. per sq. in.; (*c*) the same as (*b*) with the substitution of a reciprocating engine or turbine for the reducing valve. We shall suppose, in each case, that the boiler furnishes dry saturated steam, and we shall neglect pressure drop in the transmission line, and heat losses to the outside. Numerical data on steam are from the Marks and Davis tables.

In case (*a*), dry steam at 45 lb. (60 lb. per sq. in. abs.) arrives at the vulcanizer. Its latent heat is 914.9 B.t.u. per lb., so that the amount of steam needed is—

$$M_a = 10^6/914.9 = 1093 \text{ lb. per hour}$$

The furnace has, in any case, to supply to the water the whole 10^6 B.t.u. per hour plus the outside heat loss. The work of the feed pump would be zero if there were no line drop, and is insignificant in any event.

Turning to case (*b*), the total heat of water at 45 lb. per sq. in. gage and its saturation temperature 292.7 deg. fahr. is $H_0 = 262.1$ B.t.u. per lb. The total heat of dry saturated steam at 190 lb. per sq. in. gage and 384 deg. fahr. is $H_1 = 1198.5$. The heat supplied in the boiler is therefore $H_1 - H_0 = 936.4$ B.t.u. per lb. This difference consists of 95 B.t.u. per lb. needed to heat the water from 292.7 deg. to 384 deg., and 841.4 B.t.u. per lb. which is the latent heat of evaporation at 190 lb. per sq. in. gage. If there are no heat losses, the 936.4 B.t.u. per lb. are available for heating the vulcanizer, so that the amount of steam needed is—

$$M_b = 10^6/936.4 = 1068 \text{ lb. per hour}$$

When the dry saturated steam at 190 lb. is throttled to 45 lb. its temperature falls to 334.7 deg., but it is superheated 42 deg. Before beginning to condense, it must cool to 292.7 deg., and in so doing it gives up $936.4 - 914.9 = 21.5$ B.t.u. per lb. in addition to the 914.9 which it will give up as latent heat of condensation. To put it in another way, the dry steam at 190 lb. carries $936.4/914.9 = 1.024$ times as much heat available for extraction at 45 lb. as does dry steam at 45 lb.; so that the amount needed is only $1093/1.024 = 1068$ lb. per hour.

In case (*c*), if the dry saturated steam at 190 lb. per sq. in. gage were to expand isentropically to 45 lb. its total heat would fall from 1198.5 to 1102.1 and the difference, or 96.4 B.t.u. per lb., is the "available heat drop" which could be turned into outside work by an ideally perfect motor. The dryness factor of the steam after this expansion through a perfect engine would be 0.918; and the heat remaining available upon condensing to water would be $0.918 \times 914.9 = 840.0$ B.t.u. per lb. which added to the 96.4 makes up the 936.4 originally available.

Supposing that the motor extracts, say, 0.6 of the maximum possible—corresponding to 60 per cent indicated efficiency in the

---

[1] Physicist Bureau of Standards. Mem. Am.Soc.M.E.

[2] This was written in July, 1920.

case of a reciprocating motor—the heat drop of the steam in passing through the motor will be 0.6 × 96.4 = 57.8 B.t.u. per lb., so that the total heat of the exhaust is 1198.5 − 57.8 = 1140.7 B.t.u. per lb. And since the total heat of water at 45 lb. is 262.1, the heat available in the exhaust for use in the vulcanizer is 1140.7 − 262.1 = 878.6 B.t.u. per lb., the dryness factor of the exhaust being 878.6/914.9 = 0.960.

The amount of steam needed in this case would be, for a motor of 60 per cent indicated efficiency,

$$M_c = 10^6/878.6 = 1138 \text{ lb. per hour}$$

as compared with M_b = 1068 when a reducing valve was used. The indicated power of the motor would be 1138 × 57.8/2543 = 25.9 hp.

The pump work needed to put the condensate at 45 lb. back into the boiler at 190 lb. is less than 0.5 B.t.u. per lb., so that we have been justified in ignoring it.

Pressure Drop and Heat Loss in the Transmission Line

We may now turn to the question of pressure drop and heat loss in the transmission line, and we shall assume that no motor is to be used so that we have only to compare generation and transmission at a trifle above 45 lb. per sq. in. gage, with generation and transmission at 190 lb. followed by throttling to 45 lb. Leaving aside the question of capital charges, we shall consider only the heat losses per foot length of the transmission line, assuming that the different lines are all equally well insulated. We may say, as an approximate rule for practical purposes, that the heat loss per foot of pipe in B.t.u. per hour will be proportional to the diameter of the pipe and to the difference between the steam temperature and the temperature of the surroundings.

From this rule it is evident that increasing the pressure (and temperature) of the steam in the line increases the heat loss from a line of given size. But if the high-pressure line can be made small enough the reduction in surface will more than offset the increase of temperature difference, so that the losses may be less at the high pressure. The question, then, is whether the high-pressure line can be made small enough.

We here come to an essential difference between heating lines and power lines. In designing a power line the pressure drop along the line, which is merely distributed throttling, must be kept low because throttling diminishes the available heat drop that remains for the motor to work on. But in a high-pressure heating line followed by a reducing valve this limitation on the design is absent; for, aside from the heat losses, it makes no difference at all whether the necessary throttling takes place at a reducing valve or is distributed along the transmission line as line drop. The line drop may therefore be made large, leaving only enough drop at the reducing valve to take care of overload.

This plan seems to present several advantages. In the first place, the line can be made small and its surface reduced. Then the wire drawing in the line tends to dry or superheat the steam, which, of itself, reduces the ease of transmission of heat from the steam to the pipe. Moreover, the wire drawing, while it superheats the steam, reduces its temperature and so again decreases the heat loss. It appears, therefore, that a high-pressure heating line should be designed on entirely different principles from a power line. The line should be as small in diameter as practicable, the limit being set either by the necessity of having some drop remaining at the reducing valve, or, more probably, by the erosion of the line, which may become troublesome when the steam speed is run up very high.

Illustrative Computations of Pressure Drop and Heat Loss

It may be worth while to make some sample computations to illustrate the foregoing. Let D equal the inside diameter of the pipe in ft., S the linear speed of the steam in ft. per sec., M the mass flow in lb. per hour, and v the specific volume of the steam in cu. ft. per lb. Then we have—

$$M = 3600\,\frac{\pi}{4}\,D^2\,\frac{S}{v} = 2827\,\frac{D^2S}{v} \text{ lb. per hour} \ldots\ldots [1]$$

whence—

$$S = (Mv/2827D^2) \text{ ft. per sec.} \ldots\ldots\ldots\ldots\ldots [2]$$

Let P be the pressure drop per foot length of the line. Then since the steam speed is to be high so that the resistance is nearly proportional to the square of the speed, we have, approximately,

$$P = \text{const.} \times S^2/Dv \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

where the value of the constant depends on the roughness of the pipe line as well as on the unit used for P. Eliminating S we have—

$$P = \text{const} \times M^2v/D^5 \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

whence—

$$D = \text{const.} \times (M^2v/P)^{1/5} \ldots\ldots\ldots\ldots\ldots [5]$$

To use this equation for designing purposes we should have to take a value of the constant from known experimental results; but for our present purpose of comparing different sets of conditions we only need to assume that it is the same for the different lines compared; i.e., that the lines are similarly rough. If the subscripts 1 and 2 refer to the two sets of conditions, we then have for the ratio of the pipe diameters—

$$\frac{D_1}{D_2} = \left\{\left(\frac{M_1}{M_2}\right)^2 \times \frac{v_1}{v_2} \times \frac{P_2}{P_1}\right\}^{1/5} \ldots\ldots\ldots\ldots [6]$$

an equation which we may proceed to apply to numerical examples.

Let our two sets of conditions be: transmission at 45 lb. per sq. in. gage; and transmission at 190 lb. followed by throttling to 45 lb. We have already found in an earlier paragraph that M_{45}/M_{190} = 1093/1068; and from the steam tables we find that v_{45}/v_{190} = 7.17/2.237. Substituting these values in Equation [6] we have—

$$\frac{D_{45}}{D_{190}} = 1.26\left\{\frac{P_{190}}{P_{45}}\right\}^{1/5} \ldots\ldots\ldots\ldots\ldots [7]$$

Equation [7] tells us that if the line drop is to be the same in both lines so that $P_{45} = P_{190}$, the diameter of the low-pressure line must be 1.27 times that of the high-pressure line. The steam temperatures are 384 deg. and 293 deg., respectively, and if we assume an outside temperature of, say, 80 deg. we shall have approximately—

$$\frac{\text{heat loss at 45 lb.}}{\text{heat loss at 190 lb.}} = 1.26 \times \frac{293 - 80}{384 - 80} = 0.89$$

Hence if the lines were designed for equal total line drop, the low-pressure line, under ordinary outside conditions, would lose something like 10 per cent less heat than the high-pressure line.

But suppose that we let the drop be 10 times as great in the high- as in the low-pressure line, so that $P_{190} = 10P_{45}$. Then Equation [7] gives us D_{45}/D_{190} = 2.02, and in this case for 80 deg. outside temperature we have approximately—

$$\frac{\text{heat loss at 45 lb.}}{\text{heat loss at 190 lb.}} = 2.02\,\frac{293 - 80}{384 - 80} = 1.41$$

so that the heat loss would be considerably less for the *high*-pressure line. The figures are, of course, only roughly approximate, but they suffice to show the advantage of using high-pressure transmission with a small pipe and large line drop, altogether aside from questions of the capital cost of the line.

Although we have no precise data which would enable us to estimate the probable change in the combined furnace and boiler efficiency caused by changing from low to high pressure, it would seem, in view of the foregoing reasoning, that unless the transmission line is very short, a properly designed high-pressure plant may be made decidedly more economical in operation than a low-pressure one for the same heat supply to the vulcanizer.

Summary

The information requested may be summarized as follows:

a The use of a reducing valve in a steam-heating line does not, in itself, have any effect on the economy of the heating.

b If a steam motor is substituted for the reducing valve, the heating value of its exhaust is decreased by the amount of heat turned into work by the motor.

c Line drop is merely distributed throttling and has no direct effect on the final heating value of the steam.

d By generating at high pressure and transmitting through a small line, with large line drop, the heat loss from the line may be made much smaller than when the pressure is low throughout the system.

Forces in Rotary Motors

A Paper Dealing with the Determination of the Forces in a Rotary Motor Caused by the Reciprocation of the Pistons and Connecting Rods and by the Rotation of the Motor as a Whole, in Which Novel Methods of Calculation Are Employed

By KARL H. WHITE,[1] KEYPORT, N. J.

THE object of this paper is to present methods of determining the turning effort and the inertia and shaking forces of the pistons and connecting rods in a rotary motor, the LeRhone 9-cylinder 80-hp. internal-combustion motor being used as a concrete example. The data on this motor are given in Table 1.

The Indicator Card

From the data given in Table 1 the indicator card shown in Fig. 1 may be implied.

$$V = \frac{667}{9} = 74.11 \text{ cu. in.}$$

$$\text{Clearance} = \frac{74.11}{4.8} = 15.43 \text{ cu. in.}$$

Total volume of cylinder = 89.54 cu. in.

In Fig. 1—

$$\frac{P_b}{P_a} = \left(\frac{V_a}{V_b}\right)^n$$

Assuming an intake pressure of 13 lb. per sq. in. and $n = 1.35$ according to good practice,

$$\frac{P_b}{13} = \left(\frac{89.54}{15.43}\right)^{1.35}, \quad \text{whence } P_b = 139.8 \text{ lb. per sq. in.}$$

It can be shown theoretically that the mean effective pressure is equal to—

$$P_m = \frac{P_x V_x - P_x \frac{P_a}{P_b} V_d - P_b V_x + P_a V_d}{(n-1)(V_d - V_x)}$$

Substituting known values and employing a card factor of 0.96,

$$\frac{84}{0.96} = \frac{15.43 P_x - \dfrac{13 \times 89.54 P_x}{139.8} - 139.8 \times 15.43 + 13 \times 89.54}{0.35\,(89.54 - 15.43)}$$

whence—

$$P_x = 459 \text{ lb. per sq. in.}$$

The equation PV_n = Constant may be plotted as a straight line with a slope n on logarithmic cross-section paper. Plotting the compression and expansion curves in this manner the pressure P_d at d may be obtained from the expansion curve, as the pressure P_x at x and slope n are given.

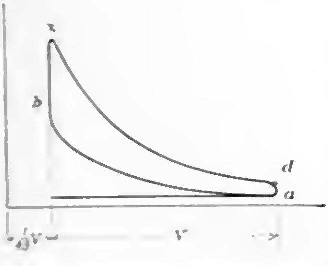


Fig. 1 Preliminary Indicator Card

TABLE 1 DATA ON THE LE RHONE 9-CYLINDER 80-HP. MOTOR INVESTIGATED

Speed	1200 r.p.m.
Direction of rotation	Normal (counterclockwise from propeller end).
Bore of cylinders	4.1339 in.
Stroke	5.512 in.
Length of connecting rods	9.6458 in.
Compression ratio	4.8
Piston displacement (9 cylinders)	667 cu. in.
Order of firing	1, 3, 5, 7, 9, 2, 4, 6, 8
Mean effective pressure	84 lb. net
Weight of engine dry	245 lb.
Weight of engine in running order, less fuel, oil and tanks	270 lb.
Weights of parts:	
Piston, with piston rings (each)	1.727 lb.
Wristpin with wristpin retainer screw	0.363 lb.
Inner connecting-rod assembly (each)	1.203 lb.
Center connecting-rod assembly (each)	1.240 lb.
Outer connecting-rod assembly (each)	1 340 bl.

The theoretical and actual indicator card may now be constructed as shown in Fig. 2.

Inertia Forces of Pistons and Connecting Rods

In order to obtain the inertia forces of the pistons and connecting rods, it is first necessary to obtain the absolute accelerations of these parts, because $F = MA$, where F = inertia force, M = mass, and A = absolute acceleration.

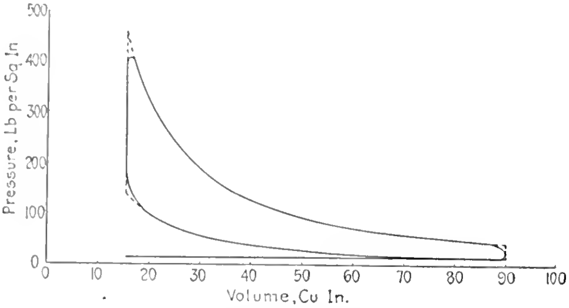


Fig. 2 Indicator Card for LeRhone 80-Hp. Motor
(Theoretical card also includes dotted areas.)

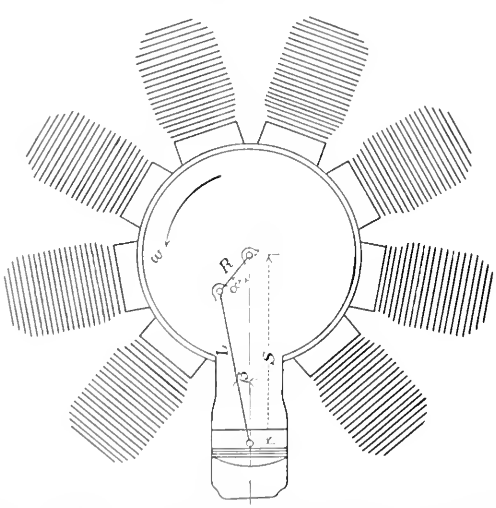


Fig. 3 Diagrammatic View of One Connecting Rod of LeRhone 80-Hp. Motor

Inertia of Pistons. The absolute acceleration of the piston is rather complicated, but may be found by using Coriolis' law.[1] According to this law, the absolute acceleration may be divided into three parts:

a The acceleration of a point on the cylinder opposite the center of gravity of the piston toward the center of rotation $= S\omega^2$. See Fig. 3.

b The acceleration of the piston relative to the cylinder, $= dS/dt$.

c Twice the product of the velocity of the piston relative to the cylinder, (U), and the angular velocity, $= 2U\omega$.

From Fig. 3, it will be seen that—

---

[1] Airplane Engineering Dept., The Aeromarine Plane & Motor Co. Abridgment of paper awarded the A.S.M.E. Student Prize for 1921.

[1] See Kinematics and Kinetics of Machinery, by Dent and Harper.

$$S = R\cos\alpha + L\cos\beta$$

also $$\sin\beta = \frac{R}{L}\sin\alpha$$

hence $$\cos\beta = \sqrt{1 - \frac{R^2}{L^2}\sin^2\alpha}$$

Since $(R\ L)^2\sin^2\alpha$ is a small term, we may write with sufficient accuracy—

$$\cos\beta = \sqrt{1 - \frac{R^2}{L^2}\sin^2\alpha} = 1 - \frac{R^2}{2L^2}\sin^2\alpha$$

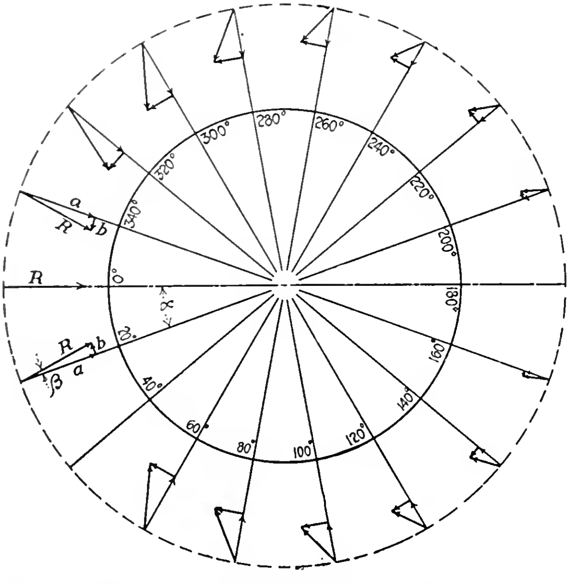


Fig. 4 Acceleration Diagram of Piston, Showing Direction of Resultant

This is equivalent to adding the small quantity $\frac{R^2}{4L^4}\sin^4\alpha$ under the radical.

Substituting this value for cos β,

$$S = R\cos\alpha + L\left(1 - \frac{R^2}{2L^2}\sin^2\alpha\right) \qquad [1]$$

The velocity of the piston relative to the cylinder is—

$$\frac{dS}{dt} = U = -R\,\omega\left(\sin\alpha + \frac{R}{2L}\sin 2\,\alpha\right) \qquad [2]$$

The second derivative of S with respect to time is equal to the acceleration of the piston relative to the cylinder, or—

$$\frac{d^2S}{dt^2} = -R\,\omega^2\left(\cos\alpha + \frac{R}{L}\cos 2\,\alpha\right) \qquad [3]$$

The negative sign simply indicates the direction of the acceleration.

Let us now rotate the motor through one revolution and consider accelerations every ten degrees.

Crank length = 0.2297 ft.

Length of connecting rod = 0.8038 ft.

$$1200 \text{ r.p.m.} = \frac{2\,\pi \times 1200}{60} = 126 \text{ radians per sec.} = \omega$$

From Equation [1]—

$$S = 0.2297\cos 10° + 0.8038\left(1 - \frac{0.2297^2}{2 \times 0.8038^2}\sin^2 10°\right)$$
$$= 1.027 \text{ ft.}$$

From Equation [2]—

$$U = 0.2297 \times 126\left(\sin 10° + \frac{0.2297}{2 \times 0.8038}\sin 20°\right)$$
$$= 6.45 \text{ ft. per sec.}$$

From Equation [3]—

$$\frac{d^2S}{dt^2} = \frac{dU}{dt} = 0.2297 \times 126^2\left(\cos 10°\ \frac{0.2297}{0.8038}\cos 20°\right)$$
$$= 4575 \text{ ft. per sec.}^2$$
$$S\omega^2 = 1.027 \times 126^2 = 16{,}300 \text{ ft. per sec.}^2$$
$$2U\omega = 2 \times 6.45 \times 126 = 1625 \text{ ft. per sec.}^2$$

From Coriolis' law, 2 $U\omega$ is at right angles to $S\omega^2$ and $\frac{dU}{dt}$, and the absolute acceleration R of the piston is the vector sum of these three quantities.

As $S\omega^2$ and $\frac{dU}{dt}$ are in the same direction at this position of the motor,

$$R = \sqrt{\left[(S\omega^2) + \frac{dU}{dt}\right]^2 + (2U\omega)^2}$$
$$= \sqrt{(16{,}300 + 4{,}575)^2 + 1625^2}$$
$$= 20{,}900 \text{ ft. per sec.}^2$$

R may be determined graphically, however, with sufficient accuracy.

TABLE 2 ACCELERATIONS OF PISTON BY CORIOLIS' LAW

α Deg.		S ft.	U ft./sec.²	$S\omega^2$ ft./sec.²	$\frac{dU}{dt}$ ft./sec.²	$2U\omega$ ft./sec.²	R ft./sec.²	$S\omega^2$ + or − $\frac{dU}{dt}$
0		1.033	0	16420	4690	0	21110	21110
10	350	1.027	6.45	16300	4575	1625	20925	20875
20	340	1.011	12.57	16050	4220	3170	20500	20270
30	330	0.985	18.07	15650	3650	4550	19800	19300
40	320	0.952	22.70	15120	2970	5720	18975	18090
50	310	0.912	26.20	14480	2160	6600	17900	16640
60	300	0.870	28.65	13800	1300	7220	16750	15100
70	290	0.824	29.90	13070	448	7530	15450	13518
80	280	0.780	29.95	12400	−346	7550	14250	12050
90	270	0.738	28.95	11720	−1042	7300	12950	10678
100	260	0.700	27.10	11100	−1610	6840	11750	9490
110	250	0.667	24.55	10600	−2020	6180	10600	8580
120	240	0.640	21.50	10180	−2340	5420	9600	7840
130	230	0.616	18.10	9780	−2520	4560	8600	7260
140	220	0.599	14.50	9500	−2600	3660	7850	6900
150	210	0.588	10.90	9350	−2640	2750	7300	6700
160	200	0.580	7.23	9210	−2630	1820	6850	6580
170	190	0.575	3 62	9130	−2610	912	6600	6520
180		0.574	0.0	9100	−2605	0	6505	6505

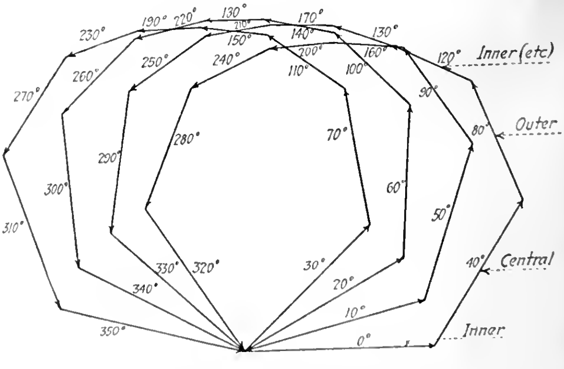


Fig. 5 Acceleration Polygons for Pistons

In a similar manner the absolute acceleration of the piston is found for every 10 deg. rotation of the motor, the results being given in Table 2.

Fig. 4 is an acceleration diagram of the piston showing the direction of its absolute acceleration. If we now plot acceleration polygons of the pistons at any particular position of the motor, we can determine the amount and direction of any shaking force due to the inertia of these pistons. Such polygons are plotted in Fig. 5; the vectors representing the absolute accelerations of the nine pistons at the particular instants of rotation of 0, 10, 20, and 30 deg. The polygons are similar to inertia polygons because the masses of the pistons are constant. From this figure it is seen that there are no unbalanced piston inertia forces, and consequently

no shaking force coming from the reciprocation of the pistons. This figure shows the magnitude of the compound supplementary acceleration, which has heretofore been neglected in similar calculations.

Let us now determine the actual inertia force of the piston per square inch of piston area and plot this force on an indicator diagram.

The total weight of a piston is 2.090 lb.

The inertia force at any instant equals 2.09/32.2 times the acceleration of the center of gravity of the piston along the line of stroke at that particular instant. The center of gravity of the piston assembly is considered at the center of the piston pin.

In Table 3 this inertia force is given for every 10 deg. rotation of the motor.

TABLE 3 INERTIA FORCE OF PISTON

(Piston area = 13.42 sq. in.)

α Deg.		$S\omega^2 = \frac{dV}{dt}$ ft/sec.²	Total inertia of piston, lb.	Inertia force, lb./sq. in.
0		21110	1370	102.0
10	350	20875	1355	101.0
20	340	20270	1315	98.0
30	330	19300	1250	93.2
40	320	18090	1173	87.4
50	310	16640	1080	80.5
60	300	15100	980	73.0
70	290	13518	877	65.3
80	280	12054	782	58.2
90	270	10678	692	51.5
100	260	9490	616	45.8
110	250	8580	556	41.4
120	240	7810	508	37.8
130	230	7260	471	35.0
140	220	6900	447	33.3
150	210	6710	435	32.4
160	200	6580	427	31.8
170	190	6520	423	31.5
180		6505	422	31.4

Fig. 6 is a total-pressure diagram of a piston developed on a base line, representing the total motion of the piston relative to the cylinder (disregarding reversals) in two revolutions of the motor. In this diagram gaseous forces tending to help the motion of the piston and inertia forces tending to resist the motion of the piston are plotted above the base line. Gaseous forces tending to resist the motion of the piston and inertia forces tending to help the motion of the piston are plotted below the base line. These two force curves are combined to represent the resultant net piston force, as shown by the heavy lines. The resultant net piston force is plotted above the base line if tending to help the motion of the piston, and below if tending to resist the motion of the piston.

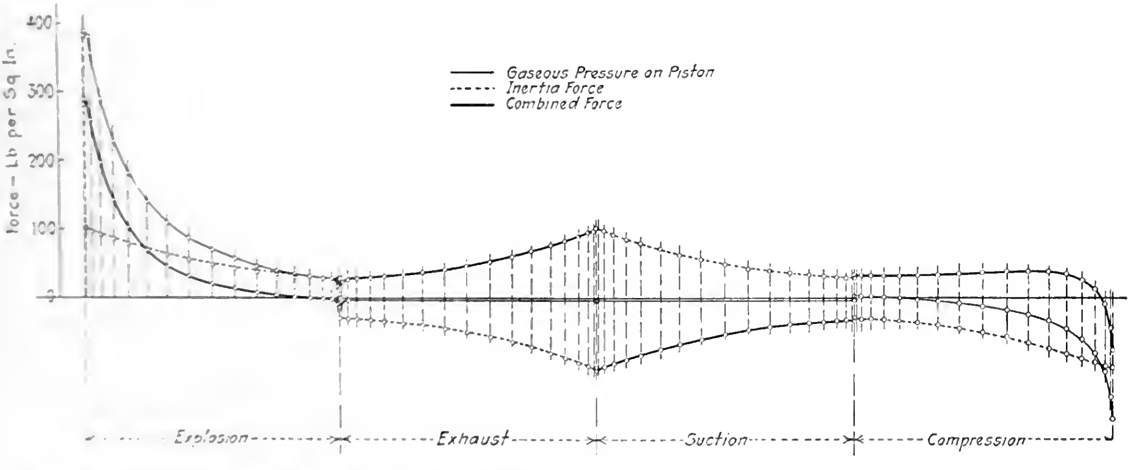


Fig. 6 Diagram of Gaseous Pressure on Piston, of Inertia Force of Piston, and of Combined Gaseous and Inertia Forces

Fig. 6 shows that due to the inertia of the piston there is as much work done on the exhaust stroke as on the explosion stroke. It also shows that the inertia force compresses the gas on the compression stroke. On the other hand, during the explosion and suction strokes this inertia greatly hinders the motion of the piston.

Inertia of Connecting Rods. In order to determine the inertia forces of the connecting rods, it is first necessary to find their centers of gravity. The connecting rods are accordingly laid out full size and sections are taken at intervals. The area of each section is calculated and plotted as an ordinate from a base line. The areas of the figures obtained represent the volumes of the connecting rods. Fig. 7 shows the layout for the inner connecting rod.

The area of each section is now multiplied by its distance from the end of the connecting rod, and this product, which is the moment of that area about the end of the rod, is plotted as an ordinate from a base line. If each of these last areas obtained be divided by the first areas, the distances of the centers of gravity from their respective connecting-rod ends are determined. The center of gravity as found for the inner rod is shown in Fig. 7.

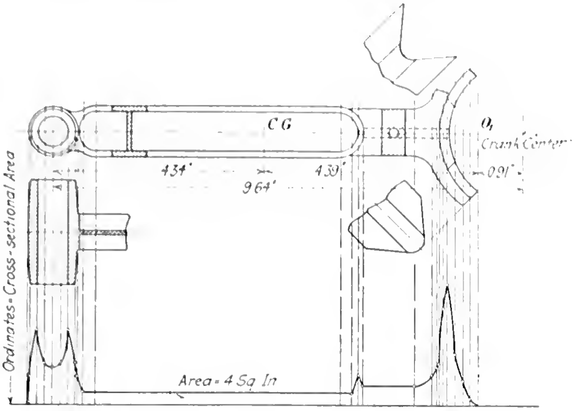


Fig. 7 Inner Connecting Rod and Volume Diagram

Let us now consider the accelerations of the connecting rods. From Fig. 7 the center of gravity of the inner connecting rod is 55 per cent of the distance from the crank center to the center of the piston pin. Therefore the acceleration of the center of gravity of this connecting rod is 0.55 times the acceleration of the piston and lies in the same direction at any instant. Similarly, the accelerations of the central and outer connecting rods are found to be respectively 0.548 and 0.53 times the acceleration of the piston, and in the same direction.

The accelerations and inertia forces of the connecting rods for every 10 deg. rotation of the motor are given in Table 4.

Knowing the magnitude and direction of these inertia forces, an inertia polygon may be plotted showing the resultant unbalanced inertia force of the connecting rods at any instant. Such a polygon is shown in Fig. 8 for angles of rotation of 0, 10, 20 and 30 deg. Due to the difference in weights of the connecting rods, the polygons do not quite close.

TABLE 4 ACCELERATIONS AND INERTIA FORCES OF CONNECTING RODS

α Deg.		Accelerations, Ft./per Sec.² Inner	Central	Outer	Inertias, Lb. $M = 0.0372$ Inner	$M = 0.0385$ Central	$M = 0.0416$ Outer
0		11600	11580	11190	432	446	465
10	350	11500	11480	11100	428	442	462
20	340	11270	11250	10870	419	433	453
30	330	10900	10850	10500	406	417	437
40	320	10430	10400	10050	388	400	418
50	310	9850	9830	9490	366	378	394
60	300	9220	9200	8870	343	354	369
70	290	8500	8480	8190	316	327	341
80	280	7840	7820	7550	292	301	314
90	270	7125	7100	6860	265	273	285
100	260	6460	6440	6225	240	248	259
110	250	5830	5810	5620	217	224	234
120	240	5280	5260	5080	196	202	211
130	230	4730	4710	4560	176	181	190
140	220	4320	4300	4160	161	166	173
150	210	4020	4000	3870	150	154	161
160	200	3770	3750	3630	140	144	151
170	190	3630	3620	3500	135	139	145
180		3580	3560	3450	133	137	143

TURNING EFFORT

The turning effort of a rotary motor, according to the manner in which this paper is planned, is dependent upon three separate forces:

1 The net force on the piston acting toward the center of rotation and transmitted along the connecting rod.

2 The compound supplementary inertia force $2U\omega m$, which, according to Coriolis' law, acts at right angles to the velocity of the piston and in such a direction that it tends to rotate the velocity vector of the piston in the direction of rotation of the motor.

3 The inertia force of the connecting rod acting in the same direction as the resultant inertia force of the piston.

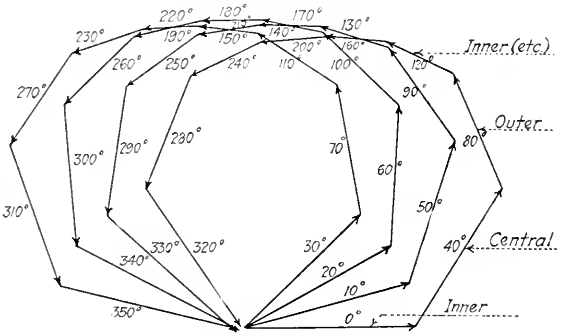


Fig. 8 Inertia Polygons of Connecting Rods

By simply determining now the moment arm of the first two forces, we have that much of the turning effort; but in order to get the turning effort caused by the third force, it is first necessary to get the moment of inertia of the connecting rod about its center of gravity.

Moment of Inertia and Radius of Gyration of Connecting Rods. If the ordinates of the moment diagram mentioned earlier be multiplied by their distances from the ends of the connecting rods, and these products be plotted as ordinates on another base line, the area formed is the moment of inertia, I_0 of that connecting rod about its end 0, for:

$$I_0 = \Sigma MX^2 \text{ or } \Sigma VX^2.$$

From such a diagram it is found that for the inner connecting rod

$$I_{01} = 123.74 \text{ volume inches}^2$$

Also—

$$I_g = I_0 - Vh_3^2 = Vk^2$$

where I_g = moment of inertia about the center of gravity
V = volume of connecting rod
k = radius of gyration
h_3 = distance from center of gravity to point about which the moment of inertia is taken.

From Figs. 7 and 9—

$$I_g = 123.74 - 4 \times 4.39^2 = 46.54 \text{ volume inches}^2$$

$$k^2 = 11.635 \text{ sq. in.}$$

Similarly, for the central rod,

$$I_g = 43.83 \text{ volume inches}^2;\ k^2 = 10.28 \text{ sq. in.}$$

and for the outer rod,

$$I_g = 40.98 \text{ volume inches}^2;\ k^2 = 8.196 \text{ sq. in.}$$

TABLE 5 INERTIA OF KINETICALLY EQUIVALENT SYSTEM

α Deg.		Acceleration of m_2 ft. per sec.² Inner	Central	Outer	Inertia of m_2, lb. $F = 0.00263A$ Inner	$0.00282A$ Central	$0.00316A$ Outer
0		16420	15880	14700	43.2	44.7	46.5
10	350	16300	15720	14580	42.8	44.4	46.0
20	340	15960	15400	14280	42.0	43.4	45.1
30	330	15410	14900	13800	40.5	42.0	43.6
40	320	14780	14270	13210	38.8	40.2	41.8
50	310	13940	13460	12470	36.7	38.0	39.4
60	300	13040	12600	11680	34.3	35.6	36.9
70	290	12030	11620	10780	31.6	32.8	34.0
80	280	11100	10720	9930	29.2	30.2	31.4
90	270	10100	9740	9030	26.6	27.5	28.5
100	260	9150	8830	8200	24.1	24.9	25.9
110	250	8250	7970	7390	21.7	22.5	23.4
120	240	7475	7220	6680	19.7	20.4	21.1
130	230	6700	6460	5990	17.6	18.2	18.9
140	220	6110	5910	5470	16.1	16.7	17.4
150	210	5680	5490	5080	14.9	15.5	16.1
160	200	5330	5150	4770	14.0	14.5	15.1
170	190	5140	4960	4600	13.5	14.0	14.5
180		5060	4890	4530	13.3	13.8	14.3

TABLE 6 TURNING EFFORT OF NET PISTON FORCE

α Deg.	Net piston force, lb.	Component up con. rod, lb.	Moment arm, ft.	Turning effort, ft-lb.
0	285	285	0.0	0.0
10	290	289	0.050	14.45
20	262	261	0.100	26.10
30	200	198	0.140	27.70
40	143	140	0.176	24.64
50	105	102	0.202	20.60
60	70	68	0.222	15.10
80	30	28	0.228	6.38
90	22	21	0.220	4.62
100	15	15	0.205	3.08
120	5	5	0.164	0.82
140	1	1	0.115	0.11
160	−1	−1	0.057	−0.06
180	−30	−30	0.000	0.00
200	27	27	0.057	1.54
220	30	29	0.115	3.34
240	35	33	0.164	5.41
260	42	40	0.205	8.20
270	47	44	0.220	9.68
280	54	51	0.228	11.63
300	69	66	0.222	14.66
320	83	82	0.176	14.42
340	96	95	0.100	9.5
360	−102	−102	0.000	0.0
380	−100	−100	0.100	−10.00
400	−89	−88	0.176	−15.50
420	−75	−73	0.222	−16.20
440	−59	−58	0.228	−13.22
450	−50	−49	0.220	−10.78
460	−45	−44	0.205	−9.03
480	−40	−39	0.164	−6.40
500	−35	−35	0.115	−4.03
520	−32	−32	0.057	−1.82
540	−32	−32	0.000	0.00
560	32	32	0.057	1.82
580	32	32	0.115	3.68
600	33	32	0.164	5.25
620	36	35	0.205	7.18
630	37	36	0.220	7.92
640	39	38	0.228	8.66
660	39	38	0.222	8.43
680	26	26	0.176	4.57
700	−10	−10	0.100	−1.00
720	−75	−75	0.000	0.00

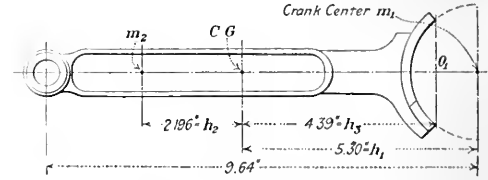


Fig. 9 Inner Connecting Rod

TABLE 7 TURNING EFFORT OF CONNECTING RODS

α Deg.		Inner Rod Equivalent inertia, lb.	Moment arm, ft.	Turning effort, ft-lb.[1]	Central Rod Equivalent inertia, lb.	Moment arm, ft.	Turning effort, ft-lb.[1]	Outer Rod Equivalent inertia, lb.	Moment arm, ft.	Turning effort ft-lb.[1]
0		43.2	0	0	44.7	0	0	46.5	0	0
10	350	42.8	0.078	3.34	44.4	0.076	3.38	46.0	0.073	3.36
20	340	42.0	0.141	5.92	43.4	0.140	6.08	45.1	0.135	6.09
30	330	40.5	0.213	8.64	42.0	0.208	8.74	43.6	0.204	8.90
40	320	38.8	0.271	10.52	40.2	0.265	10.65	41.8	0.260	10.87
50	310	36.7	0.313	11.50	38.0	0.307	11.68	39.4	0.302	11.90
60	300	34.3	0.351	12.04	35.6	0.346	12.30	36.9	0.338	12.47
70	290	31.6	0.372	11.75	32.8	0.366	12.00	34.0	0.355	12.08
80	280	29.2	0.380	11.10	30.2	0.372	11.24	31.4	0.362	11.37
90	270	26.6	0.384	10.20	27.5	0.375	10.30	28.5	0.364	10.38
100	260	24.1	0.369	8.90	24.9	0.363	9.05	25.9	0.348	9.03
110	250	21.7	0.344	7.46	22.5	0.336	7.56	23.4	0.320	7.49
120	240	19.7	0.318	6.26	20.4	0.307	6.26	21.1	0.293	6.18
130	230	17.6	0.281	4.95	18.2	0.273	4.07	18.9	0.258	4.88
140	220	16.1	0.237	3.82	16.7	0.230	3.84	17.3	0.218	2.77
150	210	14.9	0.185	2.76	15.5	0.180	2.78	16.1	0.167	2.69
160	200	14.0	0.129	1.81	14.5	0.127	1.84	15.1	0.117	1.77
170	190	13.5	0.068	0.92	14.0	0.065	0.91	14.5	0.060	0.87
180		13.3	0.000	0.00	13.8	0.000	0.00	14.3	0.000	0.00

---

[1] Turning effort is positive up to 180 deg. and negative from 180 to 360 deg. as shown in Fig. 10.

TABLE 3 TURNING EFFORT OF COMPOUND SUPPLEMENTARY INERTIA OF PISTON

α Deg.		Inertia, $2C'\omega m$, lb.	Moment arm, S, ft.	Turning effort, ft-lb[1]
0		0	1.033	0
10	350	105.3	1.027	108
20	340	206	1.011	208
30	330	293	0.983	291
40	320	371	0.952	353
50	310	428	0.912	390
60	300	469	0.870	408
70	290	489	0.824	404
80	280	491	0.780	382
90	270	474	0.738	350
100	260	445	0.700	311
110	250	401	0.667	267
120	240	352	0.640	225
130	230	296	0.616	182
140	220	237	0.599	142
150	210	178	0.588	105
160	200	118	0.580	68
170	190	59	0.575	34
180		0	0.574	0

---

[1] Turning effort is positive up to 180 deg. and negative from 180 to 360 deg. as shown in Fig. 4.

Turning Effort of Connecting Rods. The simplest way of now determining the turning effort caused by the inertia of the connecting rods is by the Kinetically Equivalent System Method.

A kinetically equivalent system is a group of bodies rigidly connected together which will be given the same acceleration as an actual link under the action of the same forces. To meet this requirement, three conditions must be fulfilled:

1 The two systems must have the same mass
2 The two systems must have the same center of gravity
3 The two systems must have the same moment of inertia.

The simplest kinetically equivalent system which can be substituted for the connecting rods is shown in Fig. 9. It consists of two heavy particles m_1 and m_2 connected by a weightless link. Then, to satisfy the conditions of equivalence:

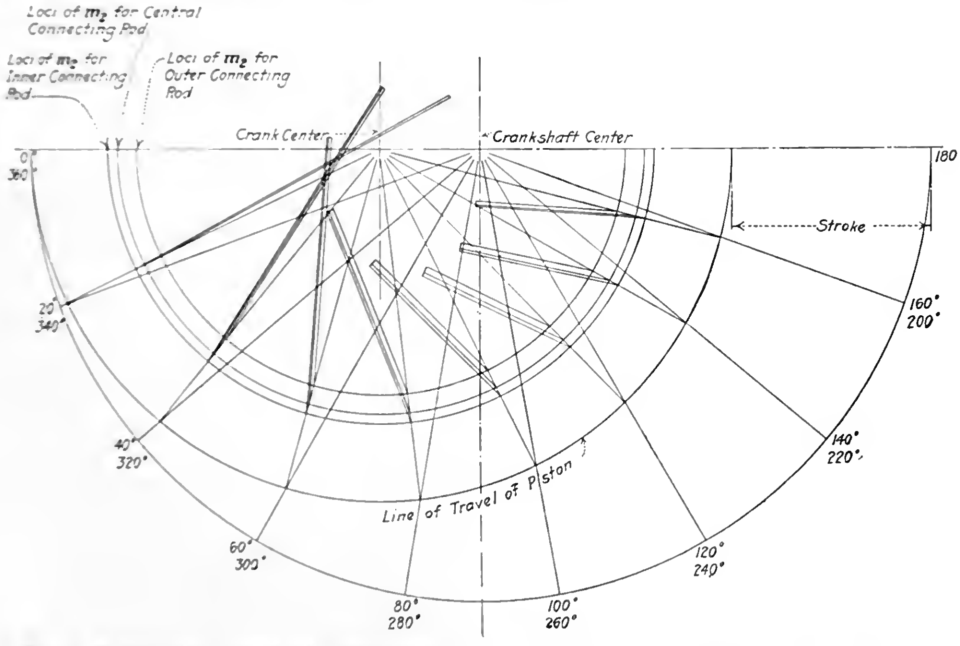


FIG. 10 MOMENT-ARM DIAGRAM FOR INERTIA FORCE OF KINETICALLY EQUIVALENT SYSTEM OF CONNECTING RODS

$$m_1 + m_2 = m \quad [4]$$

$$m_1h_1 = m_2h_2 \quad [5]$$

$$m_1h_1^2 + m_2h_2^2 = I = mk^2 \quad [6]$$

Eliminating the masses m_1, m_2 and m, Equation [6] reduces to $h_1h_2 = k^2$. Assuming any convenient value for h_1, h_2 can be found, thus locating the masses m_1 and m_2.

The mass m_1 is taken at the crank center so that it has no acceleration, and therefore it also has no inertia force. The mass m_2, its distance h_2 from the center of gravity of the connecting rod, and the inertia of the connecting rods can now be found. For the inner connecting rod—

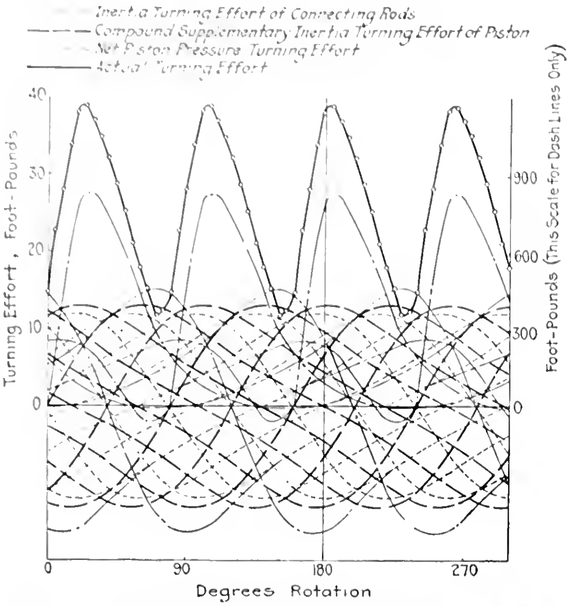


FIG. 11 TURNING-EFFORT DIAGRAM OF LERHONE 80-HP. MOTOR

$$h_1h_2 = k^2 \text{ and } h_2 = \frac{11.635}{5.3} = 2.196 \text{ in.}$$

Solving Equations [4] and [5] simultaneously:

$$m_1 + m_2 = 1.2$$

$$5.3^2m_1 + 2.196^2m_2 = 1.2 \times 11.635$$

$$m_2 = 0.848 \text{ lb.}$$

From Fig. 9, the acceleration of $m_2 = 0.778$ times the acceleration of the piston at any instant and lies in the same direction.

Similarly, for the central and outer rods $m_2 = 0.907$ lb. and 1.017 lb., respectively, and the corresponding accelerations of m_2 are 0.752 times and 0.697 times the acceleration of their pistons at any instant and lie in the same direction.

(Continued on page 654)

The Degasification of Boiler Feedwater

Fundamental Laws Governing the Separation of Dissolved Gases from Water by Air-Tension Control, and the Extent of Their Application to Conventional Types of Feedwater-Heating Equipment

By J. R. McDermet,[1] Jeannette, Pa.

Deäeration of the water fed to boilers and economizers for the prevention of corrosion is now a commercial realization. Engineering experience has also established empirically the degrees of degasification required, and indicated broadly the field in which it will be useful. One method among several which have met with success has been discussed from these relationships by the author in two previous papers,[2] and he proposes here to deal with the fundamental laws governing the operation of this method, and to indicate the extent of their application to conventional types of feedwater-heating equipment.

The method of degasifying water referred to above consists in first heating it to a temperature some 25 deg. fahr. above the temperature at which it is to be deäerated, this latter temperature being selected by reason of operating conditions. The heated water is then suddenly introduced into a chamber in which a vacuum is maintained by a condenser and an air exhauster in series. The vacuum is so correlated with the heater temperature that the water entering the deäerator chamber is superheated roughly 25 deg. above the temperature of the vacuum. This superheat energy produces a partial flashing into steam, and a pulverization of the liquid as it is suddenly injected. The steam, from the instantaneous boiling, enters the condenser, which is cooled by the supply water on its way to the heater. The heat liberated is recovered by the condenser and recirculated back to the heater. The non-condensable gases originally dissolved are removed from the end of the zone of condensation in the condenser by the air exhauster.

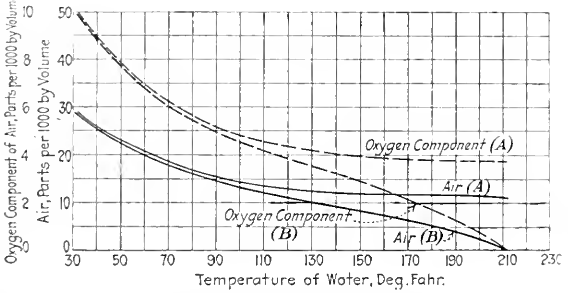


Fig. 1 Solubility Curves for Air in Water

[(A) Total pressure of air = 29.92 in. Hg.; (B) Partial pressure of air + pressure of water vapor = 29.92 in. Hg.]

The process is significant in that it involves no heat losses. A small quantity of heat, amounting roughly to 25 B.t.u. per lb. of water handled, is continuously recirculated between deäerator and heater, and any degradation of form which it suffers is not significant in heating processes. There are, however, energy charges in removing the water from the region of vacuum and in exhausting the non-condensable gases from the condenser.

The successful operation of this process depends upon three factors: (*a*) The inevitable reduction of solubility of dissolved gases in water with increase of temperature. This advantage is common to all forms of water-heating apparatus; (*b*) the explosive boiling caused by the rapid injection of heated water into a zone of lower boiling temperature. While only a very small amount of heat energy is involved, the rate of energy liberation is quite rapid, producing a boiling action, which is independent of diffusion currents within the liquid and results in a very effective disruption of the liquid; (*c*) a method of control and agitation of the water subsequent to the explosive boiling in a region of reduced air tension. This reduction of air tension is secured partly by the reduction of total pressure incident to the vacuum, and partly by the control of the boiling process to furnish a partial vapor component of total pressure to reduce the partial air tension, the sum of the two being equal to the pressure in the region of vacuum. Factors (*b*) and (*c*) in their application are unique with this apparatus, but the control of air tension is significant in any process of aeration or deäeration. This factor of air tension is the criterion by which to judge the performance of other types of feedwater-heating apparatus from the standpoint of the removal of dissolved gases.

The solution of gases from the atmosphere, eliminating carbon dioxide which goes into chemical combination, follows Henry's law. The principal gases in air—oxygen, which produces corrosion, and nitrogen, which furnishes the bulk of the volume—have different solubility constants, and it is expedient, therefore, to consider the application of Henry's law to the individual constituents. Henry's law is formulated by Nernst[1] thus: "Gases dissolve in any selected solvent in the direct ratio of their pressures." When applied to a gaseous mixture this law may be made more specific by saying that the solubility of any constituent is equal to a proportionality factor, which is different for each permanent gas and itself a function of the temperature multiplied by the partial pressure of the constituent. At any constant temperature the solubility of any constituent for purposes of engineering calculation varies directly as the partial pressure.

The solubility curves for air in water presented in Fig. 1 have been recomputed from the solubility data of Winkler. Two sets of curves are given, for both the oxygen component of air and for air, one set having been computed for a total pressure of air equal to 29.92 in. of mercury, and the other so that the sum of the partial pressure of the air and the pressure of the water vapor corresponding to the temperature will be 29.92 in. of mercury. Obviously, in the first case the total pressure is indeterminate without calculation, and in the second case the same is true of the partial air pressure. However, the two groups of curves are useful, for between their intercepted ordinates lie the solubility values of air in water for any open feedwater heater operating on raw water and under atmospheric pressure.

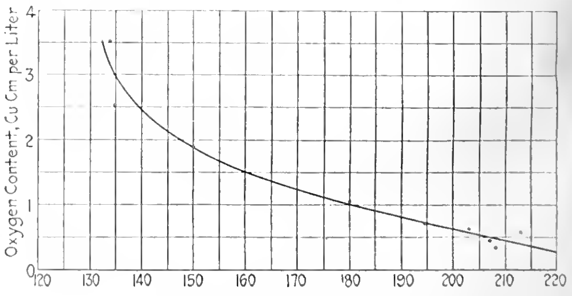


Fig. 2 Dissolved Oxygen in Water in Open-Type Feedwater Heater in Representative Central Stations

(Heaters fed with condensate from condensers.)

It is characteristic of an open-type feedwater heater that it operates under atmospheric pressure irrespective of the temperature to which it heats, and that the supplies of water and steam are not interrelated. As a result the control of partial air pressure in the heater depends primarily on the control of venting if the heater is

---

[1] Research Engr., Elliott Co. Mem. Am.Soc.M.E.

[2] Trans. Am.Soc. M.E., vol. 42, p. 267; and Mechanical Engineering, vol. 43, no. 5, p. 319.

Presented at a meeting of the Baltimore Section of The American Society of Mechanical Engineers, Baltimore, Md., April 12, 1922.

[1] W. Nernst, Theoretical Chemistry.

operated at a temperature close to the atmospheric boiling point. Invariably, there is a high air tension and a very considerable saturation if the heater is operated appreciably below the boiling point. Fig. 2 gives the results obtained from various types of such heaters fed with condensate from surface condensers. The data plotted were collected in a general survey of representative central stations scattered over an area east of the Mississippi River and are indicative of the average performance.

One point on this curve, however, is taken from a thoroughfare heater operating at 208 deg. fahr. This heater was installed in a blast-furnace boiler plant, and the entire exhaust of the blowing engine was discharged through the heater. This corresponded to a more extravagant venting than is permissible in standard practice, but it indicates decisively the results a heater may give under proper reduction in partial air tension. All of the other heaters operate with the minimum amounts of venting consistent with temperature desired and in accordance with usual central-station practice.

The results to be expected from any standard heater operating with raw-water feed are illustrated in Fig. 3. One point is significant in this curve—that for an Elliott 1000-hp. open heater—and, in general, is applicable to all types of open heaters. There is a viscosity-surface tension relationship in water which prevents the liberation of air bubbles at temperatures below 160 deg. fahr. As a result, unless considerable precaution is taken, the air-removal results for heaters operating below this temperature are very erratic and sometimes represent no separation at all. As temperatures rise above 160 deg. the solubility values more closely approach the theoretical, but in any event the equilibrium of solubility between gases and water is obtained very slowly, and accordingly, heater results even within this range are sometimes disconcerting. It is possible, however, to calculate, as in Fig. 4, the minimum solubility to be expected from an open heater. This calculation is primarily a proposition in air tension. It is very difficult, if not impossible, however, to get a heater which will equal this performance on saturated supply water, and the curve, therefore, is only of suggestive significance.

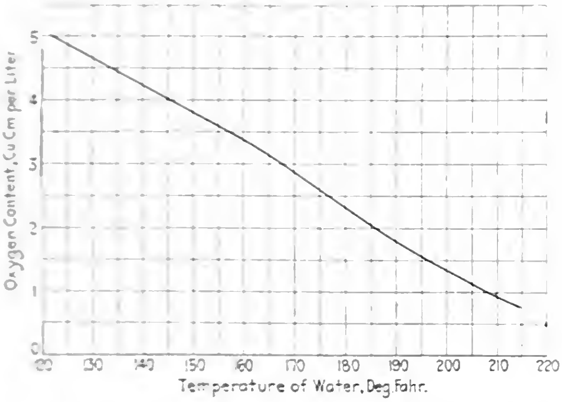


Fig. 3 Dissolved Oxygen in Water in Standard Heaters Operating with Raw-Water Feed

(Water saturated at 70 deg. fahr.)

The reason for the high values shown in the heater-performance curves is explainable from the curve of Fig. 5, which is plotted for vent mixtures from open feedwater heaters. It is an axiom in condensation work that the most efficient place for the removal of non-condensable gases is at the end of the zone of condensation. Unfortunately, there is no correlated control of steam and water in an open heater, and as a result no definite zone of condensation exists; it is therefore necessary to consider air removal on a pure vapor-mixture basis. As a result, in order to adequately remove a pound of air, it is necessary to remove a very significant amount of steam, even though the actual quantity of air involved is small. This curve rises so rapidly at 210 deg. as to make adequate venting almost prohibitive from a heat standpoint. It is primarily for this reason that open heaters do not adequately solve the deäeration problem.

A series of curves analogous to Fig. 5 but for a condenser heater of the jet type, are shown in Fig. 6. Since these heaters operate under vacuum and with different degrees of air exhaustion, the curves are plotted for different air tensions in the condenser body. The condition of control of steam and water exists under the same unfavorable circumstances as in the atmospheric heater, and air-removal conditions are extremely severe. Therefore, the three upper curves, for 0.2, 0.4 and 0.6 in. of mercury air tension, are of comparatively little significance, and the expense of pumping out the air mixtures has practically relegated the zone of operation to air tensions within the zone of the three lower curves, for 0.8, 1.0 and 1.2 in. of mercury air tension.

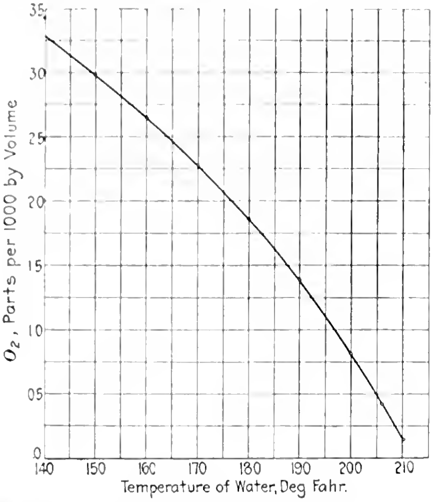


Fig. 4 Minimum Oxygen Saturation to be Expected with an Atmospheric Open Heater

In the open feedwater heater, venting is secured at the expense of steam only. In the jet-condenser heater, operating at vacuum, the vapor mixture must be mechanically exhausted. From a steam-ejector standpoint it requires practically as much energy to evacuate a pound of steam as it does a pound of air. Jet-condenser heaters have uniformly been more efficient äerators than deäerators, although their other merits are making their use extremely popular. In one installation, which perhaps may be said to represent the best from the standpoint of deäeration, the solubility of the water leaving the condenser is practically regulated by the condensate coming over from the main turbine condenser. In this case the jet condenser removes no air, but fortunately does not allow any to be added. It is also true that equilibrium between air and the solution of air in water is so slowly attained that spraying

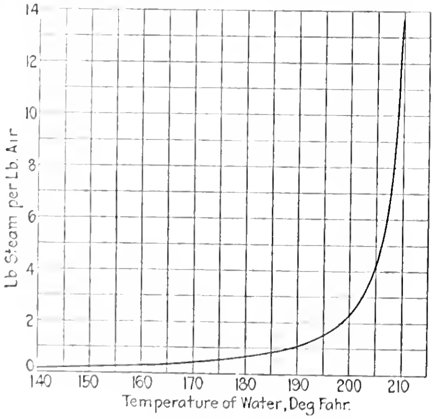


Fig. 5 Air-Steam Ratios in Venting Atmospheric Open Heaters

methods are uniformly unsuccessful in producing complete deäeration. There is, therefore, little probability that the jet-condenser heater, even with extravagant air-removal capacity, will offer a successful solution. It has, however, under the best conditions of heating, marked one step in advance, in that it has been found capable of preventing pollution of the water handled.

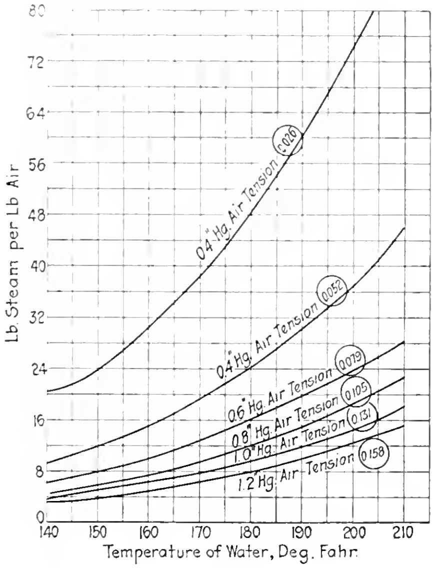


Fig. 6 Air-Steam Ratios in Removing Air from Jet-Condenser Heaters

(Figures in circles are mean solubility values in cubic centimeters per liter.)

The use of surface-condensing apparatus has two inherent disadvantages. While the condensate or water which is to be heated does not come in contact with air, the use of such apparatus for exhaust steam from small turbines under modern boiler conditions is limited by the conductivity of superheated steam. The exhaust from small auxiliaries is so high in superheat under high boiler pressure and high boiler superheat that it is almost impossible to secure a workable conductivity without desuperheating. Where desuperheaters are employed or steam is extracted from an intermediate stage of the main unit within the saturated zone, the problem is complicated by the äeration of the condensate in the heater.

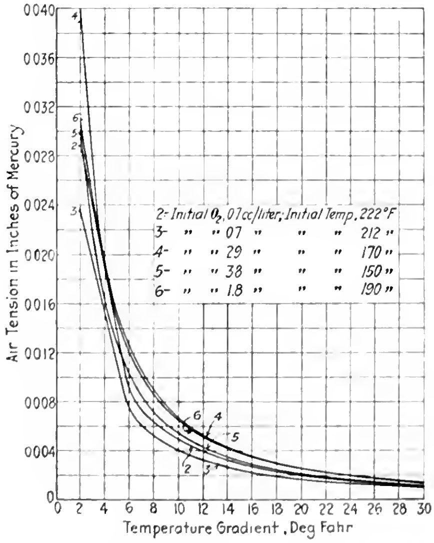


Fig. 7 Characteristic Curves of DeÄreator Described in Text

Fig. 7 indicates the analogous condition of control of air tension in the deäeration process previously described. The scale of ordinates for these curves is inches of mercury air tension, and the scale of abscissas the B.t.u. drop in the instantaneous boiling. The various curves range between the maximum and minimum operating temperatures employed in the process and for initial air contents which ordinarily accompany these temperatures in feedwater heaters of the open type. Obviously, the closed type merely retains the air content of the water entering it. It is a fortuitous circumstance that the natural coördination between normal air contents in heating apparatus and vacuum are such that these curves even for widely different conditions are approximately parallel and lie within the same zone. The minimum air tensions in the operating range amounting to less than 0.002 in. of mercury, indicate very forcibly the reason for the effective results which are secured by this process. However, the results which are theoretically obtainable are decidedly lower than the results actually obtained. The water is handled in the region of vacuum by agitating pans, which as a general premise are very much more effective than any type of spray nozzle. These curves are not in any sense an exposition of the complete operation of the deäeration process under consideration, but they do explain very satisfactorily and very accurately the underlying principles upon which successful operation is based, and indicate in radically new ways the relation of these principles to other features of power-plant apparatus.

Some mention was made in an earlier paragraph of the fact that a gradient of 25 deg. was employed between the heater and the deäerator. For all conditions of pressure the characteristic curves become practically parallel to the axis of abscissas in the neighborhood of 25 deg. There is no appreciable gain from increasing this value and it is economically wrong to extend the range of temperature gradient unless it be for some purpose of regulation as a part of a complete power plant. It is true, however, that the process does not operate efficiently at heater temperatures below 160 deg. fahr., and in case it is desired to go to operating temperatures on the deäerator as low as 130 deg. fahr., the temperature range must be extended beyond 25 deg., regardless of economic proportioning.

Vanadium metal is a silver-white lustrous metal with an atomic weight of 51.2 and a specific gravity of 5.5. It owes its great economic value to the fact that when added to steels in quantities ranging from 0.05 per cent to 0.50 per cent, it removes occluded oxygen and nitrogen, and combines with the steel to the very great improvement of its physical properties. In the smaller proportions, it confers great toughness to steel, making it particularly well adapted for automobile axles and other parts subject to excessive stress. In larger proportions it is used in high-speed and other tool steels to which it imparts certain desirable qualities which no other known substance can give in an equal degree. This fact has led to its becoming a standard constituent of such steels. Nearly all the vanadium in such steels is found in the pearlite as a combined carbide of vanadium, iron and any other metals present.

In English high-speed tool steels, the vanadium proportion is usually from 1 per cent to 1.5 per cent. Prior to the war, high-speed steels contained carbon, chromium, tungsten, and vanadium in varying proportions but the vanadium proportion was not more than 1.5 per cent. While these steels were excellent materials for high-speed tools, very much better steels have since been discovered, practically all of which contain vanadium. An interesting development has been the subject of a British patent in which the inventor claims that 18 per cent of tungsten can be replaced with advantage by 6 per cent of molybdenum in the presence of a little over 1 per cent of vanadium. In these steels vanadium is regarded as the key element, and its functions are described as stabilizing the variable properties of molybdenum steel and the prevention of cracking during the water-hardening operation. The result is said to be not only a steel of remarkable hardness but also thermal stability. Moreover, it is claimed that this molybdenum-vanadium steel does not "let down" until a heat of 700 deg. cent. is reached, in which respect it is superior to most other steels of this class.—*Engineering* (London), Aug. 4, 1922, p. 151.

An Investigation of the Herschel Type of Weir

Results of Tests Made to Determine the Effect of Various Modifications in Construction on the Action of the Improved Type of Weir Designed by Clemens Herschel for Gaging in Open Channels

By RICHARD H. MORRIS,[1] HARRISON, N. J., AND ALBERT J. R. HOUSTON,[2] BOSTON, MASS.

THE great multiplicity of weir types and the corresponding multiplicity of weir formulas early led Mr. Clemens Herschel to believe that the problem of measuring large quantities of water was being attacked from the wrong angle. As early as 1888, in an article in *Engineering News* for November 10 of that year, he protested against the usual method of making weir observations and suggested that the measurements be taken at the crest. When The American Society of Mechanical Engineers appointed a committee to draft a revised form of Power Test Code in 1917, Mr. Herschel was made a member and the Engineering Foundation made an appropriation to be expended by him in research work on weirs. In September, 1919, in the Hydraulic Laboratory of the Massachusetts Institute of Technology, he built and tested a weir which he briefly described in an article entitled An Improved Weir for Gaging in Open Channels, as follows:

> The fundamental idea followed in the design of the new weir was to have the water to be measured conducted over the weir in a gentle manner, and so as to have it flow smoothly and regularly from the time it first encounters the weir construction until it leaves it. Instead of allowing the body of water to impinge with more or less violence, according to the velocity with which it approaches the weir, against a perpendicular wall in its path (the upstream face of the ordinary weir), it is gently led to the crest by a 2:1 slope. Instead of striking on or being torn over a sharp edge at the crest, the crest is made in the form of an arc of a circle; and instead of bothering about air under the nappe, the nappe is supported on another 2:1 slope downstream from the crest. Moreover, the crest is made hollow so that observations of the pressure or lack of full pressure, whichever the water may elect to exercise, can be taken at the crest, not at a distance upstream from the crest at a distance varying according to the fancy of the experimenter.
>
> If the quantity passing over the weir turn out to be a function of this observed pressure, well and good. If not, we will see what virtue there is in the difference of water elevations or pressures, the one taken upstream from the weir and the other taken by means of the hollow weir crest.

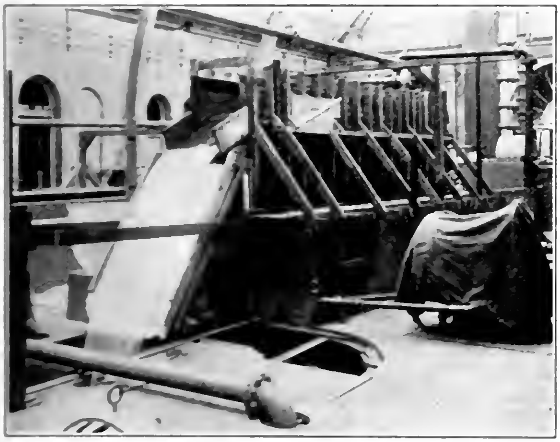


FIG. 1 HERSCHEL-TYPE WEIR AS ARRANGED FOR TESTING

> The difference referred to above proved to be the sought-for solution of the problem at hand...... A United States patent has been applied for covering the weir construction herein described.
>
> Our weir crest had a radius of 0.198 ft., and the outside surface was hard and smooth oil paint.

The results of this test were presented to The American Society of Mechanical Engineers at their Spring Meeting in May, 1920, an abstract of the paper having been published in MECHANICAL ENGINEERING for February of the same year. Mr. Herschel's tests showed that for discharges of from 0 to 9.55 cu. ft. per sec. per ft. of weir length (the limits covered by the experiments) the quantity of water flowing, Q, was directly proportional to the difference, d, in two pressures, one measured just upstream from the weir, and the other measured at the crest, the formula being $Q = 5.50\ d$.

NATURE OF THE INVESTIGATION UNDERTAKEN

The work herein described constitutes an investigation of a Herschel-type weir from six distinct points of view. First, an attempt was made to check the work of Mr. Herschel. Next, it was desired to find the effect on the action of the weir of the following five modifications in its construction:

1 The degree of smoothness of the crest and slopes
2 The radius of the crest
3 The position at which the upstream measurement is made

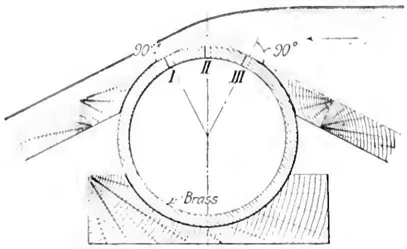


FIG. 2 DETAIL OF CREST OF HERSCHEL-TYPE WEIR

4 Increasing or decreasing the velocity of approach
5 Changing the position of the orifices in the crest.

Undeniably, the work should have included an investigation of the effect of different slopes. However, neither time nor funds were available for such extensive work as this would require.

DEFINITIONS OF TERMS

Throughout this paper whenever any of the following terms are used their meaning will be covered by the definitions here given.

Crest: The brass tube set at the juncture of the two slopes, forming a smooth, slightly curved surface over which the water flows.

Weir Length: The length of the crest at right angles to the direction of flow.

Velocity of Approach: The mean forward velocity of the water in the section of the weir box at the foot of the upstream slope, computed by the formula $V = Q/A$.

Sharp-Crested Weir: The ordinary type of weir in which the crest and sides are made of a thin slab of metal so constructed that the nappe or overfalling water touches only the sharp upstream corner or edge of the crest.

THE APPARATUS USED

The tests to be described were performed in the Hydraulic Laboratory of the University of California. Among other things this laboratory is equipped with six electrically driven centrifugal pumps, two calibrated measuring tanks, and two storage tanks. A sharp-crested weir is arranged to overflow into one of the calibrated tanks. The Herschel-type weir to be tested was built on top of the sharp-crested weir. All six of the pumps were arranged to discharge into the new weir. From it the water ran into one of the calibrated tanks, which in turn overflowed into the other calibrated tank. By means of a sliding gate the water could be diverted from the calibrated tanks into one of the storage tanks without stopping the pumps. The combined capacity of the six

---

[1] Worthington Pump & Machinery Corp. Jun. Mem. Am.Soc.M.E.
[2] 44 The Fenway. Jun. Mem. Am.Soc.M.E.
Abridgment of paper awarded the A.S.M.E. Student Prize for 1921.

pumps was approximately seven and one-half cubic feet of water per second.

In external appearances, as shown in Fig. 1, the new weir very much resembles a long, narrow box with its sides braced on the outside. The box was 17$^{1}/_{2}$ ft. long, 5 ft. high, and a little over 2 ft. wide. The crest was 2.0335 ft. long and was made of a brass pipe with a line of $^{1}/_{8}$-in. holes along its length, spaced 1 in. apart. Two different sizes of pipe were tried, one being a standard 4-in. pipe and the other about 2 in. in diameter. The actual external radii of these pipes were 0.1878 ft. and 0.0792 ft., respectively. The crest was placed 3 ft. above the floor of the weir. The approach to and from the crest had a slope of 2:1, that is, 1 ft. rise for each 2 ft. horizontal distance. The whole construction, except the pipe, was of wood, the supporting timbers being 4 in. by 4 in., the braces 2 in. by 4 in., and the sides, floor and slope $^{7}/_{8}$-in. tongued and grooved flooring. The weir was fitted with three orifices for measuring the upstream pressure. These were flush with the side, $^{3}/_{4}$ ft. below the level of the crest, and respectively 6 ft., 7$^{1}/_{4}$ ft., and 8$^{1}/_{2}$ ft. upstream from the crest. From these orifices rubber tubing led to a water manometer constructed on an angle as is the conventional draft gage. The angle at which the manometer was set was such that 3 ft. along the slope corresponded to 1 ft. rise vertically. It was calibrated by comparison with a vertical gage. The pressure from the crest was also led to this same manometer, where suitably arranged valves made it possible to read the pressure at any of the three orifices or the crest. Baffle plates were used to steady the flow.

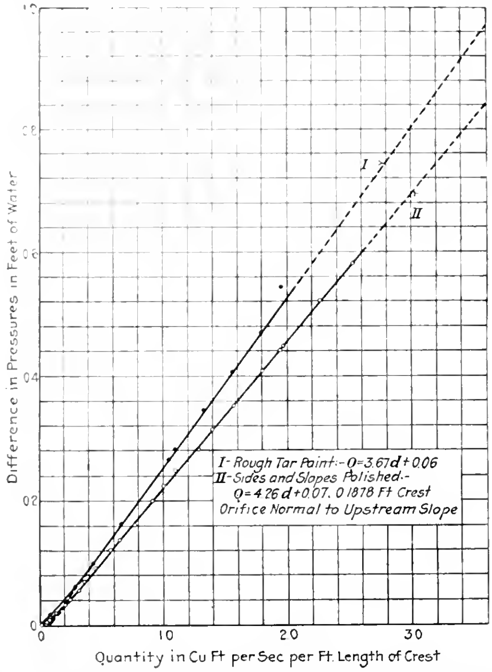


Fig. 3 Effect of Roughness of Surfaces on Discharge of Herschel-Type Weir

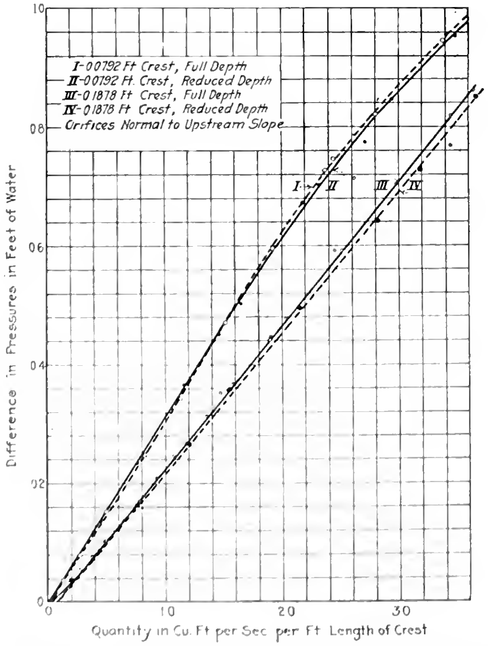


Fig. 4 Effect of Radius of Crest and Velocity of Approach on a Herschel-type Weir

In order to increase the velocity of approach a raised floor or false bottom was sometimes set in the weir. It was 2 ft. above the original floor and terminated 9$^{1}/_{2}$ ft. upstream from the crest in a 1:1 slope.

Laboratory Procedure

At first the 4-in. pipe was fitted with the $^{1}/_{8}$-in. orifices at right angles or normal to the upstream slope (position III, Fig. 2). A preliminary test of ten runs was made with the sides and slopes covered with rough asphaltum paint. The small cracks between the wooden slopes and the brass pipe were left open.

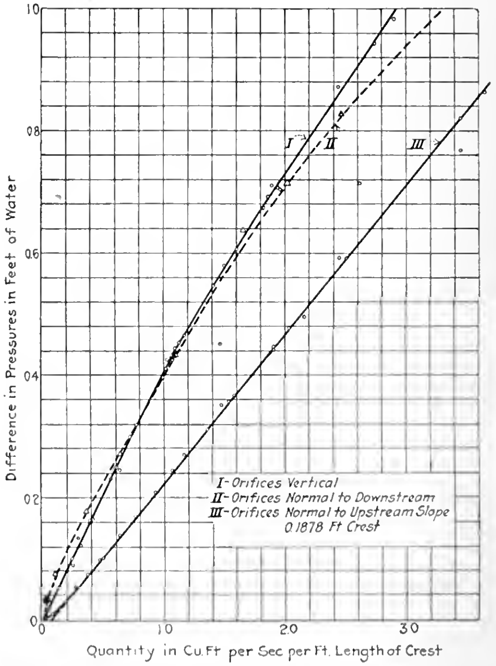


Fig. 5 Effect of Position of Orifices in a Herschel-Type Weir

These cracks were then filled and smoothed with modeling clay and the sides and slopes were scraped, oiled and polished. Another test of twenty-three runs was then made.

After completion of these tests the orifices in the crest were changed to the vertical position (II) and thirty-five more runs taken. A test of thirteen runs was then taken with the orifices at right angles to the downstream slope (position I, Fig. 2). It was found that pressure conditions were too unsteady with the orifices in positions I and II, so they were changed back to position III and a further test of twenty-five runs was then made. The

velocity of approach was next increased by fitting in the weir the raised floor and nine runs made.

With this raised floor still in place, the large pipe in the crest was replaced by the small one and the orifices set at right angles to the upstream slope. A test of ten runs was made with these conditions. The raised floor was then removed and eleven runs made.

The work of constructing the weir was begun on June 3, 1920, the first run was made on the 28th of the same month, and the last run was finished on July 23. The data obtained in the tests are given in an appendix to the complete paper.

The typical procedure in taking a run was as follows: The sliding gate was set so as to divert the stream of water into one of the storage tanks. Whatever pumps it was desired to use were then started and the throttle valves regulated to give the desired reading on the differential gage. The hook gages on the measuring tanks were then read. After the flow became steady the sliding gate was pushed under the stream so as to allow it to flow into the measuring tanks. The stop watch was started just as the gate moved under the stream. Readings were taken on the differential gage of the pressure both at the crest and at each of the three upstream orifices. Usually there was time to take several sets of readings and the mean of each was used in calculating the results. When the tanks were sufficiently full the sliding gate was pulled back into its first position so as to again divert the water into the storage tank, and the watch was stopped. Hook-gage readings were then taken of the water level in the measuring tanks.

It was found that if this weir was treated as an ordinary broadcrested weir of irregular section and the quantity discharged plotted on logarithmic coördinate paper against the upstream reading, the result was a very good straight line. Therefore the measuring tanks were not always used, but instead sometimes the quantity discharged was read off this logarithmic calibration curve.

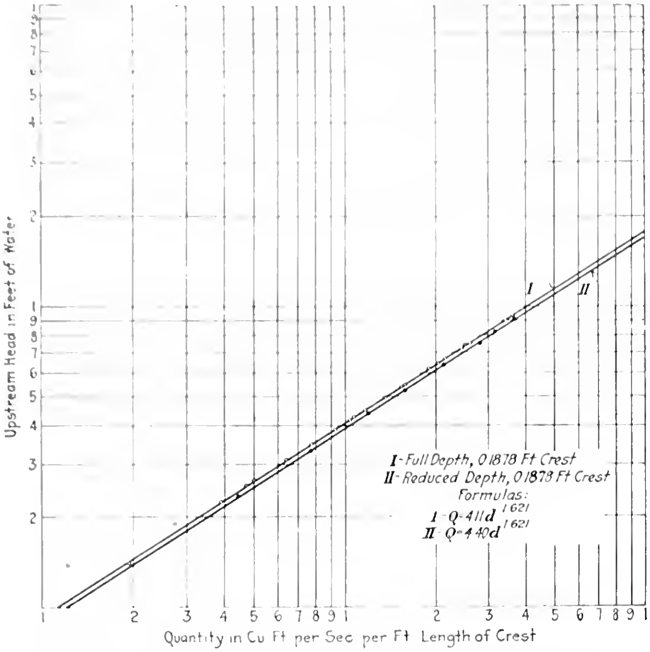


Fig. 7 Effect of Velocity of Approach on a Herschel-Type Weir
(For 0.0792 ft. crest, Q(full depth) = $4.3d^{1.621}$; Q(reduced depth) = $4.5d^{1.623}$.)

Calculation of Results

Curves were plotted of head due to velocity against quantity for both the full depth and the raised floor. It was then unnecessary to figure out the velocity head for each run. Instead it was merely read off the curve from the corresponding quantity. The following is a sample of the computations made for the full-depth curve:

$$\text{Quantity} = \text{Area} \times \text{Velocity, or } V = Q/A$$
$$\text{Velocity Head} = h_v = V^2/2g$$

where g is the gravitational constant. Q is measured in cubic feet per second per foot of length of crest. Then the area per foot of length of crest equals the height of the crest above the bottom of the weir plus the observed measured head upstream.

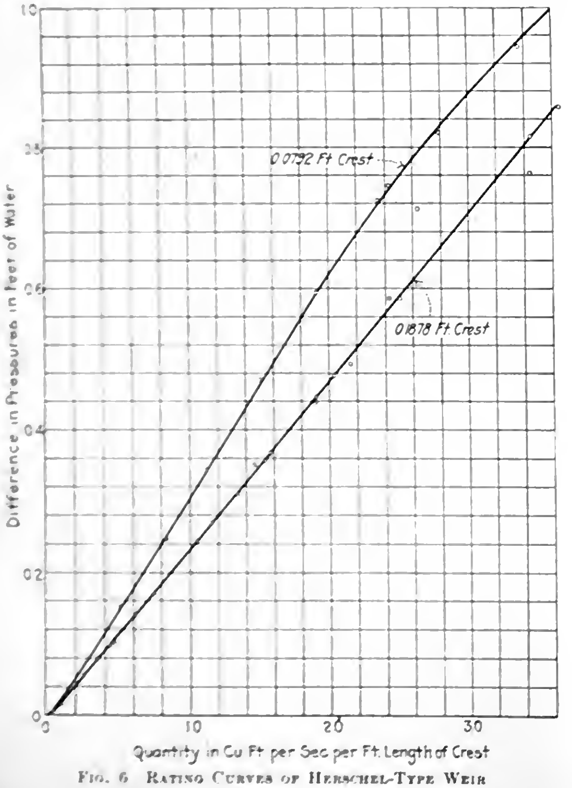


Fig. 6 Rating Curves of Herschel-Type Weir

From the logarithmic calibration curve of the weir with full depth a quantity of 3.00 cu. ft. per sec. per ft. of length of crest corresponds to an upstream head of 0.810 ft. The crest is 3.015 ft. above the floor. Therefore the area per foot of length of crest is 3.015 + 0.810 = 3.825 sq. ft. Then—

$$V = Q/A = 3.00/3.825 = 0.785 \text{ ft. per sec.}$$
$$h_v = V^2/2g = (0.785)^2/2g = 0.615/64.36 = 0.00956 \text{ ft.}$$

Summary of Results

In plotting the accompanying curves from the data obtained the two following rules were always used: (1) $V^2/2g$ was always added to the difference between the crest and upstream pressures. (2) When a curve did not pass through the origin on rectangular coördinate paper, the value of the quantity where the curve cut the line of zero difference was subtracted from each quantity when plotted on logarithmic paper, giving an equation of the form $(Q-K) = Cd^n$.

From an examination of the curves it is evident that all the factors mentioned earlier in the paper affect the discharge to some extent. The discharge constant varies over a wide range, depending upon the existing conditions.

Friction greatly affects the discharge of this type of weir and, as is shown in Fig. 3, this variation may be as great as 12 per cent. This is a disadvantage and will have a bearing upon the change of slope, the effect being proportional to some function of the velocity—probably the square. Friction and contraction are the two limiting factors of the discharge, and from Bazin's experiments it seems that a 2:1 slope represents the point where the combined effect is about a minimum and the discharge a maximum. In order to offer a basis of comparison, it would be well if future experi-

menters would do their work with surfaces that are capable of fairly accurate reproduction, such as cement, hardwood flooring or germanstone.

Figs. 4, 6 and 8 indicate that the formula for the discharge is materially affected by the size of the pipe forming the crest. This may be explained in several ways. Generally speaking, by decreasing the radius of the crest a sharp-crested weir is approached, and the smoothness of flow is thereby altered. Thus the size of the crest affects the contraction and consequently the actual discharge. On the other hand, it will be seen that the size of the crest affects the crest gage reading and therefore the formula for the weir. For, since the holes are normal to the upstream slope, the size of the crest determines the distance from the top of the crest to the orifices. Therefore the size of the crest will vary the component of the velocity that enters the orifices. It is not known, however, whether these two effects tend to increase or oppose each other.

The particular curves (Figs. 6 and 8) of the small crest seem to indicate that each size of crest has definite limits between which the discharge varies as a straight-line function.

Upstream measurements taken with three gages were identical below about $3^1/_2$ cu. ft. per sec. per ft. length of crest. Above that quantity the gage nearest the crest showed a slight drop, indicating that the upper-surface curve extended at least 6 ft. upstream from the crest.

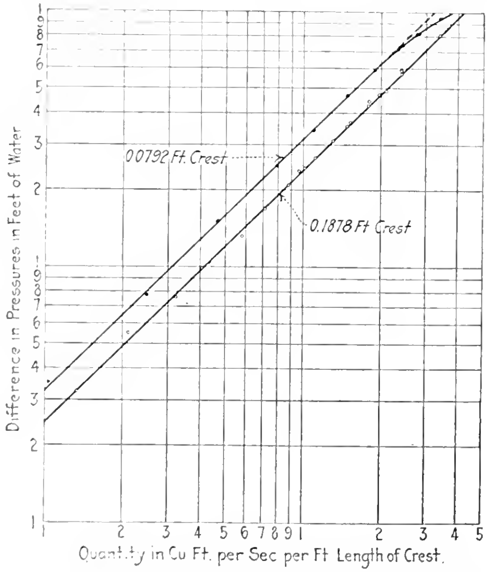


Fig. 8 Logarithmic Rating Curves of a Herschel-Type Weir
(For 0.1878 ft. crest, $Q = 4.16d + 0.07$.)

That the velocity of approach cannot be corrected for by means of the simple formula $V^2/2g$ is shown in Figs. 4 and 7. The velocity of approach was increased nearly 300 per cent, with a corresponding difference of about 7 per cent in the corrected discharge curves. The weir is therefore similar to a sharp-crested weir in this respect, because both Bazin and Francis specify that the height of the crest above the floor of the weir box must fall within certain limits if their formulas are to be applicable.

The most important factor is the position of the orifices in the crest as shown by Fig. 5. The discharge is a straight line-function only when the holes are normal to the upstream slope, or nearly so. The constant may be varied almost at will by rotating the orifices with respect to the horizontal axis of the crest. It is doubtful, however, if the constant 5.50 as obtained by Mr. Herschel could have been obtained with the weir used in these experiments, due to the difference of about 0.01 ft. in the crest radii.

Conclusion

The results of this investigation tend to show that when a weir of the Herschel type is properly constructed there is a constant ratio between the quantity of water passing over the weir and the difference in the two observed pressures. However, so many are the determinant factors and so great is their influence upon the discharge formula that a weir of this type, in its present state of development, would probably be valueless unless calibrated by actual tests. It is believed that further extended research may remedy this difficulty. Probably the chief advantage of the new weir lies in the fact that for the same upstream head it discharges about 20 per cent more water than the ordinary type of weir.

FORCES IN ROTARY MOTORS

(Continued from page 647)

Table 5 gives the accelerations and inertia forces of these equivalent masses for every 10 deg. rotation of the motor.

Plotting the net component piston force acting up the connecting rod for every 10 deg. rotation of the motor, and drawing its moment arm, the turning effort of the net piston force is calculated, the results for 20-deg. intervals being presented in Table 6. The maximum turning effort from this source for one piston is 27.7 ft-lb. and occurs when the cylinder is 30 deg. off dead center at the beginning of the stroke.

In Fig. 10 the direction of the equivalent inertia force of the connecting rods, for every 10 deg. rotation of the motor, is plotted and the moment arm shown. From this diagram the turning effort of the connecting rods is calculated and the results are given in Table 7. The turning effort is positive up to 180 deg. and negative from 180 to 360 deg. These positive and negative turning efforts exactly balance each other, the maximum occurring 60 deg. off dead center and amounting to about 12.5 ft-lb. per connecting rod.

Table 8 gives the turning effort due to the compound supplementary inertia force of the piston, $2U\omega m$ (heretofore neglected in similar calculations); which amounts to almost fifteen times that of the net piston force, and over thirty times that due to the inertia of the connecting rods. This is also positive up to 180 deg. and negative from 180 to 360 deg., the negative balancing the positive.

Fig. 11 shows a representative portion of the final turning-effort diagram of the LeRhone 80-hp. motor. The dotted lines represent the turning effort due to the inertia of the connecting rods; the dot-and-dash lines the turning effort due to the net piston pressure; the dash lines the turning effort due to the compound supplementary inertia of the piston; while the heavy lines represent the combined turning efforts. The inertia forces balance, and the final turning effort depends only upon the net piston pressure.

The "heat pump" is an apparatus working on a reversed heat-engine cycle, the object of which is to economize heat in evaporating processes, such as the concentration or the distillation of liquids.

In the heat-pump process the vapor from the evaporator is taken to a compressor, in which its pressure, and hence also its temperature, are raised to such a degree that the compressed vapor may serve as the heating medium in the evaporator. It is returned to the heating element of the evaporator accordingly, where it is used for the evaporation of a further amount of liquid.

While in certain circumstances a small quantity of live steam may have to be supplied, in general the only energy required in order to carry on the process is that necessary to drive the compressor. The efficiency of the process from the thermal or energy point of view may therefore be measured by comparing the evaporative effect produced with the power expended in driving the compressor. This power may be derived from fuel consumed in the power unit or station from which the compressor is driven, or, of course, from any other source of power, such as water power, and involve no expenditure of fuel at all. Also the compressor may be driven directly by the prime mover or the drive may be indirect, the transmission being effected electrically. The compressor may also take the form of a jet pump supplied from an external source with steam which mixes with the vapor from the evaporator, and is delivered with it to the heating element. The variations of the process are numerous, but all are characterized by the fact that the vapor produced is compressed and returned to the evaporator as the heating medium. T. B. Morley in *The Engineer* (London), July 14, 1922, p. 27.

The Fuel Problems of the Pacific Coast

The Future Fuel Supply of California—Reasons Why the Railways and Merchant Marine Should Receive Preferential Treatment in Case Oil-Fuel Conservation Becomes Necessary

AT A MEETING of the San Francisco Local Section of the A.S.M.E., held February 23, 1922, three papers were presented dealing with the conservation of the present fuel supply of the Pacific Coast and the development of new sources. Reasons were given why the railways and merchant marine of the Pacific Coast should not be affected by any restrictions in the use of fuel oil which the diminishing supply might make necessary. Abridgments of these three papers follow, together with the introduction to the discussion given by F. H. Sibley, dean of the College of Engineering, University of Nevada.

THE FUTURE FUEL SUPPLY OF CALIFORNIA

By C. H. DELANY,[1] SAN FRANCISCO, CAL.

IT IS the purpose of this paper to point out certain facts in connection with the future fuel supply of California which appear to be of importance in view of the possible decrease in available supply of California oil.

A recent joint survey, made by the United States Geological Survey and the American Association of Petroleum Geologists, estimates that the quantity of oil recoverable by present methods remaining in the ground in California on January 1, 1922, including known and probable fields, amounts to 1,850,000,000 bbl. For some years the production of oil in California has been in excess of 100,000,000 bbl. per year, so that it appears that if the present rate of production could be continued, the oil supply would be exhausted in less than twenty years. The estimate represents the best judgment of the geologists, but unknown fields may be discovered in the future, so that it is impossible to predict with any degree of certainty how long the oil supply will last.

While it is true the development of new oil fields in the state may increase the total supply of oil, it is also probable the development of methods of oil refining will in the future use more and more of the oil for gasoline and other valuable products and leave less and less for fuel purposes. It is also probable that the many advantages of oil for marine purposes will tend sooner or later to cut off the supply for many uses for which fuel is required on land. It therefore seems appropriate at this time to discuss the situation in which we will some day find ourselves when our present fuel supply is cut off.

The production of California oil, as shown by the records of the State Mining Bureau, has increased from 4,329,950 bbl. in 1900 to 114,800,000 bbl. in 1921. About 8 per cent of this is used as fuel in the oil industry itself, and over 80 per cent of the remainder is distributed as fuel to the industries of California and other states.

Table 1 shows the purposes for which oil was used as fuel in California during the year 1917. It is seen from this table that in that year the quantity of oil used as fuel in California amounted to 4,467,000 bbl. per month, or at the rate of 53,604,000 bbl. per year. On the basis of 3$^1/_2$ bbl. of oil to one ton of coal, this quantity of oil is equivalent to 15,300,000 tons of coal. In addition there were used in 1917 in California over 700,000 tons of coal, bringing the total annual fuel requirements of the state up to an equivalent of 16,000,000 tons of coal. The population of California in 1917 was somewhat over 3,000,000, so the fuel requirements amount to about 5 tons of coal per capita. This compares with an average coal consumption throughout the United States for the year 1920 of 5.7 tons per capita. It is evident, therefore, that if the growth of California is to continue at the present rate, producing a population of 10,000,000 by 1950, and if the supply of California oil is cut off, we shall require by that time for fuel purposes the equivalent of 50,000,000 tons of coal per year.

TABLE 1 FUEL OIL USED IN CALIFORNIA
(Crude and residuum)

	Bbl. per Month	Per Cent
Railways	1,956,000	43.8
Steamships	555,000	12.4
Public utilities	555,000	14.7
Mining and smelting	52,000	1.2
Industries	483,000	10.8
Lime and cement	158,000	3.5
Sugar refining	103,000	2.3
Agriculture	73,000	1.6
Heating buildings	150,000	3.4
Miscellaneous	282,000	5.3
Total	4,467,000	100.0

Hand in hand with the development of the oil industry has gone the development of the hydroelectric-power industry, which is of course also responsible in a large part for the development and growth of California during the last twenty years. There is an impression among many that hydroelectric power will serve as a substitute for fuel and that when our oil supply has been used up we shall simply have to turn to the "white coal" of the Sierra Nevada Mountains.

There are many industries, however, that cannot do without fuel of some form, regardless of the quantity of electric power available. Of the 655,000 bbl. of oil used per month by public utilities, probably at least one-half was used for the manufacture of gas. Gas is a direct product of the oil itself, and if oil is no longer available some other fuel must be substituted for it. Lime and cement works used 158,000 bbl. per month. Electric power is already used extensively in these industries for operating the machinery, but fuel of some sort must be used in the kilns themselves. Heating by electricity is a possibility, but electric energy is of far greater value for the production of power than for the production of heat, and it is certain that the heating of buildings and industries requiring heat such as fruit canning, sugar refining, etc., will continue to demand an adequate supply of fuel.

Even if it were practicable to substitute electric power for all of the industries which are now using fuel oil, it must be borne in mind that there is a limit to the quantity of hydroelectric power available. It has been estimated that at the present rate of growth of the hydroelectric-power industries, the economic limit of hydroelectric development in the State of California will be reached in the year 1941. This limit, of course, will be reached all the sooner if hydroelectric power is substituted for fuel oil wherever practicable, such as by electrifying the railroads and the greater use of electric power in industry.

The question, therefore, is what kind of fuel is to be used after the California oil is exhausted, and where it is to come from? At first thought it would appear that fuel oil may be imported from other countries. However, on investigation we find that the petroleum supply of the whole world is quite questionable and cannot be depended upon to last more than 20 or 30 years, and as California would be in competition with the rest of the world in its use, we cannot count on a supply of imported oil that would meet our requirements. Natural gas is available in certain sections of California, but its use is only local in these particular sections, and it cannot be considered as a fuel supply for the whole state; moreover it is probable that the natural-gas supply will be exhausted sooner than the oil supply.

We must therefore turn to coal as the only reliable fuel for the future, and the problem accordingly becomes a question of where can we obtain our required supply of coal at the least expense and in a manner best suited to our own development.

A very complete survey of the coal resources of the world was made by the International Geological Congress held in Canada in 1913. From this report the information in Table 2 has been selected, applying to the Pacific Coast and neighboring states.

California coal is low-grade lignite, running from 9,000 to 12,000 B.t.u. per lb. Owing to the small quantity available it need not be given serious consideration as a substitute for fuel oil.

Oregon has a considerable supply of coal in Coos Bay region, much of which has been sent to California in former years, although

---

[1] Pacific Gas & Elec. Co. Mem. Am.Soc.M.E.

the output from the Oregon mines has always been small. Oregon coal is a very low-grade lignite, high in ash and moisture and running from 7,000 to 10,000 B.t.u. Owing to its low grade it would not be a satisfactory source of supply of fuel for power purposes although it has met with favor when used for domestic purposes.

The state of Washington has available large quantities of coal of a variety of grades. Bituminous coal is mined extensively and is of fair quality. Large deposits are found to the west of the Cascade Mountains, within 50 miles of Puget Sound, so that shipment by water to San Francisco and other California ports can be readily effected Sub-bituminous coal or lignite, is found extensively within a few miles of Puget Sound, but this coal is of very low grade, contains a large amount of moisture and volatile matter, and disintegrates when exposed to the air so that it cannot be transported without losing much of its heating value.

TABLE 2 COAL RESOURCES OF PACIFIC-COAST AND NEIGHBORING STATES

	Area, Sq. Miles		Estimate of Original Amount of Coal in Million Metric Tons	
	Known coal fields	Possible coal fields	Low-grade lignite or sub-bituminous	Fair-grade bituminous
California	10	30	15	25
Oregon	90	140	907	....
Washington	1800	....	47588	10355
Idaho	230	1000	90	544
Nevada	....	....	....	....
Utah	3646	....	141	3630
Arizona	3610	....	12832	9
New Mexico	13220	....	156903	17173

Nearly 80 per cent of the coal now used in California comes from Utah, which state has a large supply of a fairly good grade of bituminous coal running from 12,500 to 13,000 B.t.u. per lb. However, owing to the distance and the high freight rate for rail transportation, amounting at present to over $7 per ton, this can never be a cheap coal on the Pacific Coast. In 1918 the total quantity of coal consumed in California amounted to 830,368 tons, of which 653,766 tons or nearly 80 per cent came from Utah.

New Mexico has abundant reserves of coal. Some of this coal now finds its way into California, but as it is a poorer grade than the Utah coal and must absorb as high a freight rate, it is not likely to become a serious factor in the fuel supply for California.

Practically no coal is now mined in Arizona, Nevada or Idaho. The coal fields of Arizona are located in the eastern part of the state and are at present inaccessible. The coal is of poor quality, having ash content in some cases as high as 50 per cent, and while it may eventually prove of value for local use it is not worth shipping to the coast. Nevada has only one known coal field, of small extent located in the central part of the state. Idaho contains three known coal fields, but the seams are thin, the coal is of an inferior quality and little development work has been done.

The most promising supply of high-grade coal for the Pacific Coast is in the territory of Alaska. The Pacific Coast section, which is in the southern part of the territory bordering on the Gulf of Alaska, contains 458 square miles of known coal fields and over 8000 square miles of possible coal fields. The coal available is of all characters, from low-grade lignite to the highest grade semi-bituminous and anthracite. An estimate of the quantity available is given in Table 3.

TABLE 3 COAL AVAILABLE IN THE PACIFIC COAST SECTION OF ALASKA

	Estimated amount of coal, million metric tons
Lignite	1971
Sub-bituminous	485
Bituminous	2
Semi-bituminous	1293
Anthracite	1931
Total	5682

The best grade of coal for steaming purposes is found in the Matanuska field, which is not far from the coast and through which the recently completed Government railroad passes. No coal has as yet been exported from Alaska, but it is probable that this will eventually become one of the main sources of coal for the Pacific Coast, especially for such purposes as require the higher grades of coal.

Turning now to the possibility of importing coal from foreign countries, we find that the nearest foreign coal available is that on Vancouver Island. Much of this coal has been imported into California in the past from the well-known Wellington Mine. This is a fair grade of bituminous coal running from 12,500 to 13,000 B.t.u. The quantity of coal available is estimated at 5,191,000,000 tons. Large reserves of coal are also found on the mainland of British Columbia.

Turning to South America, we find a good grade of bituminous coal located in Chile. This coal is near the coast and could readily be shipped. There is also in Chile some anthracite coal of excellent quality. The quantity of coal available is estimated at 2,000,000,000 tons. The best coal is found in the neighborhood of Santa Maria Island and contains only 4 or 5 per cent of moisture and from 2 to 11 per cent of ash. It burns with a long, smoky flame and contains over 13,000 B.t.u. per lb.

In Peru there is also an abundant supply of coal, although very little is mined at the present time. The reserve is estimated at 1000 million tons of commercial coal.

With the present development of commerce with the countries so far considered, if large importations of coal were made there would be no return cargo for the ships carrying it. In other words, unless commerce can be developed to such a point as to bring about a considerable export trade from California to Chile or Alaska, as the case may be, the cost of transportation of coal would be doubled by the necessity of sending the ships back in ballast. It is thus evident that the question of future coal supply for California is intimately associated with the development of California's export trade. This leads us to consider the possibility of importing coal from countries at greater distance, with which trade is most likely to develop. Previous to the development of the California oil industry coal was imported from Australia, Japan, England, Wales and Scotland, as well as from British Columbia.

Some of the world's greatest coal deposits are found in China. It is estimated that China contains 999,000 million tons of high-grade coal, amounting to about one-fifth of the world's total supply. Half of the coal supply is supposed to be anthracite. Some of the coal fields are located fairly near the coast, so that with the cheap labor available in China for mining it would be possible to ship the coal at a low price.

To sum up, while the exhaustion of our oil fields will deprive us of a native fuel, there is no cause for alarm. Domestic coal can be secured from Washington and from Alaska, where there is a supply sufficient to last us for hundreds of years. Besides this, our ports are open to the commerce of the world. The demand for coal will assist our trade by providing a return cargo for our ships, and the greater our export trade, the easier it will be to secure an adequate supply of coal.

THE RAILWAY FUEL PROBLEM OF THE PACIFIC COAST

By J. C. MARTIN, JR.,[1] SAN FRANCISCO, CAL.

INASMUCH as fuel represents the second greatest item of the operating cost of a railroad, its importance cannot be underestimated. In order to have a clear understanding of the amount of steam fuel annually used by the Pacific Coast railroads, it is first necessary to know to a reasonable degree of certainty the quantity that must be provided and how its transportation can most expeditiously be arranged for to meet the demands of service.

In the states of Washington, Oregon, California, Nevada and Arizona there are now 4002 locomotives. Figuring that under normal operating conditions the modern locomotive consumes daily an average of 10 tons of coal, and that 90 per cent of the locomotives are used daily, in order not to underestimate the amount of fuel required, we find that the total fuel consumption per year is 13,146,570 tons. Considering the average B.t.u. content of the coal used as 12,500 per lb. and that 4 bbl. of fuel oil (42 gal. per bbl.) of 18,500 B.t.u. per lb. is equal to one ton of this coal, we have an equivalent of 52,586,280 bbl. of fuel oil required annually.

With this information in hand and considering that any hydroelectric development which would effect steam railroads by putting into use electrical units on certain divisions instead of steam-operated locomotive units would, in the development of our Pacific

---

[1] J. C. Martin & Co., Mem. Am.Soc.M.E.

Coast section during the next twenty years, call for further steam locomotives, to the extent that the total number of locomotive steam units will be substantially the same as today, it is then necessary to determine where the segregation of fuel oil and coal can best be made to serve the respective state mentioned from an economic point as well as a conservation of supply for the next twenty years.

Of first consequence is the matter of securing an adequate supply to meet the demands of service, for obviously without fuel operation ceases; and secondly, to lay down the most economical fuel to use in that particular state or territory in which the locomotives are operating, the kind of fuel used being governed very greatly by the transportation costs plus the fuel costs overlapping the equivalent B.t.u. value of the coal or fuel oil.

It is extremely difficult to assume what the future has in store in the way of railroad-locomotive fuel oil, as predictions in the past have been so materially upset through the development of new oil fields of consequence even in the past two years, which today have a direct bearing on the fuel-oil situation in California and the Pacific Coast, that the best we can say at this time is that, in view of reliable statistical information readily obtainable on the coal supply, there is sufficient fuel oil and coal directly within or immediately adjacent to the states of Washington, Oregon, California, Nevada and Arizona for the next twenty years, if properly segregated, conserved and restricted to the districts in which it should be economically used. This leaves fuel oil for railroad use entirely within the state of California, should the present processes now in the state of perfection, involving improved methods of cracking and refining, materially reduce the amount of fuel oil over that at present being produced to such an extent that no shipment out of California to other adjacent states could be made without detracting from California railroad requirements. It is quite true that it is within the possibility of cracking processes to materially increase the output of the lighter fractions in the crude so as to leave only a relatively small fraction of fuel oil, yet there is a question just how far practically this will go, as no means or system has yet been devised to properly handle in the locomotive firebox, for combustion purposes, or in fact the combustion chamber of any furnace, the so-called pitch or coke which is the final issue of the ultimate cracking process. This pitch has given considerable concern in firing owing to its adhesive nature.

Again, we find that the production of California crude oil has materially increased in 1921 over 1920, the total production in 1921 being 114,849,924 bbl. which exceeds the 1920 production by 9,128,738 bbl., and that the total crude oil stocks on December 31, 1921, were 35,021,912 bbl. as against 22,240,271 on December 31, 1920. The storage increase during the year being 12,781,641 bbl. and the daily gain 35,018 bbl.

At the present point it is illuminating to call attention to the report of the Fuel Committee of 1917, appointed by Governor Stephens to investigate the consumption of fuel oil. That part of the Committee's report and findings in reference to the consumption of fuel oil keeping pace with the production is herewith set out:

> The consumption in 1916 outran production an average of 1,100,000 barrels per month and 35,650 barrels per day.
>
> During the first five months of 1917, consumption outran production 5,415,000 barrels, being 1,083,000 barrels per month and 35,860 barrels per day.
>
> Consumers of California petroleum will shortly face a condition of decreasing production and increasing demand. This condition points inevitably to the necessity of developing other sources of fuel or power.

There is no question but what this committee used extreme care and handled the situation in a masterful manner at that time, but as previously stated, it will always be extremely difficult to determine, with any degree of certainty, just what the future sets forth in the way of fuel-oil supply and this is no better evidenced than by the Standard Oil Company's report of 1921, which shows that the production of crude is now 35,018 barrels per day ahead of the consumption, whereas in 1917, production of crude was 35,860 barrels below consumption.

At the outset the logical thing to do is to use the kind of fuel best and most economically obtainable in sufficient supply in that particular state of our Pacific slope where it is best found. As long as fuel oil is produced in California in sufficient quantity to ship to other adjacent states for railroad use, it is the ideal locomotive fuel for the railroads of such states to buy, provided suitable contracts to give them a reasonable assurance of at least three years' time can be entered into, and even on the basis that transportation costs on a relative B.t.u. basis of oil vs. coal show coal to be equal in price to fuel oil. This latter statement requires an explanation in that the modern fuel-oil-fired steam locomotive is conservatively 10 per cent more efficient than the same locomotive coal-fired either by hand or automatic stoker. The stoker as applied on the locomotive does not show the same degree of efficiency as compared to oil firing as does the automatic stoker applied to land-fired boiler furnaces shows to oil firing. It is the ability to maintain a practically constant boiler pressure in the modern oil-fired locomotive within 5 lb. of the pressure for which the pop valves are set that brings about this increased efficiency, whereas it is impossible to do so in meeting the maximum demands of service with the hand firing of coal or by stoker firing, which latter simply accomplishes what man cannot do physically, but without any greater efficiency in fuel saving.

Again, the ability to increase the steaming radius of the oil-burning locomotive over the coal-fired engine, whether hand- or stoker-fired, is greatly in favor of the use of oil, it being possible, for example, on the Southern Pacific System in California to operate an oil-burning locomotive a distance of 537 miles in passenger service from Sparks to Ogden without taking oil, this being over two passenger divisions, whereas it would not be possible through the use of coal with the accompanying necessity of cleaning fires to operate these engines coal-fired over more than one division.

From an operating point of view, this makes available power in oil-burning locomotives not possible to obtain in coal-fired engines, and it is a generally accepted fact in operating that for every ten oil-burning engines fitted there is the equivalent of one extra engine available for service over coal-fired engines.

From the foregoing it would therefore seem that, as far as it is within our knowledge to know at this time, we have ample fuel in the Pacific states to meet the present demands, if proper judgment and regard are used in their distribution, and probably so for a period of twenty years to come.

In conclusion, we can justly expect that in view of the great economy of fuel in locomotive fireboxes and its ability to increase the steaming radius of the locomotive, as it were, making available the maximum operatable locomotive power for the hauling of tonnage, that oil fuel will have precedence in railroad use over any other land-fired uses, should, for any reason, steps in the direction of conservation be required to be taken on account of declining production.

THE MARINE FUEL PROBLEM OF THE PACIFIC COAST

By D. Dorward, Jr.,[1] San Francisco, Cal.

In the operation of the American Merchant Marine there is no one problem more vitally important than the question of fuel, it being the dominant factor attending steamship operation and the largest single item of cost entering into the operating schedule of a vessel.

The greater part of the fleet of vessels now operating from Pacific Coast ports of the United States use oil as fuel, and with the exception of Australian and Japanese bunkering ports, coal supplies for replenishing bunkering stations are brought from very distant points of origin and therefore the cost of bunker coal at foreign stations, and even at Pacific Coast ports, is very high—so much so that even at the present prices ruling for fuel oil the oil-fired vessel is the most cheaply operated from a fuel standpoint.

Fuel oil as a source of power is today receiving the closest attention by maritime interests, for the world's merchant shipping is now rapidly being converted to fuel oil. The advantages derived from liquid fuel instead of coal are so important, particularly in facilitating bunkering and increasing the steaming radius and conservation of labor on shipboard, that it will undoubtedly tend to rapidly increase the use of oil as fuel, particularly in view of the highly competitive situation developing between the merchant marine of Great Britain and the United States.

---

[1] Consulting Engineer. Mem. Am.Soc.M.E.

Statistics show that at the beginning of 1920 the world's merchant shipping approximated 55,000,000 tons, of which tonnage approximately 9,000,000 tons was already on an oil-burning basis and of which proportion approximately 1,000,000 tons was fitted for Diesel-engine drive. This amount of shipping fully employed would occasion a demand for fuel oil annually of approximately 90,000,000 bbl. In 1918-1919, 12 per cent of the total world's tonnage was fitted to use oil, while in 1920 it had increased to 18 per cent.

The change from coal to oil has been occasioned by two conditions: The conversion of coal-burning vessels to an oil-burning basis and the construction of motor- or Diesel-engine-driven vessels. The adoption of the internal-combustion or Diesel type of propulsive equipment is just beginning to assume important proportions in the United States; but in Great Britain and on the continent of Europe this phase of the development has been and is making rapid strides.

The motor-equipped ship has unquestionably a strong advantage in point of economy over oil-fired steam-equipped vessels; but it is expected that the change from coal to oil as applying on the world's shipping will be greater through the intermediate stage of oil-fired steam vessels, which it is expected will create a requirement of at least 10,000,000 bbl. of fuel oil for each million tons of shipping using oil as fuel. Practically all of the vessels in operation by the United States Shipping Board and under private American ownership are substantially on an oil-burning basis, there being 49.4 per cent of these ships exclusively oil burners, 23.3 per cent coal burners, and 27.3 per cent convertible to burn either coal or oil.

In 1920 the fuel-oil requirements of the United States Shipping Board were in excess of 30,000,000 bbl., and while this demand was somewhat curtailed during the industrial depression of 1920–1921, it is expected, however, that the resumption of international trade will not only revive but intensify the fuel requirements of the merchant-marine fleet.

The navies of the world are largely on an oil-burning basis, for the advantages of oil over coal for naval operations are of the utmost importance and undeniably make for greater efficiency. While the naval demand for fuel oil is small in comparison with that required by the merchant marine shipping, there are, however, about five million barrels required annually for the American Navy.

It is now more than evident that oil for merchant-marine transportation has assumed a standing of the utmost importance and it has been conceded by well-known authorities that the strength of this demand is such that if necessary it can and will divert from industrial purposes the quantity required for shipping interests. At any rate, the significance of oil in maritime matters explains to a considerable extent the present world-wide interest that has been shown in oil. Particularly Great Britain has, by her policy in acquiring foreign reservations of petroleum, indicated beyond question the great advantage of fuel oil for naval operations and ocean transportation, and which factors have in addition been the source of much activity in the United States.

In the use of fuel oil on board vessels there are many economical features involved which would make the continuance of the use of oil as a fuel for maritime purposes of the greatest importance, and which are briefly summarized as follows:

More economical operation
Reduced crew
Greater cargo capacity of the vessel on account of its ability to carry oil in compartments not otherwise available for cargo, such as double bottoms, peak tanks, etc.
Ability of vessel's propulsive equipment to render more continuous service, steady steaming and uniform speed, thereby tending for more efficient operation
Lessened wear and tear on vessel's equipment, machinery, boilers, and reduced cost of upkeep
Less frequent painting
Preserving effect of oil on vessel's double bottom, it being rarely necessary to undertake the most expensive item of renewing tank tops in oil-burning vessels.

On large passenger vessels fitted for oil fuel it has been noted that an enormous saving in operating costs has been effected on account of lessened wear and tear on such items as carpets, draperies and cabin equipment.

The great problem confronting steamship operators today is the question as to whether the world's supply of petroleum is sufficient to sustain automotive transportation on land, industrial power plants, lubrication requirements of industry, and whether the supply will support the great change in the conversion of ocean shipping to an oil-burning basis.

Were the 55,000,000 tons of world's ocean shipping converted to an oil-burning basis, it would require an annual consumption of over 500,000,000 bbl. of oil, which represents nearly the total quantity of petroleum produced in the world today. While this consumption could, of course, be somewhat reduced by a more universal adoption of Diesel engines, it would, nevertheless, be of huge proportions.

Utilization of oil by ocean shipping, however, is today governed largely by the matter of price; and upon the production of the world's most extensive deposits being exhausted it is possible that some reduction may be forced in the amount of fuel oil used for maritime purposes. This possibility seems to have been lost sight of under the present competitive conditions existing and on account of the great advantages offered by the use of fuel oil at the present price level. Regardless of the future of fuel oil, the fact remains that it is now definitely involved in competitive shipping efforts and its use is fully expected to grow for a considerable period at least.

Powdered coal is still in an experimental stage and it is questionable if its use on board vessels could be attended with any degree of success. It is expected, however, that the development of automatic stokers for use on shipboard will aid materially in the continued use of coal for marine purposes.

The consumers of petroleum oil are now facing a condition of decreasing production and increasing demand, which condition points inevitably to the necessity of developing other sources of fuel for power.

Hydroelectric plants can aid materially in the conservation of fuel oil in the power they produce, but industrial plants, railroads, and similar institutions will eventually have to find other sources of power than that developed by fuel oil, in order to supply the increasing demand for marine purposes, although of the substitute fuels coal will undoubtedly occupy the chief position.

Even at this stage it is significant that coal is now being brought from Australian ports in American vessels using oil as fuel; and large steamship companies having many vessels usually confine that portion of their fleet operating in Pacific Coast waters to those vessels fitted for oil burning.

Approximately 60 per cent of the crude oil produced in California is refined, at least in part, before being utilized. The increased demand for gasoline and lubricants and the rapid strides in refinery efficiency are resulting in the refining of a constantly increasing proportion of the oil with a resultant smaller quantity available for fuel purposes. Practically 50 per cent covers oil exports to the Orient from California ports, though these exports are confined mostly to fuel oil to Hawaii, Central America and South America, gasoline and distillate to Australia, and kerosene to the Far East.

The demand for refined oil products is rapidly increasing and will be accelerated by the potential oil shortage in other fields of the United States and by the necessity of using California oils to offset this shortage. To meet this increasing demand, California oil must be used more efficiently and sparingly.

California now produces between one-quarter and one-fifth of the world's supply of petroleum oils and one-third of the United States' supply. Statistics show that to January 1, 1921, the United States had produced 5.4 billion barrels; and subtracting this quantity from the original supply of 11.3 billion barrels as estimated by the U. S. Geological Survey in 1918, would leave as a working reserve only 5.9 billion barrels, with the annual requirements running over half a billion barrels.

Important strides have been made in refinery efficiency, also in number of refineries. The refining capacity of the entire country increased 18 per cent during 1919 and 23 per cent in 1920. This increase in refinery capacity together with greater efficiency will certainly have the effect of reducing the quantity of oil available for fuel.

It is a fact, however, that petroleum cannot be expected to radically displace coal in industry and transportation, since a crude

petroleum production of about three billion barrels per year would be necessary to drive coal from its present position.

For the future, fuel oil will represent a reducing percentage of the crude petroleum produced, for the more specialized uses, such as automotive power, lubricants and chemical by-products are coming into more importance and must be considered in preference to the demand for industrial fuel. However, fuel in liquid or gaseous forms is of such importance and has so many advantages in convenience and efficiency that it may reasonably be expected to continue to supplant solid fuels, which solid fuels must take second place as regards certain industrial uses and marine propulsion.

The output of crude petroleum in the United States is conceded to have virtually reached its maximum, and as the proved fields of Mexico are showing a rapid decline, a marked falling off in imports from that source may be expected.

Cheap supplies of petroleum will soon be a thing of the past; and the answer to the domestic petroleum problem does not lie in importations from foreign sources.

Efficiency in production and utilization and supplemental sources of supply at home must share with foreign supplies the responsibility of sustaining those activities exclusively dependent upon liquid fuel, and of which none are more important than the question of fuel for marine purposes.

CONSERVATION OF THE FUEL SUPPLIES OF THE PACIFIC COAST[1]

BY F. H. SIBLEY,[2] RENO, NEVADA

THE three papers presented have raised so many interesting points for consideration that a discussion of them becomes a somewhat difficult matter of selection. Reviewing the papers, four points stand out prominently:

1 The paramount importance of an adequate supply of fuel of one sort or another (regardless of other sources of power) if industrial activity is to increase or even continue at its present rate.
2 To maintain this supply new sources will probably have to be developed in the not distant future.
3 Conservation of present available supplies must be looked after.
4 If restrictions on the use of fuel oil become necessary because of a diminishing supply, such restriction should not be placed on the use of oil for locomotive and marine service, because of its great convenience as well as efficiency for such service.

The first point mentioned, i.e., the importance of an adequate fuel supply, may well pass without further discussion.

As to the second point, namely, that of developing outside sources of fuel supply, it would be interesting to learn what forces are holding back development in Alaska; whether satisfactory trade relations, tariffs, etc., will be established between Canada and other countries so that fuel can be profitably imported to the Pacific Coast states; whether supplies from Columbia, S. A., said to be one of the greatest potential oil-producing countries in the world will be available in this group of states through the Panama Canal; whether the Philippine Islands, said to contain vast supplies of coal and oil that are only awaiting capital for their exploitation, will serve as a source of supply for the Pacific Coast states; and whether the peninsula of Southern California has ever been extensively explored for fuel deposits.

The third point, conservation, constitutes the great ready-to-hand problem of engineers not only here but in most other parts of the country. There are two main factors, it would appear, in the conservation of our fuel supplies:

(*a*) Prevention of waste and (*b*) increasing the efficiency of power equipment.

Fuel wastes again may be classified under two headings, namely, direct waste and indirect waste.

Few outside the engineering profession and by no means all engineers realize how enormous these wastes are. The Bureau of Mines is authority for the statement that 122,000,000 gal. of gasoline, representing a value of $26,000,000, are wasted annually by evaporation from storage and transportation. It has also been stated that $1,000,000 are lost by fire, due mainly to electrical discharges at storage tanks.

A recent news item stated that 5,000,000,000 cu. ft. of natural gas was wasted from four wells in Texas in a period of a few weeks. Another stated that a 100,000-bbl. well ran wild for twelve days in Mexico. Similar losses are recorded weekly from almost every production center.

These are direct and obvious losses and if we examine into the less obvious wastes of useless activity we find the situation no less disheartening. For example the Bureau of Mines, again informs us that the needless use of passenger cars consumes a million gallons of gasoline a day. Wastes from leaky carburetors, idling motors, etc., amount to half a million more.

When we turn to the question of fuel efficiency in power equipment we see that real progress has been made in the past twenty-five years in that such efficiencies have been nearly doubled, but there is still room for improvement when we consider that of the total production of fuel for power purposes only a pitiful ten or fifteen per cent is transformed into effective work.

Estimates of time that fuel supplies will last are based, rightly enough, on the assumption that losses will continue to increase with consumption or at least will continue at somewhere near the present rate. But will they? And if not, how are we going to prevent it?

The following suggestions are most of them old. Some of them may be visionary. But the visionary things of today often become the realities of tomorrow. At any rate a discussion of them may be worth while, even if they should lead only indirectly to better conditions.

1 Getting a larger proportion of oil from the sand. Lewis of the Bureau of Mines estimates that an average of only 20 per cent of the total petroleum in the ground is recovered by present methods. In Louisiana and presumably in California also are crudes of such low gravity that they can not be removed by pumps at all. Driving off this oil by air or water has not, in the main, been very successful. What about the suggestion to mine the oil sand? The problem apparently presents no difficulties not met with in other forms of mines, and if these sands contain from 50 to 80 per cent of the original oil, mining them would seem to be a better proposition commercially than distilling oil shales.

2 Making greater use of slow sailing ships to transport cargoes not subject to deterioration.

3 Development of artificial fuels, mixtures of alcohol and benzol being an example.

4 More efficient prime movers. The advantages of the Diesel motor for marine service have been pointed out in Mr. Dorward's paper. Compounding it may give even better results. Should it be applied to railway locomotives as well?

5 The substitution of large central stations for small individual plants should, and doubtless will, go forward. The gain from this change is larger even than most people suppose. Small plants where the overall efficiency is probably not more than two or three per cent are still all too common.

6 More scientific study of storage and other field conditions both in coal- and oil-producing districts should be made. Problems like proper painting and roofing of oil tanks to prevent evaporation losses and fire losses due to electrical discharges need more systematic study.

7 Finally as to indirect wastes due to careless or useless activities. Here is where our economic education comes in. Will people in time become wise enough to realize the wickedness of using a 60-hp. automobile for pleasure purposes when 25-hp. might do as well? Will those who have no special business abroad learn to amuse themselves at home? Shall we ever learn to stop taxing ourselves for hauling thousands of tons of worthless literature and other junk in the mails?

While this is taking rather high ground, these are some of the things we must learn if we are to keep up the present rate of industrial progress and provide for all *worth-while* activities, without exhausting our supplies of fuel before we have learned perhaps better and cleaner methods of producing power.

---

[1] Introduction to the discussion of the preceding papers by Messrs. Delany, Dorward and Martin.

[2] Dean of the College of Engineering, University of Nevada. Mem. Am. Soc. M.E.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AIR MACHINERY

Efficiency of Single-Blow Pneumatic Hammers

Single-Blow Pneumatic Forging Hammers, W. H. Snow. The author starts with a general discussion of factors affecting the efficiency of self-contained pneumatic hammers and gives diagrams to explain the relation between the movements of the pump and hammer pistons.

The single-blow hammer described in the present article is based on the idea that with the valve designed so that more use can be made of the pump as a compressor and air can be led into the hammer cylinder, above as well as below the piston, there exist the elements of a control of the up-and-down movements analogous to that obtaining in the ordinary double-acting steam or air hammer.

The simplest design of such a valve is shown in Fig. 1. If the valve be moved from the hold-up to the hold-down position a single blow will be struck. Air compressed under the pump piston passes through the one-way valve *B* into the belt *D*, and by a passage not shown to the top of the hammer cylinder. The air below the hammer piston is exhausted through passages *C* in the tube and openings *C′* in the valve. This arrangement, however, is not as efficient as it might be. The blows will not be very powerful as compared with the pump pressure, and furthermore they can be produced only comparatively slowly.

Because of this another design shown in the original article has been worked out. In this both ends of the cylinder are brought into use and the pump works as a double-acting compressor.

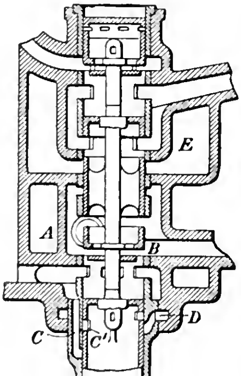


Fig. 1 Operating Valve of Single-Blow Pneumatic Forging Hammer

The governing is effected by a special rapid-acting unloading valve, which opens a by-pass *F* when the maximum pressure is reached. Finally, storage of the compressed air is arranged for in a reservoir formed in the cylinder-casting (which can, if necessary, be connected to an outside receiver to increase the storage).

The single-blow, hand-controlled, independent action in this case, where heavy blows can be struck at about one-third the rate of the automatic blow, becomes a real improvement, particularly in the larger sizes of hammers, enabling the miscellaneous processes of flattening, straightening, edging, setting, cutting off, stamping, etc., to be carried out with precision, speed, and safety. The order of events in the operation of the hammer, beginning with the valve lever in the raised position, is: (1) hold up; (2) hand blow (and hold down); (3) not working (hammer at rest, pump by-passed); (4) light automatic blows; (5) heavy automatic blows.

The heaviest blow than can be struck depends on the size of the reservoir, the pump displacement during the short time the hammer is falling being too small to affect the pressure. With a small reservoir the expansion will be considerable and the mean pressure and force of blow will diminish. The efficiency improves with increased expansion, but on the other hand the charging up of the reservoir ready for a second blow proceeds from a low pressure, and the work the pump can do in a given time is less than with a larger reservoir and smaller range of pressure. The best results are obtained with the latter, enabling the pump and motor to work up to their maximum capacity; but if the reservoir is too large, the time taken to charge up after a period of automatic working, during which the reservoir pressure may have run down, may be inconveniently long. Fig. 2 shows the results obtained with different reservoir capacities, ab and ab_1 being reservoirs of volumes 1 and 2, respectively, while cd is the hammer-piston displacement. The efficiency for ab (ignoring compressor and clearance losses) $= \frac{acdg}{acd_1g}$ and for $ab_1 = \frac{acdh}{aceh}$. Suppose $cd = ab$ and pressure = 30 lb. per sq. in. (gage). Then efficiency (1) = 90 per cent and (2) = 78 per cent. The work obtained is given by the numerator. The work done in recharging is $aec - c_2cc_1$ and $afc - c_3ec$, respectively. The ratio of work obtained in the two cases is 1:1.30, and of work done, 1:1.50. More work to the extent of 50 per cent can be done in the air with the larger reservoir. The work obtained is 30 per cent greater, the efficiency being less.

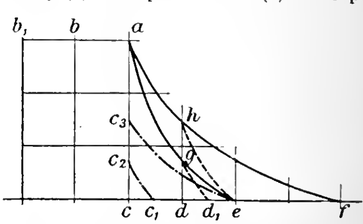


Fig. 2 Diagram Showing Hammer Results Obtained with Different Reservoir Capacities

While some hammers constructed on these lines have given satisfactory results over a considerable period, there are certain objections to the design, such as the extra first cost. Also, a single mishap, such as the failure of a valve or spring, may lead to unsatisfactory performance of the hammer through possibility of wrong assembling, and this latter might easily take place where the control valve and other parts are assembled by men accustomed to deal only with the ordinary plain equipment of a forge. An analysis of conditions therefore leads the author to take a rather gloomy view of the possibilities of single-blow pneumatic forging hammers. (*Engineering*, vol. 114, no. 2952, July 28, 1922, pp. 98 to 109, illustrated, *d*)

ENGINEERING MATERIALS (See also Machine Tools, Testing and Measurements, and Welding)

Lecfurite—High-Resistance Alloy. Brief and incomplete data on a alloy developed by an English company for use in place of such materials as nichrome.

The melting point of the material is said to be approximately 1550 deg. cent. (2822 deg. fahr.), tensile strength, 42.26 tons; elongation, 27.5 per cent; reduction of area, 68 per cent; and Brinell hardness, 187. The material can be welded, rolled, drawn, or stamped, and resists the action of most acids and alkalies. No data as to its composition are given. (*Machinery* (London), vol. 20, no. 511, July 13, 1922, p. 552, *d*)

FOUNDRY

Making High-Grade Castings Direct from the Ore, F. H. Bell. Description of a process experimentally used at the Ford Motor Works. The process has not yet been carried out to the stage where it can be called successful, but it is said that it is by no means a failure.

In this process (used at the River Rouge branch) the metal is obtained direct from a blast furnace of a construction somewhat different from that of the usual type. Different grades of ore are mixed with the view to getting the required chemical content. As ore is never uniform, every batch has to be analyzed to make sure

that it is right. The least error in charging a furnace may make a big difference in the resultant metal.

From the furnace the iron is poured into a big container, in which the metal is held while the chemist is making his calculations. This container is built on the principle of a thermos bottle, Fig. 3. It consists of one shell within another with an airtight space between, the inner one being lined with firebrick. At one end is a tap hole near the bottom, while at the other end and on the top is an opening into which the metal is poured from a 75-ton ladle.

A certain number of cupolas are always in operation melting scrap from former heats, pig iron and such special metal including steel scrap as it may be desired to mix with the furnace iron to bring it to proper analysis. The analysis of this cupola metal is fairly well known in advance and the additions are determined on the basis of the analysis in the thermos-bottle container.

The metal which is very hot when put in the container will remain hot for as long as five hours. Casting direct from the ore, therefore, does not differ essentially from the ordinary processes, except that it represents a very large outlay of money and could not be applied to a foundry of ordinary size. (*Canadian Foundryman and Metal Industry News*, vol. 13, no. 7, July, 1922, pp. 17–18, 2 figs., d)

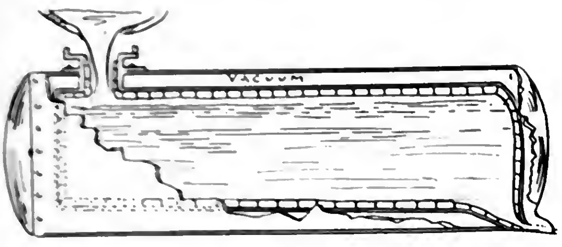


Fig. 3 Sectional View of Mixer Used by the Ford Motor Co. in Making Castings Direct from the Ore

FORGING (See Air Machinery)

FOUNDRY

Gearing and Ladle Operation. Analysis of the performance of various types of gearing as affecting ease in handling and safety of ladle operation.

The conditions of operation of gearing on ladles are rather strenuous. With most styles of geared ladles the expansion and contraction affect the alignment of the gearing. In many foundries the lubrication of ladle, gears, and trunnions receives little attention and this results in excessive wear and trouble. Unless gears, cups, and oil holes are located so that the lubricant gets to the bearings and gears in sufficient quantity, the ladle gearing will suffer, no matter how much care is exercised.

When lost motion is present in the gearing, a dangerous drop of the ladle occurs during pouring, caused by the flow of the metal. This usually results in a splash of molten metal, which may cause serious injury to the men around.

On the other hand, if the gears are too tight and bind, pouring becomes difficult and may lead to cold shuts and misrun castings.

The oldest type of gearing applied to a ladle was the worm, and it is still quite extensively used. Spur-geared ladles appeared in this country about 30 years ago in pipe foundries where a ladle operating faster than worm gearing permitted was desired. The most recent type is the helical form, which is said to be more efficient than either of the two older types. In this the housing is mounted on the trunnion and has no attachment to the bail except through a sliding support. This makes the tilting mechanism an independent unit, with the result that the alignment of the gears is not affected by the distortion of bail or bowl or by wear on the trunnion journals. In addition to this the gear is self-locking, requires little power to operate, and permits a wide range of tipping speeds.

The location of the trunnion is important, as shown by deductions from curves in the original article giving the turning moments of a 10-ton ladle at various angles. From these it appears that moving the trunnion 1 in. upward or downward changes very materially the moment required to tip or right the ladle.

The original article shows also how to calculate the force required on the handwheel for operating a given ladle. (Paper presented at the Rochester meeting (June 5–9, 1922) of the American Foundrymen's Association, abstracted through *The Foundry*, vol. 50, no. 16, Aug. 15, 1922, pp. 682–684, p)

FUELS AND FIRING

Colloidal Fuel, Lindon W. Bates. A description of the manufacture and some of the uses of colloidal fuel.

Colloidal fuel is a mixture containing pulverized coal or coke stably suspended in mineral oil or a blend of oil and liquid derivatives of coal.

To prevent settling out of the coal a stabilizing treatment is given. For this the following may be used singly or in combination. In the first place, the solid fuel may be ground to a fine state of subdivision, which is, however, a somewhat costly method. Next comes saponification, which may be accomplished by adding to the oil a soap such as a lime-rosin soap, thereby "fixating" it. About one per cent of rosin and one-half per cent of lime will serve.

Resinate of calcium gives the most persistent stability. Peptization may also be used. This is obtained by digesting bituminous coal with a moderate percentage of creosote or other coal distillate under a heat treatment of 180 deg. fahr. for over an hour.

The plant necessary for the production of colloidal fuel is described in general terms in the original article and is said to be comparatively simple. The original article presents a general discussion of the prospective field for colloidal fuel and data of some of the tests, from which it would appear that colloidal fuel is suitable for marine use under practically the same conditions and with as good results as Navy oil. Certain grades of colloidal fuel were submitted for a rating to the U. S. Fire Underwriters' laboratories and have been in general approved by them, as it was found that they present no objectionable characteristics for use as a fuel for ordinary burning purposes as compared with ordinary fuel oil.

The flash point was found to be very much higher than usual for fuel oils. The apparent ignition temperature is likewise relatively high and the material shows no tendency toward spontaneous ignition.

The application of colloidal fuel to railroad purposes is discussed in some detail. (*Steam*, vol. 30, no. 2, August, 1922, pp. 41 to 44, *dg*)

Airspray for Boiler Furnaces

Air Spraying the Fuel. Description of an appliance for supplying air to the fuel bed in a manner believed to insure complete combustion.

The Airspray, as the device is called, comprises an air-inlet pipe fitted with a special silencing device. This pipe is carried from above the boiler to the top of the furnace front and here joins a specially constructed air-heating pipe made to stand high temperatures. This air-heating pipe is passed through the furnace front and is carried almost in contact with the furnace crown to a high-temperature air chamber built of firebrick within the combustion chamber.

The bottom of this chamber, Fig. 4, is formed by a special spraying plate. An air-balancing forked sprayer is fitted to the furnace-front end of the high-temperature air pipe and is controlled by a small valve.

The amount of air entering the air-inlet pipe is regulated by the steam coming from the air-balancing forked sprayer. The air is raised to a very high degree of temperature as it passes over the furnace through the heating pipe, when it is discharged through the open shaft into the hot-air chamber, and thence through the perforated plate in a fine spray, combining with the unburned gases generated in the furnace. It is claimed that by this method the unburned gases are consumed immediately after they have passed over the furnace bridge and before they have passed through the combustion chamber.

It is of course possible to overdilute the gases. This is said to be taken care of by the air-balancing device. It is also claimed that

the device makes combustion smokeless. Of course, if carbon particles contained in the otherwise unburned gases are consumed within the combustion chamber instead of passing through the flues into the atmosphere, smokeless combustion must result. (*Practical Engineer*, vol. 66, no. 1848, July 27, 1922, pp. 52 and 53, 2 figs., *d*)

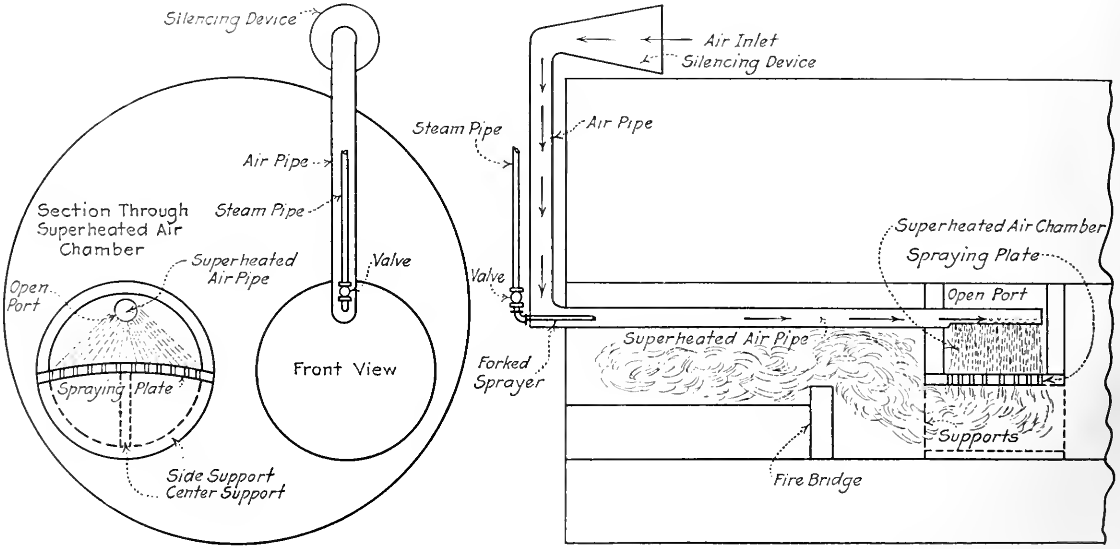


Fig. 4 Airspray Fitted to a Lancashire Boiler

GLASS MANUFACTURE

Balanced-Toggle Mechanism for Pressing Glassware

Balanced-Toggle Mechanism for Pressing Glassware. In the manufacture of pressed glassware with automatic machinery a good deal of trouble has been experienced due to the inability of the ordinary automatic press to distinguish between an over- and an under-weight charge of glass in the mold, and to apply automatically pressure of the proper degree. To meet this condition the compound balanced-toggle principle has been employed in automatic glass presses by William J. Miller, and it is said that the balanced toggle is capable of applying the correct degree of pressure to the glass, be it cut under or over weight.

As the same principle may be applicable in other lines of manufacture, some data are reproduced here.

Fig. 5 illustrates at a glance the principle of the toggle. The curved line shows how the pressure mounts and the speed decreases as the plunger advances on its working stroke, and vice versa on its idle stroke. The piston area being 78.54 sq. in. and the effective air pressure 39.5 lb., by neglecting friction the piston delivers to the toggle 3000 in-lb. for the first inch period of piston travel, and as the plunger is caused to travel 2.3 in. per inch of piston travel, it is evident that the pressure applied to the plunger is 3000 divided by 2.3, or 1315 lb. The last inch of piston travel results in only 0.03 in. travel of the plunger, therefore 3000 divided by 0.03 equals 100,000 lb. average pressure on plunger during the last inch of piston travel. This is the maximum pressure. If more glass be deposited in the mold, so the plunger can penetrate only to within 0.01 of its maximum, the total plunger pressure will be reduced $66\frac{2}{3}$ per cent or to 33,333 lb. Add enough glass so the plunger penetrates only to within 0.13 of its maximum, then the total plunger pressure will be still further reduced to 13,636 lb. Therefore as more glass is deposited in the mold, the plunger cannot penetrate so deep and consequently less pressure is applied.

By following the curve on the diagram it will be observed that, as the plunger advances into the mold, its speed of travel decreases and its power increases. Experience tells one that as the plunger advances into the glass, to propel it, due to the decreased fluidity of the glass and to the gradually decreasing space between plunger and mold wall through which the glass must be forced, an enormous pressure is required.

This peculiarity is also taken advantage of to provide a quick, reliable and simple adjustment of maximum pressure applied to the plunger. The toggle mechanism and press cylinder are suspended from the top girder of the machine by a screw secured to the top cylinder head, and this screw is provided with adjustment nuts above and below the top girder, thereby adjustably securing and locking the entire pressing mechanism at any desired height.

To reduce the pressure from its maximum of 100,000 lb. as shown in Fig. 5*e* to 33,333 lb., the operator simply lowers the pressing mechanism approximately 0.04 in. If only 7500 lb. pressure is required, the pressing mechanism is lowered so the toggles assume the position shown in Fig. 5*d*. If adjusted as in Fig. 5*c*, but 2803 lb. are applied to the plunger, and at the beginning of its stroke, Fig. 5*b*, but 1315 lb. are applied to the plunger.

It would require a monstrous cylinder with a $56\frac{1}{2}$-in. bore, supplied with an enormous amount of compressed air at 40 lb. per sq. in. pressure, to deliver the same degree of power to the plunger that is obtained with a 10-in. cylinder transmitting its power through this toggle at its maximum.

The area of a 10-in.-bore cylinder is 78 sq. in. and the area of a $56\frac{1}{2}$-in. cylinder is 2500 sq. in. Therefore, the direct-acting press will require ($2500 \div 78 =$) 32 times as much air as the toggle press at its maximum.

At the other extreme of the toggle which is at the beginning of the plunger's descent, the power applied to the plunger is over (1315 lb. $\div$ 40 =) 33 sq. in. in area, which is the area of a $6\frac{1}{2}$-in.-bore cylinder. In other words, the plunger starts down with a power equal to that of a $6\frac{1}{2}$-in.-bore direct-acting cylinder and terminates with a power equal to that of a $56\frac{1}{2}$-in.-bore direct-acting cylinder. Between these two extremes the increase of power is gradual.

No system of springs, cushions, air-control valves, etc., however ingenious and complicated, can perform the functions possessed by this correctly designed and simple compound balanced-toggle pressing mechanism. The simplicity, convenience, and freedom from breakdowns appeal to the practical glass man.

For making of high-grade pressed ware requiring a great amount of pressure correctly applied, the toggle is practically indispensable. It required years to develop this toggle to its present degree of perfection according to the statement and data presented in the original article. (*The Glass Worker*, vol. 41, no. 43, July 22, 1922, pp. 11, 29 and 30, *d*)

HYDRAULIC ENGINEERING

The California Pipe Method of Water Measurement, Blake R. VanLeer. The method described is intended for use by the man on the job who has only ordinary tools at his disposal, such as the irrigation farmer or the man operating trench pumps. It is applicable only where the discharge of the water is not submerged or under pressure

The necessary apparatus is very simple and consists only of a tee (same size as the discharge pipe), nipples, a spirit level, and a 2-ft. carpenter's rule

The California pipe method of water measurement is based upon the principle that if water is delivered to a short pipe nipple with a zero or at least a very small velocity head, then for the same size of pipe and the same quantity the depth of water in the pipe will always be the same

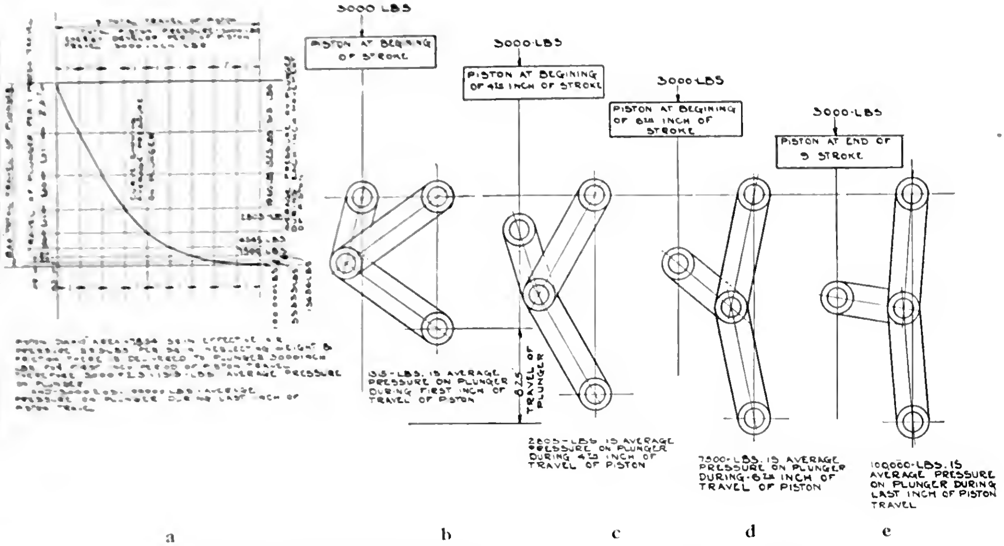


Fig. 5 Miller Compound Balanced Toggle as Applied to Pressing Glassware

In the Hydraulic Laboratory of the University of California the following general formula was derived:

$$Q = K\ (D - a)^{1.55}$$

(See Report on the Measurement of Water Discharged from a Short Horizontal Pipe, a thesis by Ejnar Smith and Clarence A. Pollard, submitted in partial satisfaction of the requirements for the degree of B.S. in Mechanical Engineering at the University of California, May, 1921.) In this formula—

Q = quantity in second-feet
K = a constant depending upon the diameter of the pipe
$= 0.0116 + 0.00787\ D$ in this general case
D = diameter of the pipe in inches
a = distance in inches from the upper inside surface of the pipe to the surface of the flowing water, measured in the plane of the discharge end of the pipe.

The formula has been checked by experimentation with pipe up to 6 in. in diameter and has been found to be quite accurate. The error was at all times less than 5 per cent.

The original article describes the apparatus and gives two sets of curves from which Q may be obtained directly from experimental data without the use of logarithms or a slide rule. One set of the curves gives $(D - a)$ plotted as abscissas on logarithmic paper against Q (quantity in second-feet) as ordinates. The other set of curves gives the relation betwen the distance a and the quantity Q in second-feet, thus avoiding the use of logarithmic paper. Finally, the original article gives tables that make the use of charts unnecessary. The original article also describes in detail the method of setting up the measuring apparatus, which is quite simple, however. (*Engineering News-Record*, vol. 89, no. 5, August 3, 1922, pp. 190–192, 3 figs., *p*)

HYDRAULIC MACHINERY (See Shipbuilding)

INTERNAL-COMBUSTION ENGINEERING

Description of Diesel-Type Engine of Unconventional Design. The engine consists of an open-ended cylinder, or rather two cylinders bolted together in the middle. Though operating together, these two cylinders are to a certain extent independent in action. Moreover, the cylinder, together with its water jacket and scavenging and exhaust branches, is free to reciprocate relatively to the two cylinder covers provided at its top and bottom. The covers themselves are made in the form of stationary pistons with gastight rings, and each cylinder cover contains a fuel valve and starting air valves.

There are certain obvious theoretical advantages in this design. The scavenging system is exceptionally good, since a thorough scavenge is obtained both top and bottom, owing to the scavenge and exhaust ports being at the opposite end of the cylinders, this, in addition, eliminating certain awkward heat stresses. The engine is well suited to accommodate expansion due to heat, which is one of the biggest problems, especially in connection with the design of high-powered engines. The cylinder is entirely free to expand both axially and radially. The combustion space takes the form of a plain cylindrical tube, entirely surrounded by cooling water and free from any valve holes. The rubbing speed of the piston is about 70 per cent of the normal, owing to the cylinder having a motion nearly synchronizing with that of the piston.

The engine upon which tests were run and which is the first of its type yet built, has two working cylinders of $11^1/_2$ in. bore and $14^1/_2$ in. stroke, and develops 240 b.hp. at 250 r.p.m. It was found to have a mechanical efficiency of 65 per cent, which is considered to be very satisfactory, since the scavenge pumps and air compressor are both overdesigned. This motor will be installed as an electric generating engine in one of the large Diesel-engined ships now being equipped by the North British Diesel Engine Works with their four-cycle Diesel motors. It is stated that the builders are considering the construction of a three-cylinder set to develop 2250 i.hp. or about 2000 shaft hp. It will have cylinders $24^1/_2$ in. bore with a piston stroke of 44 in. and will run at 100 r.p.m. (*Practical Engineer*, vol. 66, no. 1816, July 13, 1922, p. 26, *d*)

Carburetor Adjustment by Gas Analysis, A. C. Fieldner and G. W. Jones. Data of experimental work in the determination of carbon dioxide in exhaust gas from motor-vehicle engines, thus having a direct bearing upon carburetor adjustment.

The percentage of carbon dioxide in the exhaust gas bears a direct

relation to the completeness of combustion and to the air-fuel ratio.

Curves are given showing the carbon dioxide percentage relation to the air-fuel ratio and also to completeness of combustion, both by laboratory and road tests.

Characteristic curves are given of two types of carburetors, the results of which were plotted from road tests, showing how the air-fuel ratio changes with change of mixture rate through the carburetor.

Methods of procedure for sampling exhaust gases while adjusting carburetors, on the road are given, and a portable carbon dioxide indicator is described. Examples of carburetor adjustment by gas analysis are also given. (*Journal of Industrial and Engineering Chemistry*, vol. 14, no. 7, July, 1922, pp. 594–600, 10 figs., *eA*)

MACHINE DESIGN (See Foundry)

MACHINE PARTS (See Railroad Engineering)

MACHINE TOOLS

Diamond Alloy—A New Cutting Metal. Data on a non-ferrous alloy composed mainly of chromium, molybdenum, and tungsten. It is said that tools made of this alloy may be used under conditions of feed and speed that raise the temperature of the tool to the fusion point without producing softening of the cutting edge. The metal is non-magnetic.

The alloy cannot be forged and tools made from it are cast in permanent molds. Some tools are cast on a steel core or center while others are made entirely from the alloy. Diamond alloy can be welded to steel as for making laminated tool bits, which consist of a strip of the alloy welded to a strip of chrome-vanadium steel.

The following is quoted as results obtained with tools made with this alloy:

"In milling cast iron the cutter was run at a speed of 370 ft. per min. with a feed of 15 in. per min. and a $^1/_8$-in. depth of cut. In turning machine steel having a carbon content of from 0.35 to 0.40 per cent, the tool was operated at a cutting speed of 125 ft. per min. with a feed of $^5/_{16}$ in. per revolution of the work and a $^1/_8$-in. depth of cut. In turning a chrome-nickel steel shaft, the cutting speed was 125 ft. per min. with a feed of $^1/_{32}$ in. per revolution of the work and a $^7/_{32}$-in. depth of cut. (*Machinery*, vol. 28, no. 12, August, 1922, pp. 958–9, 2 figs., *d*)

MECHANICS

Contribution to the Problem of Stability of Rotating Shafts, Dr. Theodor Poeschl. Mathematical discussion of the problem. The author endeavors to establish the existence of a critical range of the second order differing from the critical velocity proper, this range denoting a periodical variation of motion appearing for certain angular velocities, and which, should it prove to be unstable—a fact which has by no means been fully established—would make itself noticeable during the passage of the shaft through the range in the course of speeding up to operating velocity.

The analysis given in the article does not solve the problems arising during the process of getting the shaft up to speed, but expresses them in the form of an equation of which the method of solution is not given. (*Schweizerische Bauzeitung*, vol. 80, no. 3, July 15, 1922, pp. 23–25, 1 fig., *m*)

METALLURGY (See Machine Tools)

POWER-PLANT ENGINEERING

Steam-Pipe Coverings at High Temperatures. Data of tests at the National Physical Laboratory and of apparatus designed by C. Jakeman. The covering under test was put on mild-steel pipes of 4 in. inside diameter with the pipe ends closed by blind plate flanges, radiation from these blank ends being taken care of by a proper correction.

The two pipes under test were respectively $13^3/_4$ ft. and 2 ft. in length. When the heats lost by the two pipes at any particular temperature are determined, the difference between the two heat values represents the loss of heat in a pipe of the differential length, namely, $11^3/_4$ ft. The pipes were heated electrically. The original article describes in detail the installation and methods of calibration.

The following data were obtained in testing an asbestos covering of very good quality:

Mean temperature of pipe	804 deg. fahr.
Mean temperature of air	68 deg. fahr.
Mean difference of temperature	736 deg. fahr.
Energy supplied to long pipe	1,216 watts
Energy supplied to short pipe	222 watts
Net energy required by the test length of pipe	994 watts

The net energy required for the bare pipe having been found in previous tests to be 13,240 watts, the efficiency of the cover is—

$$\frac{13{,}240-994}{13{,}240} = 92.5 \text{ per cent}$$

(*Engineering*, vol. 114, no. 2953, August 4, 1922, p. 155, 2 figs., *e*)

Ljungstrom Air Preheater for Boiler Furnaces

Ljungstrom Air Preheaters for Boiler Furnaces. Description of a novel type of air preheater designed by the originator of the Ljungström steam turbine and turbo-locomotive, the peculiar feature of this preheater being that it carries heat continuously in a mechanical way from the flue gases to the incoming air.

Fig. 6 shows diagrammatically the internal arrangements. Fresh air is drawn by a fan into the upper portion of the casing, which is divided into two parts by a vertical partition. The air is confined to one side of the partition, and passes downward to a similar semicircular chamber through the body of a porous cylindrical drum. The flue gases from the boiler traverse the apparatus in the reverse way, entering a lower semicircular chamber and passing upward through the drum to the upper chamber, whence they are exhausted and impelled to the stack by another fan. The porous drum is kept in a state of continual slow rotation, so that the part heated by the flue gases is constantly passing to the other side of the apparatus and giving up its heat to the cold air sweeping through it. Similarly, of course, the cooled part of the drum is continually returning to be reheated by the flue gases. It will be observed that there is no transference of heat through metal in the process. A deposit of soot or tarry matter, therefore, does not have any very serious effect upon the action of the apparatus, which, moreover, may be cleaned in a few moments by means of a steam jet. The latter blows the soot along with the air going to the furnace, so that what heat value it has is returned to the fire.

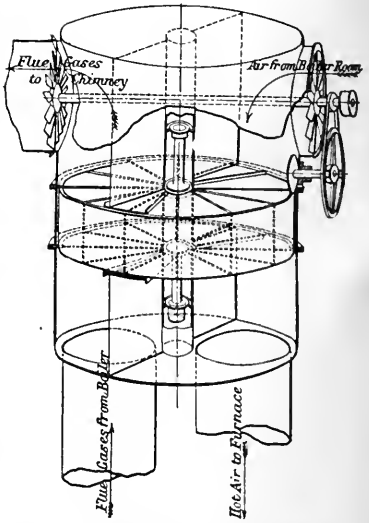


Fig. 6 Ljungström Air Preheater for Boiler Furnaces

The porous drum is built of thin sheet steel and divided into sectors by radial plates which serve as stiffening spokes. Each sector is packed with a number of thin sheet-steel plates, which are kept apart by a large number of small channel-shaped strips spot-welded to their sides.

One of the first Ljungström air preheaters was installed in conjunction with a pair of small hand-fired boilers already in service. The preheater was mounted over the flue at the rear end of the boilers and the flue gases returned to the flue outside the wall.

The hot air was led along the top of the boilers to the ashpits. A small motor of about one-half horsepower carried on a bracket from the boiler-house wall drove the fans and the rotors of the preheater.

Tests on a boiler were carried out with and without the preheater in operation. The boiler was of the return tubular type, with a heating surface of 66.3 sq. m., and fitted with an ordinary grate of 0.6 sq. m. area for hand firing. The conditions of the test were somewhat unfavorable to the preheater, as the grate area of the boiler was so small in relation to the heating surface that the waste gases normally left the boiler at an unusually low temperature. Moreover, the upper part of the boiler and the steam dome were unlagged, so that the whole efficiency was lowered by excessive radiation losses. All measurements were made in a careful and scientific manner, and the coal and the waste gases were analyzed. The results published in the official report of the Steam Boiler Association are given in Table 1.

TABLE 1 TESTS OF LJUNGSTRÖM AIR PREHEATERS

	Test 1, without Preheater		Test 2, with Preheater	
	Heat units per kg coal	Per cent	Heat units per kg. coal	Per cent
Heat transferred to steam	4509	66 9	5370	77.6
Heat lost to waste gases ..	1031	15 3	401	5.8
Heat lost by unburnt gases .	243	3 6	125	1.8
Heat lost by radiation, ash, etc	957	14 2	1024	14.8
Net calorific value of coal. ..	6740	100 0	6920	100.0

It will be noted from the first line of Table 1 that the efficiency of the boiler was raised from 66.9 per cent to 77.6 per cent by the use of the air preheater, the saving of fuel being thus about 16 per cent. No sign of overheating of the grates was observed. The rate of combustion was about normal for such grates, being 113.2 kg. of coal per square meter per hour. The air for combustion was raised from 29 deg. cent. to 135 deg. cent. by the preheater, and the flue gases were at the same time cooled from 222 deg. to 123 deg. cent.

The original article gives data of another test on a water-tube boiler.

It is claimed that the Ljungström air preheater as an alternative to an economizer is not only more efficient but is smaller, lighter, and cheaper both in first cost and maintenance, which the article attempts to prove by showing, side by side, an air preheater and an economizer drawn to the same scale and expected to achieve the same results. (*Engineering*, vol. 114, no. 2949, July 7, 1922, pp. 24 to 27, 12 figs., *dA*)

PRESSES (See Glass Manufacture)

PUMPS

Combined Centrifugal and Rotary Pump

Combined Centrifugal and Rotary Pump. Description of a pump known as the "Drum," which combines centrifugal action with that of a direct-acting piston pump.

The pump (Fig. 7) consists of a revolving piston sweeping out the cylinder at every revolution. The revolving piston dips into a revolving valve of cylindrical drum, the openings of which are so arranged that the piston passes through without slip, back pressure, or undue friction. When the revolving piston moves around from the revolving valve, a vacuum is formed into which the water flows and is forced around in the front face of the piston.

Contrary to what happens in case of the ordinary rotary pump, the present type passes the water through in one continuous flow without interruption and utilizes the power in the momentum of the moving column. As there is only one rotary working piston, the friction and strain on the gear wheels and bearings of driving a second revolving piston (as in the ordinary rotary) is avoided.

No air vessels are required and the pump works equally well in either direction and at slow speed. The quantity of water delivered is varied by changing the speed, in addition to which a by-pass fitted with a regulating valve may be used to take care of excess water delivered by the pump; throttling of suction or delivery pipes cannot be used, however. (*Practical Engineer*, vol. 66, no. 1849, August 3, 1922, p. 74, 2 figs., *d*)

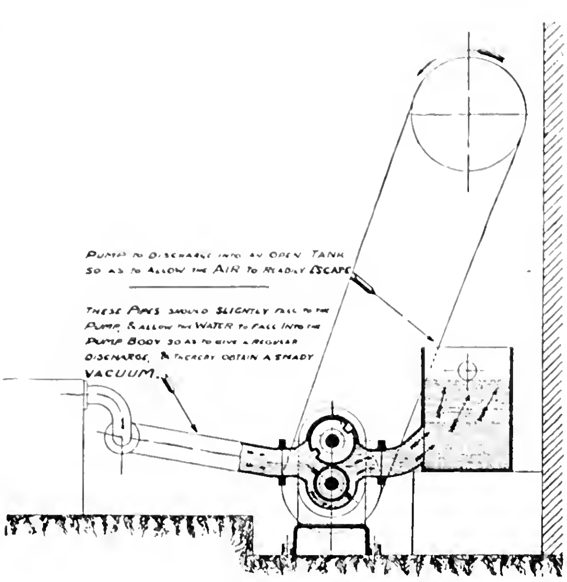


Fig. 7 Drum Pump Applied to Suction Boxes of Paper-Making Machines

RAILROAD ENGINEERING (See also Testing and Measurements)

British Gasoline Shunting Locomotive. Description of a four-wheel gasoline locomotive used at the Kelso Yards of the North British Railway.

The engine is of 40 b.hp., water-cooled. The transmission comprises heavy roller chains driving each axle in combination with a Dixon-Abbott gear box providing two speeds in both directions. The engine is fitted with four spring plunger buffers and two central spring couplings. Otherwise the locomotive carries standard equipment. (*The Railway Gazette*, vol. 37, no. 1, July 7, 1922, p. 17, 2 figs., *d*)

Roller Bearing for Railway Rolling Stock. Description of a bearing recently tested on an English railroad. The bearing includes a series of rollers of particularly hard but not brittle steel, mounted in a chain-type carrier and arranged to run between two annular members, one surrounding the axle and the other fitted into the axle box.

The rollers are of the largest diameter permitted by the dimensions of the bearing to which they are applied, and are held in position axially by links of the pattern used for transmission roller chains. One link in each set is fitted with a spring fastener designed to permit disconnection if required in the course of maintenance. (*The Railway Gazette*, vol. 37, no. 7, Aug. 18, 1922, pp. 219, 2 figs., *d*)

Large Garratt Locomotive for South African Railways. Description of a 2-6-6-2-type Garratt locomotive, said to be the largest constructed on that system. It develops 50,000 lb. tractive effort and weighs 133.75 tons when in working order.

One of the principal advantages of the Garratt system is that the proportions of the boiler are practically unlimited, it being carried by a long girder frame unencumbered with tanks, etc., and away from the wheels. Its construction is on the simplest possible lines with large water spaces, while the copper stays, etc., are readily reached for inspection and repairs, the washing-out doors etc., being usually accessible. As there are no axles under the firebox, the latter can be made of any reasonable depth and volume desired, and this feature, combined with the moderate length of the tubes, has much to do with the excellent steaming qualities and economy in fuel obtained in actual service. The ashpan also is very accessible, as not only are the ends fitted with the usual air-admission doors, but each side has a large cleaning door or doors.

The weight distribution is naturally affected by the gradual consumption of the fuel and water, but as they constitute only a small proportion of the total weight of the engine, the variation of the adhesion weight on the wheels is not a serious problem. There is always sufficient adhesion for the tractive effort, and therefore the weights of the fuel and water only represent so much extra adhesion weight. This point should be clearly recognized.

In spite of there being 2554 sq. ft. of heating surface and a grate of 51.8 sq. ft. area, the boiler is built up of only six steel and three copper plates, all of which are of plain outline. This, of course, does not include the dome. (*Railway Gazette*, vol. 37, no. 4, July 28, 1922, pp. 126–217, 2 figs., *d*)

Gasoline Switching Locomotive with Hydraulic Drive

Gasoline Switching Locomotive with Hydraulic Drive. Description of a Canadian locomotive in which the power transmission and speed control are effected by a Waterbury (Waterbury Tool Co., Waterbury, Conn.) hydraulic variable-speed gear which gives any speed from zero to the maximum in either direction without steps and gradations and without varying the speed or direction of rotation of the engine.

Neither shift gears nor electric transmission are entirely satisfactory for use on railroad equipment with internal-combustion engines, partly because of their complicated nature (electric transmission) or lack of flexibility (shift gears). The Waterbury variable-speed gear consists of an oil pump designated as the A-end and a hydraulic motor designated as the B-end.

The construction of the gear is shown in Fig. 8. The driven shaft of the A-end, which receives the power from the gasoline engine, is shown at the extreme right-hand side, while the driving shaft of the B-end is at the extreme left. A cylinder barrel (27) is keyed to the inner end of each shaft. Each barrel has nine cylinders parallel to the shaft and fitted with pistons. When the barrels revolve, their inner faces slide on the valve plates (53), each of which has two ports, the ports in A-end being connected to those in the B-end by piping. The cylinder ports in the barrel faces register with semi-annular passages or ports in the valve plates, except at the bridges at the top and bottom of the plates. The connecting rods have one end secured in the piston and the other in the socket ring (35). The socket rings are connected by universal joints with the shaft so that while they revolve with the shaft their planes of revolution may be at any angle with the shaft provided by the setting of the roller bearings on which the socket rings revolve.

In the B-end of the gear the socket ring runs in an angle box secured in the end of the case and making a fixed angle of 20 deg. with the shaft. Thus as the shaft, the barrel, and socket ring revolve in the B-end, the pistons will have a reciprocating motion with a constant stroke. In the A-end the angle box is hung on trunnions and may be adjusted to any desired angle while the gear is running by means of the control shaft. If the angle box in the A-end stands in the neutral position at right angles to the shaft, the pistons are carried around with the cylinder barrels but have no reciprocating motion. No oil is therefore taken from or delivered to the passages in the valve plates. If the tilting box is inclined by moving the control shaft, the pistons begin to reciprocate, the stroke depending on the angle between the socket and the axis of the shaft. Every cylinder during one half of the shaft's rotation is drawing in oil from one of the passages in the valve plate, which it carries over and delivers into the other passage during the next half of the shaft's rotation.

The oil from the A-end is forced into one of the passages of the valve plate of the B-end. The cylinders of the B-barrel in communication with this passage make room for the oil by sliding back from the valve plate, but they cannot do this without forcing their respective sockets in the socket rings farther from the valve plates. This can only be done by turning the socket ring as a whole in its inclined plane in the angle box. While the pistons facing the pressure passage of the B-valve plate are receding to make room for the incoming oil and so imparting rotation to the B-shaft, the pistons facing the no-pressure passage are moving toward the valve plate and delivering oil into the respective cylinders of the A-barrel. Since the receiving capacity of the B-cylinders

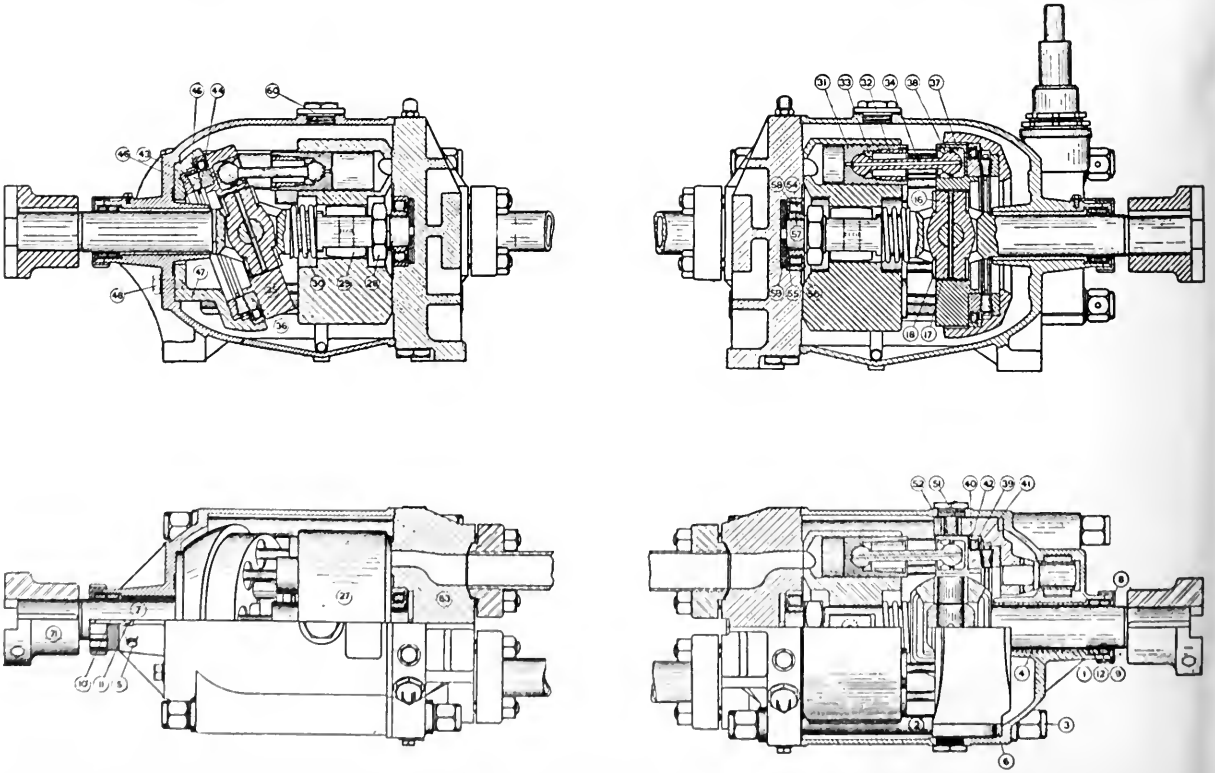


Fig. 8 Pump Unit (Right) and Motor Unit (Left) of the Waterbury Hydraulic Variable-Speed Gear on Gasoline Switching Locomotive of Universal Engineering Corporation

is constant and the delivery capacity of the A-cylinders is varied at will by turning the control shaft, the speed of the B-shaft is correspondingly varied. With the engine running at constant speed the speed of the B-end depends upon the angle which the socket ring in the A-end makes with the shaft, while the direction in which the B-end revolves is governed by the direction in which the socket ring in the A-end is removed from the neutral position.

The efficiency of this type of transmission is said to range from 68 per cent to 75 per cent at normal speed to 82 per cent at full speed, and the combined weight of pump and hydraulic motor is less than 25 lb. per horsepower transmitted.

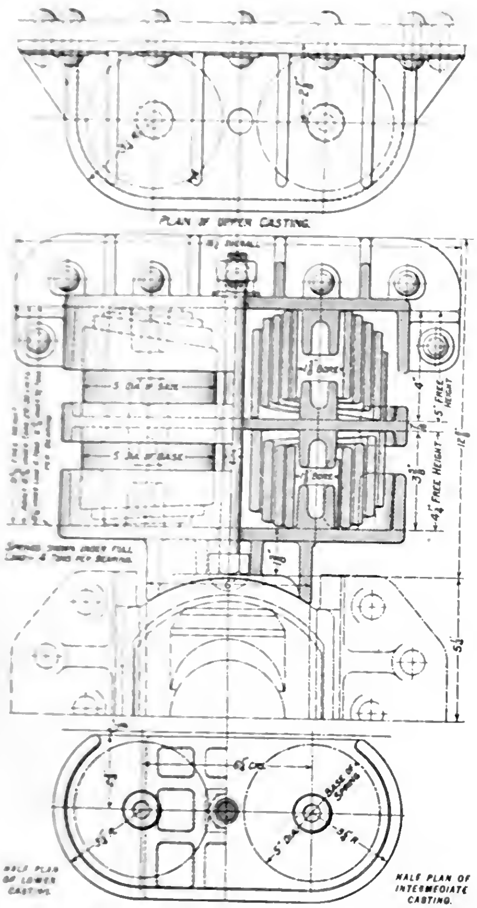


Fig. 9 Volute Spring Differential Bearing-Spring Gear as Applied to Tenders on an Indian Railroad

The control of speed and direction is effected by means of either of two handwheels placed in the driving compartment at each end, one man only being required to operate and control the locomotive, the speed of which is governed automatically by a hydraulically operated control gear which acts independently of the control shafts of the pump units as soon as the drawbar pull exceeds a predetermined amount.

In actual service the locomotive has shown great flexibility, which is of importance in switching service. The locomotive may be started under a dead load of any amount without overloading the engine, and three turns of the handwheel from the neutral position will bring the locomotive up to full speed.

In one trial the locomotive took three cars weighing 150 tons up a 4 per cent grade, stopping at the steepest point and starting again under full load without difficulty. Designs are under consideration for the application of hydraulic drive to passenger locomotives and high-capacity passenger cars. (*Railway Age*, vol. 73, no. 8, Aug. 19, 1922, pp. 323–326, 3 figs., *dA*)

Novel Differential Bearing-Spring Gear in Passenger Locomotive

Passenger Locomotive with Novel Differential Bearing-Spring Gear. Description of a 4-4-0-type meter-gage passenger locomotive recently rebuilt on an Indian railway. An interesting feature of the equipment of the engines is the bearing-spring arrangement on the tenders (known as the Herculo). As shown in Fig. 9, the springs are of the volute type, arranged in a group of four over each axle box, each group consisting of two upper and two lower springs in series. The upper springs are graduated to deflect under load at a greater ratio than the lower springs, thus insuring easy riding conditions irrespective of whether the tender is full or partly loaded. It is also said that breakage is reduced, as the total stroke is divided between the upper and lower springs; as the springs are reversely wound they have different periods and oscillation is stamped out.

An underhung differential spring gear has been employed on engine driving axles for several years on the same Indian railway and has been found quite satisfactory.

Volute springs of the same type have been used also in the engine truck control. In this arrangement two springs are reversely wound and arranged right and left hand, which prevents hunting of the truck at high speeds and restores it quickly to a normal center when leaving a curve. It is claimed in the original article that this arrangement has materially reduced the wear of tire flanges. (*Railway Gazette*, vol. 37, no. 4, July 28, 1922, pp. 124–125, 5 figs., *d*)

REFRIGERATION

Refrigerating Machine with Centrifugal Compressor and New Low-Pressure Refrigerant

Carrier Refrigerating Machine. In air conditioning it is necessary to apply mechanical refrigeration to the cooling of water near its freezing point. Neither anhydrous ammonia nor carbon dioxide have proved to be entirely satisfactory, both because of their comparatively low efficiency and exacting conditions of operation, requiring, for example, an operating engineer in the case of the ammonia system.

Furthermore, the designers of air-conditioning apparatus have been looking for some refrigerating medium that could be worked in a centrifugal type of compressor direct-connected to an electric motor or steam turbine. For this purpose ammonia, owing to the large ratio of compression, low density, and high absolute pressure is unsuitable.

For centrifugal compression a vapor of high specific density, low ratio of compression, and low absolute compression is essential, and it is stated that such a medium has been developed, although its name and formula are not disclosed.

The centrifugal compressor for use in this new type of refrigerating machine is a horizontally disposed main shaft supported by two outside main bearings. The compressor has no valve and requires no lubrication, the conditions of operation being therefore similar to those in steam-turbine practice. Furthermore, an evaporator has been developed wherein the new low-pressure refrigerant evaporates without ebullition, leaving no film tension to be overcome, which is a very important feature when working under a vacuum.

Since the entire system operates under a vacuum, special provisions have had to be made to expel all the air entering the apparatus, this being done in this case by an oil seal.

In the new machine the flash system of operation is employed. Expansion valves are not required. A steam trap can be used for feeding the liquid, hence no skilled engineer is necessary for watching the feed. Even if the cooling water is shut off, no accident can happen.

During the test the steam turbine operated at 4000 r.p.m. with 120 lb. pressure, exhausting to the atmosphere; the rated output of the turbine was 119 hp. Only preliminary tests have so far been conducted on the new machine, and no performance data are therefore available at this time. The machine is rated at 100 tons refrigerating effect for air-conditioning work. It is not intended at present for cooling liquids below 32 deg. fahr. (*Ice and Refrigeration*, vol. 63, no. 1, July, 1922, pp. 43–45, 2 figs., *dA*)

SHIPBUILDING

Vane-Wheel Propulsion

Vane-Wheel Propulsion. Description of a new type of propulsion being tested out by Wm. Denny & Bros. at Dumbarton on a vessel recently built for the Irrawaddy Flotilla Co.

Vane-wheel propulsion is intended for use on shallow-draft vessels. Vane wheels are partly immersed wheels having their axes above water and substantially in the line of advance. They are fitted with propelling vanes over the immersible circumferential portion, the vanes having a pitch so that when the wheels are rotated they exert a forward thrust on the vessel.

In order to avoid steering effect, it is necessary to have two vane wheels of identical dimensions and symmetrically placed in relation to the hull of the ship. The pitch of the vanes of one wheel is right-handed and of the other left-handed. They are rotated in opposite directions, preferably outward at the top, so that the transverse thrust of each vane is balanced by that of the other, when they are driven at the same revolutions per minute, also the steering effect of each forward thrust moment is equal and opposite.

From recent experiments, both on models and full-sized ships, it would appear that vane wheels can be profitably applied not only to such shallow-draft vessels where screw propellers are unsuitable but even to deeper-draft vessels under certain conditions, the limiting consideration being the present uncertainty in regard to the ability of vane wheels to handle rough seas.

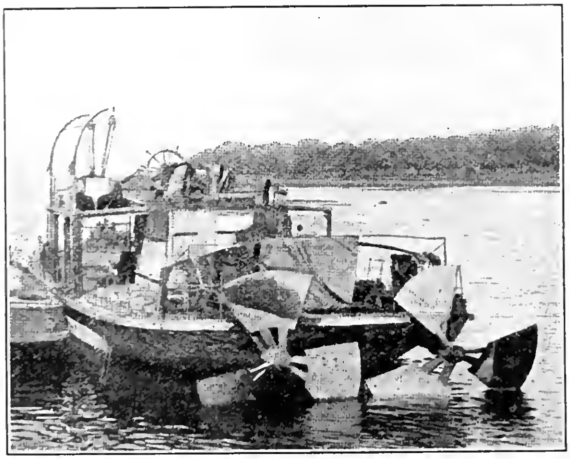


Fig. 10 Denny Bros. Experimental Vessel Fitted with Vane Wheels

The following are claimed as advantages of the vane wheel: High propulsive efficiency; on tests it has been found that vane wheels gave the same speed as twin screws (on the same vessel) with 41 per cent less shaft horsepower, in addition to which the use of vane wheels permits modifying to advantage the vessel lines and form; and great maneuvering powers, a vane wheel being capable of turning very rapidly about its own axis without advancing.

As a further advantage of vane wheels is cited the effective variation of water acted upon with variation of draft, and, therefore, variation of the thrust required. To a certain extent the same applies to side and stern paddle wheels, yet their propulsive efficiencies become considerably reduced with both overimmersion and underimmersion. In the case of vane wheels every portion of the immersed vanes is applied effectively at all drafts. The vane wheels permit of considerable variation of immersion, so that at the deeper drafts they have the advantage of acting efficiently on a greater sectional area of water, which keeps the revolutions per minute and slip for the same speed less variable in terms of draft variation than is the case with the other available methods of propulsion. In addition to this, it is claimed that vane wheels are stronger and lighter than either side paddle wheels or stern paddle wheels. (*Shipbuilding and Shipping Record*, vol. 20, no. 1, July 6, 1922, pp. 8, 9 and 19, *dA*)

Foettinger Transmission on a Liner

Foettinger Transformers on a Liner. Reference to the Foettinger transformer was made in *The Journal of The American Society of Mechanical Engineers* for February, 1914, on page 043.

The manner in which the transformer performs its maneuvering function may be briefly summed up as follows: The transformer consists essentially of an ahead and an astern "circuit," each of which is furnished with a primary wheel, guide blades and a secondary wheel, and, according to the direction of the ship, one or the other of these circuits is filled with water by the transformer pump, the water inlet and outlet being controlled by piston valves operated by a steam reversing engine. A tank is built into the framing of the ship beneath the transformer and serves to receive the water transferred during the operation of reversing, and also to accommodate any leakage water from the transformer glands. The transformer pumps, which are of the vertical type, are also placed over the tank and draw their supplies from it. In passing, it may be remarked that the turbine and transformer are separate, with an interposed thrust bearing, and are situated in different engine rooms separated by a watertight bulkhead. The reason of this arrangement is that the ship was designed shortly after the *Titanic* disaster, and special regulations were enforced regarding the watertight division of the hull. In nearly all other Foettinger installations the transformer has been built close up to the turbine, so that the prime mover and transformer together form a common unit, thus securing a close and compact grouping of the machinery. In this installation the turbine and transformer are tied together in a longitudinal direction, and are fixed to the framing of the ship in such a way that part of the thrust received by the transformer from the propeller and transmitted by it to the turbine is taken by the hull. Thrust bearings are fitted. The first transformer for this ship was completed and tested as early as 1913 at the Hamburg works of the Vulcan Company, and while the design in the main is unchanged, certain modifications have been made in the method of fastening the transformer rotors to the shafts, and in the design of the stuffing boxes, outlet channels, and cooling arrangements. At the points where the rotors project through the casing and through each other, and where the primary and secondary wheels project through each other, the peripheral surfaces are provided with brass rubbing rings, while the packing ring for the ahead primary wheel is lined with white metal.

In the present improved design of the maneuvering gear the operating of the necessary valves, both on the turbine and transformer, is carried out by means of a reversing engine, which also controls the transformer pumps which supply the water to the transformer circuits.

The steam circuit of each turbine contains an emergency stop valve which in certain circumstances is operated by the emergency gear and a shut-down piston valve which is moved by the reversing engine, while the main steam-supply valve and the overload nozzle valves may be operated by hand. Maneuvering is effected by (1) the main steam-supply valve, which regulates the supply [of steam to the turbine; and (2) by the reversing engine, which controls the piston valves on the transformer, admitting water to the ahead or astern circuits as required. The reversing valves are positively connected to the shut-down piston valve, so that the supply of steam is completely cut off from the turbine before the reversing of the transformer begins. This is necessary, because when emptying the ahead circuit of the transformer, which is no longer required for the astern course, the primary rotor is only partly loaded, and if the steam were not shut off the turbine would race. The laps of the shut-down valve and those of the reversing valves of the transformer are so arranged that when the propeller shaft is being reversed in direction the following operations take place: The steam is at first shut off, the ahead circuit of the transformer is then emptied, and the astern circuit filled by the transformer pump. Then, when steam is again admitted to the turbine, the propeller shaft rotates in the opposite direction. The reversing engine is so designed that the first part of its stroke is passed through quickly and the second part more slowly, giving sufficient time between the closing of the steam valve and its reopening for the filling up of that circuit of the transformer which is coming into action. A hand pump is also provided for hand reversing.

The transformer pump, as will be seen from the section repro-

duced, consists of a vertical-type steam turbine carrying three Curtis-type wheels, the steam inlet being governed by a nozzle valve giving steam to the required nozzles. As previously mentioned, the two transformer pumps and the reserve pump are placed over the transformer tank, and the pumps draw from this tank and deliver to the transformer circuits. In addition to the transformer pump proper, there is on each pump an overflow pump which deals with the water flowing from the tank overflow and delivers any surplus water either at the feed tanks or overboard. The steam for the transformer pumps passes through the steam-supply valve, the strainer, and the emergency and regulating valves, and the supply valve is always completely open when the pump is working.

There is also an emergency stop gear used when the pressure of the transformer pump fails and the turbine is released from its load, and when the turbine exceeds its permitted maximum speed and causes the emergency governor to operate. This gear is fully described and illustrated in the original article. (*The Engineer*, vol. 134, no. 3471, July 7, 1922, pp. 4–5, 3 figs., beginning of a serial article, *d*)

Experiments on Contrary-Turning Coaxial Screw Propellers, Gen. G. Rota. Ship propulsion by means of double coaxial contrary-turning screw propellers has long been a matter of research. In this paper are given the results of tests made at the Spezia tank. The original article gives curves showing the thrust, turning force, and efficiency obtained with various arrangements of coaxial propellers.

The experiments indicate that the arrangement described may give an improvement in total propulsive efficiency of the order of 20 per cent or more, in addition to which there will be a gain by reason of the reduced resistance of the hull itself as a consequence of the suppression of brackets, bossings, etc.

The double contrary-turning coaxial screw propellers might also be suitable for submarines with the object of obtaining the simultaneous action of both motors, electric and Diesel, for increasing the speed on the surface. It is said that this might increase the speed from, say, 12 knots to 15 knots. (*Shipbuilding and Shipping Record*, vol. 20, no. 2, July 13, 1922, pp. 47 to 49, 7 figs., *e*)

SPECIAL PROCESSES

Truck-Wheel Manufacture from I-Beams

New Process of Manufacturing Truck Wheels. Description of the process and equipment developed by the Bethlehem Steel Co. for production of wheels from rolled steel I-beams.

The wheel is of the spoked type and is punched and formed from an I-beam in such a manner that the spokes and felloe are integral, the spokes being formed from the web of the beam and the felloe from the flange. The ends of the felloe are brought into contact and electrically welded, while the spoke ends are so shaped as to "keystone" together on each side of a hub spacer.

The I-beam used in the production of this wheel has wider flanges than usual, namely, for a 3½-ton truck the flange is 10 in. wide.

The process is essentially as follows: First, holes are punched in the I-beam starting the outline of the spokes, this being done on a single-acting straight-side punch equipped with an indexing device for insuring proper spacing of the holes. The beam passes next through a coining press and die by which the sharp edges are rounded.

In the second blanking operation the outlining of the spokes is finished and the beam is cut in half longitudinally, producing two similar wheel structures, each of which ends as a complete wheel. Each of the wheel structures is then run through a press where the spokes are staggered, and, by this, spread apart at their hub ends, so that when the beam is formed to circular shape the openings left between the spokes accommodate the hub spacer. The same die which staggers the spokes also grooves them.

The forming of the wheel member to circular shape is the next stage. This is done in two operations. In the first, the ends of the beam are rounded to the shape of a quarter-circle. Before the second forming operation is started the hub spacer must be inserted between the inner and outer rows of spokes. With the hub spacer in position the wheel is bent by the second forming operation to circular shape. The press in which this operation is performed is rather unusual in size, being 118 in. between housings and having a die space of 72 in. and a stroke of 36 in. (*Automotive Industries*, vol. 47, no. 6, Aug. 10, 1922, pp. 270–273, 23 figs., *d*)

Fiber and Paper Manufacture from Reeds

Reed-Products Industry. Reeds or hydrophytes are plants of the hard kind of hydroflora, such as plain reeds, reed mace and the various kinds of rushes. They belong to the true *graminaceae* and have a stalk consisting of tubes and knots exactly similar to those of straw.

The analysis of hydrophytes shows a very high percentage of reed fiber (37 per cent), reed endosperm (9 per cent) and extractive matter containing sugar and starch (37 per cent). In addition, the root of the reed contains, roughly, 30 per cent of fiber and close to 40 per cent of extractive matter, about a quarter of which is reed sugar.

Reeds (which are here used as the generic name for all hydrophytes) contain a wealth of utilizable matter. The upper parts properly handled constitute an excellent food for cattle and were extensively used by the military authorities during the war under the name of "fragmit." The fibers of the upper reed resemble the fiber of straw and show remarkable strength.

The root fiber is particularly easy to obtain unbroken. It must be freed from the starch of the inner root and the incrustations of the outer layer of the root. But this can be done without applying expensive chemicals by the employment of a certain bacterium known as *bacillus fibrogenes Branco*. The decomposing effect of retting of the fibers by this bacterium is exceedingly vigorous, and all parts of the plant with the exception of the fibers are completely destroyed. Furthermore, the cultivation of the bacteria is very simple, a certain kind of reeds forming a good medium for this purpose. The retting is not a true decay; it begins about five to six days after the introduction of the bacteria and proceeds as a liquefaction of all the incrustations. After the roots have been treated in this way the fibers can be extracted clean and pure by simply washing the substance and without using any kind of chemical. The fiber obtained by this process of decomposition is very tough and suitable for textile purposes. The fiber of the outer layer of the root can be compared to finely separated fiber or flax, while the fiber of the core of the root represents a typical fiber that can be worked like hemp.

Practical experiments carried out on a working scale by a paper mill in central Germany have also shown that from reeds can be obtained cellulose well adapted to the manufacture of paper and cardboard. In this process the raw material is cut up into bits of 1 cm. (0.4 in.) length in an ordinary high-speed chaff-cutting machine. This chaff is fed to a beater in which leaves and parts of the plant adhering to each other are separated and the dust is extracted by an exhausting apparatus. The material is next soaked by sprinkling in large brickwork reservoirs and then boiled by means of steam. It is then ready to be worked into hard cardboard after a short treatment in a cylinder engine and without preliminary grinding, all intermediate treatment in edge mills and the like being completely eliminated. Hard cardboard does not need high-pressure treatment and has great elasticity. Unbleached cellulose from reeds is used for making all kinds of wrapping and packing papers, besides cardboards and pasteboards of various qualities, while bleached hydrophyte cellulose serves for making paper for newspapers and other printed matter, bleached cellulose also being mixed with other kinds of semi-finished cellulose such as wood cellulose, lignine and waste paper.

It is pointed out in the original article that the reed-product industry is of great importance from the point of view of world economy, partly as a source of supply of fodder, but chiefly as a means of reducing the enormous consumption of timber for paper manufacture; particularly as, according to the claim of the original article, there is actually no wood suitable for making paper in the whole of the huge stretch from 45 deg. latitude North down to the most southerly end of the continents, while reeds of a suitable character grow luxuriously in that very wood-poor area. (*Engineering Progress*, vol. 3, no. 8, Aug., 1922, pp. 181–184, 5 figs., *gA*)

STEAM ENGINEERING

Danish One-Cylinder Pass-Out Engine

Atlas One-Cylinder Pass-Out Engine. Description of an engine developed by the Atlas Company of Copenhagen, Denmark, for working economically in plants where a large heating demand exists in comparison with the power requirements.

In many industries, such as, for example, breweries, dyeing plants, etc., the proportion of power required is small compared with the steam needed for heating, and this latter is often demanded at two different pressures. In large plants of this character the pass-out steam turbine proved to be quite successful. The Atlas engine with its big valve gear is intended to solve the same problem for smaller plants.

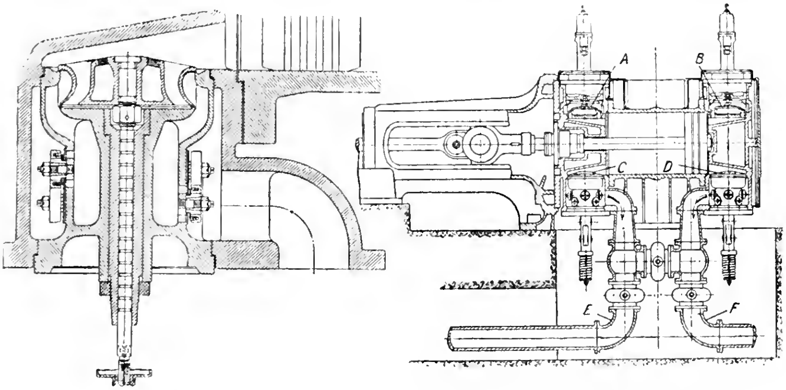


Fig. 11 Section Through Engine Cylinder of an Atlas Pass-Out Engine

The object of designing a pass-out engine is to attain maximum economy of operation by so balancing the load on the two sides of the piston that, on the one side, only the exact quantity of steam required for heating is admitted to the cylinder and exhausted to the condenser or a second heating system.

Fig. 11 reproduces a section through the engine cylinder and a detailed drawing of the arrangement of the automatic exit valves. The valves are accommodated in separate end covers, while the cylinder has a plain casting. Steam is admitted through inlet valves *A* and *B*, and is discharged through the exhaust valves *C* and *D* to the heating mains *E* and *F*. If the engine is fitted for condensing, a simple jet condenser is usually employed, with the air pump driven from the main crankshaft. Control and isolating valves are provided, and the exhaust-steam connection to the condenser may be taken from pipe *E*. The general disposition of the valve gear is indicated in Fig. 12. Double-seated drop valves are employed, and they are operated in the usual manner by eccentrics on the horizontal lay shaft. The cut-off is regulated by the speed governor, which controls the opening of the inlet valve, alternating the position of a curved lever which moves between rollers, and is attached to the eccentric rod. In addition to controlling the speed of the engine, it is also desired to balance the exhaust steam and power loads, and this is done by turning to account the variation of steam pressure in the heating mains, which variation is used independently to control and to alter the cut-off in that half of the cylinder which is dealing with the heating system. Thus, when a sudden demand for exhaust steam reduces the pressure in the heating main, the cut-off in one half of the cylinder is automatically lengthened, thereby admitting more steam, but at the same time the cut-off is reduced in the other half of the cylinder, and the balance is thereby maintained. Adjustment may be effected either by hand or by means of a special governor, which is directly controlled by the variation in pressure in the heating system.

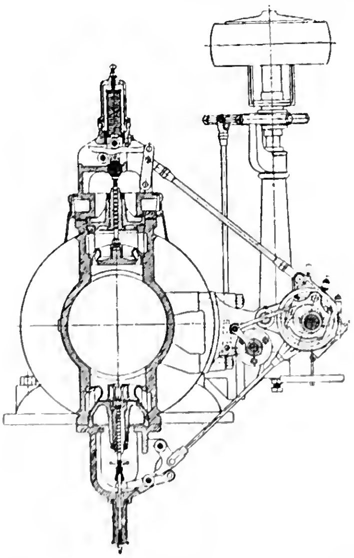


Fig. 12 Valve Gear of the Atlas Pass-Out Engine

The governing gear with hand adjustment for a single-cylinder engine is described in detail and illustrated in the original article. This part has to be omitted here because of lack of space.

The maximum back pressure against which a pass-out engine is capable of working is fixed by the initial steam pressure, and engines are generally built for back pressures varying from 5 to 50 lb. per sq. in. For a back pressure of 50 lb. per sq. in., an initial pressure of 160 to 170 lb. per sq. in. is required. The steam consumption varies according to the size of the engine and the conditions under which it has to work. The original article gives data of the test of a 280-i.hp. single-cylinder engine (19.75 in. bore, 27.5 in. stroke, running at 150 r.p.m.), the mechanical efficiencies being 92 per cent at full load, 89 per cent at three-quarter load, and 84 per cent at half load. (*Power House*, vol. 15, no. 13, July 5, 1922, pp. 26–28, 8 figs., *d*)

TESTING AND MEASUREMENTS

The Ball Hardness Tests, Doctor Moore. The author points out that the stresses developed in a specimen when a ball is forced into its surface are neither simple nor uniform. The ball hardness test is not capable of determining elementary and fundamental properties of a material and the indentation hardness as determined by the ball hardness test cannot claim to be regarded as a fundamental property. The test is purely empirical and valuable because of its practical utility. A numerical measure of hardness given by any indentation test should always be qualified by an indication of the type of test, which is the reason why we speak of Brinell hardness number. The value and meaning of the number depend upon the relations established by purely empirical methods between the hardness number and either behavior in service or other more fundamental properties.

Brinell first expressed the results obtained by the test as mean pressure per unit area; that is, as a stress. He found that the mean load per unit area increased considerably as the load was increased with the same size of ball, which was due to the fact that as the ball is forced into the material the deformation does not remain geometrically similar and the depth of the impression increases more rapidly than the diameter.

The more intense deformation produces greater strain hardening and a deep impression will carry a greater load per unit area than a shallow impression. To compensate for this effect Brinell then adopted as the hardness number the load divided by the spherical area of the impression. Though there is no rational basis for this method of impression, the Brinell hardness number

is firmly established as the accepted method. Although expressed in stress units, it is not a stress or a mean stress but a purely empirical figure derived by an arbitrary method.

The ball hardness test is applicable only to materials capable of deforming permanently under stress, that is, to materials possessing some slight degree of ductility, using this term in a wide sense. There are few metallic materials which are so brittle that a ball hardness test cannot be made on them. The range of hardness throughout which the test may be applied is very wide. There is no low limit, tests may usefully be made on lead with a Brinell hardness number over 700, the limit being somewhere in the neighborhood of 750. This may be due to the fact that as the steel ball has about this hardness, it cannot indent harder materials. Another possible explanation is that no permanent deformation can be produced in harder materials without fracture.

As regards the volume of the material to which the stress is applied, the range is very wide. At Woolwich the diameter of ball in regular use for the test ranges from 0.8 mm. to 10 mm. and a ball of 25 mm. diameter has been used. The volume of material stressed in a test varies with the cube of the ball diameter and the range mentioned is about 1 to 30,000 in volume tested.

Among other things, it has been found that, under certain conditions, a thin layer on the surface (resulting from machining, in particular planing with a shaping tool) may be harder than the rest of the specimen. This extra hardness extends, however, only to a depth of a small fraction of a millimeter. Soft metals (copper, aluminum, soft brass) are the most liable to harden on the surface when they are machined. Grinding, if properly carried out, rarely, if ever, produces this surface-hardening effect. Polishing causes a flow which is too shallow to affect appreciably the ball hardness test.

As regards the influence of the size of ball or load on the ball on the Brinell number, the author cites Meyer's second law, which he expresses in one formula and then proceeds to the discussion of the physical meaning of these laws. The Brinell hardness machine is described and illustrated. (Paper read before the London Local Section of the Institute of Metals, abstracted through *The Metal Industry*, vol. 20, no. 22, June 2, 1922, pp. 510–513, 1 fig., *dt*)

Tearing Tests of Metals

Tearing Tests on Metals, Henry L. Heathcote and T. G. Whinfrey. In impact tests, test pieces which may have given good results under the tensile test sometimes break like a carrot. It is not at all easy to break a carrot until the periphery has given way, when it tears across quite easily. The present authors have investigated this tearing and tests have shown that the tearing strength of a metal is very much inferior to the tensile strength, and of the order of about one-fifth of the latter.

Test pieces for tearing tests have to be cut from thin sheets. The form recommended is made by taking a piece of sheet about 2 in. by 4 in. in area and slitting it carefully with tinners' snips, as shown in Fig. 13, *a*. The tongue of the metal 1 in. by 3 in. is turned square out in front with the two wings exactly opposite in direction as shown at *b* on the right-hand side of the figure. This bent test piece is then mounted in a tension machine capable of registering accurately loads of a few pounds. A machine for testing paper or fabric is usually suitable. Pull is then gradually applied until the metal tears, as may be observed under a strong glass.

The pull observed is that required to tear the metal in two places and bend and unbend a total width equal to that of the specimen. In order to eliminate the work done in bending, it is necessary only to execute a similar test on a narrower or wider test piece cut from the same material.

If P is the pull required to tear, bend, and unbend a piece x in. wide, and p the pull required to tear, bend, and unbend a piece y in. wide, then $P - p$ is the pull required to bend a portion of the piece $2x - 2y$ in. wide. Therefore—

$$\text{Pull required to bend piece } 2x \text{ in. wide} = \frac{P-p}{(2x-2y)} \times 2x = \frac{(P-p)x}{x-y}$$

Pull required to tear specimen in two places =

$$P - \frac{(P-p)x}{x-y} = \frac{px - Py}{x-y}$$

$$\text{Tearing force per linear inch} \quad \frac{px - Py}{2t(x-y)}$$

where t is the thickness of the sheet.

It is apparent that the force required for bending will quite overshadow the force required for tearing in a thick piece.

It is believed that tearing tests will bring out valuable information regarding the stability of the metals tested for construction purposes, and also be of interest in connection with the investigation of the microstructure of metals and alloys.

From the appearance of the fractures which occur during the life of metals in use, it is obvious that they are for the most part tear fractures, or, as they are more commonly called, "fatigue fractures." Indeed, "fatigue fractures" doubtless start from some internal notch where the stress concentration is above the ultimate strength of the material. Probably all hardened steels break by tearing, as also do high-tensile alloy steels such as nickel-chromium steel.

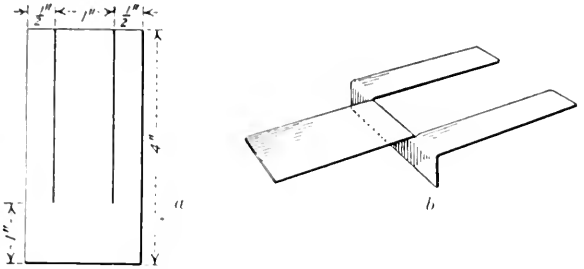


Fig. 13 Test Piece for Tearing Testing (1, Before Bending; 2, After Bending)

On the other hand, it would not do to assume that resistance to tearing should always be as high as it is possible to make it. When material is machined, the ease with which it is removed by the tool depends upon the ease with which it tears apart forward of the tool point; and a high machining speed will be obtained only when the Brinell hardness and resistance to tearing are relatively low. (*Chemical and Metallurgical Engineering*, vol. 27, no. 7, Aug. 16, 1922, pp. 310-311, *eA*)

Determining the Impact Loads on Track Bolts. Data of tests recently carried out on the Philadelphia & Reading Railway to determine the stresses in track bolts induced by the impact of trains and locomotives and the pull of a trackman on a wrench. A separate test was also made to learn the breaking strength of a track bolt and carried out under the same conditions. The load caused by the impact was measured by an adaptation of the Brinell system of testing hardness, the impact or pull of the wrench forming depressions in hardened steel washers, from which the stresses were determined.

The principle of the method consisted of the forming of impressions on hardened steel washers, through the medium of standard Brinell balls, by the loads which it was desired to determine. The original article gives the method employed for calculating the actual loads.

The average minimum and maximum loads were 25,980 lb. and 29,298 lb., giving stresses on the 1-in. bolts used of 47,236 lb. per sq. in. and 53,270 lb. per sq. in., respectively. (*Railway Age*, vol. 73, no. 7, Aug. 12, 1922, pp. 277–278, 4 figs., *e*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Cement and Other Building Materials A4-22. STORAGE AND TRANSPORTATION OF PORTLAND CEMENT. The cause of the deterioration of portland cement during storage and transportation and the means of preventing it, form the subject of an investigation recently conducted by the U. S. Bureau of Mines. This report was prepared by W. M. Myers, assistant mineral technologist, and is known as Serial No. 2377.

The material for this report was gathered from all available printed sources of information on this subject and from the leaders in the cement industry. It accordingly includes a full bibliography. Address H. Foster Bain, Director, U. S. Bureau of Mines, Washington, D. C.

Foundry Equipment, Materials and Methods A2-22. INCLUSIONS IN ALUMINUM-ALLOY SAND CASTINGS. In aluminum-alloy foundry parlance, metallic and non-metallic inclusions are termed "hard spots," and in aluminum-alloy sand castings and in die castings they are very troublesome. The inclusions differ so widely that the term "hard spots" is only roughly descriptive at best; in fact, it is exceedingly undesirable, and should not be accepted in the nomenclature of metallography. However, because it has been in common usage for such a long time, it is used in U. S. Bureau of Mines Technical Paper No. 290 to include all kinds of metallic and non-metallic inclusions that cause difficulty in polishing and machining aluminum-alloy castings. Hard spots in aluminum-alloy sand castings are well known to founders, and certain kinds of hard spots are frequently found in aluminum-base die castings.

Although many representative aluminum-alloy founders by care in practice have been able practically to eliminate hard spots and resulting trouble when aluminum-alloy castings are machined, others still have periodic difficulties because of this defect. A number of foundrymen have suggested at various times that the Bureau of Mines investigate hard spots, put the available information on record, and suggest preventive methods. Such an investigation was undertaken and carried out in connection with the Bureau's work on casting losses in aluminum-alloy foundry practice. The present paper is published as a contribution to the literature of aluminum-foundry practice and as a guide to founders in preventing scrap losses from hard spots in castings. Address the Bureau of Mines, Washington, D. C.

Highways A1-22. FLEXURAL STRENGTH OF PLAIN CONCRETE. See *Cement and Other Building Materials A4-22.*

Iron and Steel A4-22. STUDY OF ALLOY STEELS. The results of studies in the experimental production of certain alloy steels are given in Bulletin 199, by H. W. Gillett, chief alloy chemist, and E. L. Mack, assistant alloy chemist, which has just been published by the U. S. Bureau of Mines.

The production of small heats of alloy steels on an experimental scale is often desirable in beginning the study of new alloy steels before large amounts of expensive alloys are used in heats of commercial size. Such small heats can sometimes be made up at crucible-steel plants but few crucible-steel makers care to undertake experimental heats for other firms. Small electric furnaces offer some advantages over crucible furnaces for experimental work, and various types of such furnaces are being successfully used by different firms for such work.

The Bureau of Mines has recently made up experimental heats of alloy steels for the Army and the Navy. The steels for the Army were desired for work on gun erosion, especially as regards the effect of nitrogen on the steel. The request from the War Department for this experimental work was made during the course of the World War and followed the receipt of information from a creditable source that Germany was using uranium steel in the liners of some high-power naval guns. It was stated that uranium stiffens steel at high temperatures, and raises the softening point some 200 deg. cent., so that gun erosion at the end of the Jutland naval engagement was ascribed to the uranium-steel gun liners. Somewhat similar reports had been received as to the use of molybdenum steel.

The ingots made for the Navy were in two series, the first being rolled, heat-treated, and given physical tests by the Bureau of Standards. The second series was made in larger ingots, which were rolled into plates, cut up into smaller plates, and heat-treated to different Brinell hardness numbers by the Halcomb Steel Co. Physical tests of this series under several heat treatments are being made by the Navy.

Some of the points brought out in preparing the steels, particularly as to the recovery of the alloying elements from the various ferroalloys entering the steel, may be of interest and are therefore put on record at this time. The indirect-arc furnace finally used seems also to justify its description.

Detailed information regarding tests made with uranium, silicon, manganese, molybdenum, chromium, vanadium, nickel, copper-nickel, aluminum, zirconium, cerium and boron as alloying agents are given in Bulletin 199, which may be obtained by addressing the Bureau of Mines, Washington, D. C.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Iron and Steel B4-22. MOLYBDENUM AND OTHER ALLOY STEELS. In the study of molybdenum and other alloy steels being made by Dr. H. W. Gillett at the Ithaca, N. Y., office of the Bureau of Mines, 600 endurance test pieces have been ground and polished to a special mirror finish ready for testing. These bars will keep two endurance machines busy night and day for probably more than a year.

Paints, Varnishes and Resins B3-22. FAILURE OF PAINT AND VARNISH ON EXPOSURE TO WEATHER. During the recent meeting of the American Society for Testing Materials at Atlantic City, there was an extended informal discussion of the mechanism of failure of paint and varnish films on exposure to the weather. One party to the discussion claimed that a paint or varnish film should contain moisture in order to retain its elasticity. The known beneficial effect of baking a varnish film was then cited as being contradictory to this theory that moisture improved the durability of paint or varnish. The importance of the problem makes it appear advisable to study baked varnish films in order to obtain some definite data on the effect of baking. The Bureau of Standards has commenced an investigation in which a series of spar varnishes of varying lengths of oils will be baked on tin panels at different temperatures, and then tested for durability when exposed to the weather.

Steel, Its Treatment and Products B5-22. MINE-DRILL STEEL. A committee, advisory to the U. S. Bureau of Mines and Bureau of Standards, has been formed on the subject of mining-drill steels, their composition, treatment, thermal and mechanical, and reclamation; together with causes of breakage as related to standardization of design and practice, properties, manufacture and preparation, with the object of eliminating waste and delays in mining operations. Several meetings have been held, a preliminary program mapped out, and these Bureaus have made a joint survey of drill-steel practice in the metal mines of some ten western states, obtaining data which will be of use in suggestions as to standardization of design, heat treatment and practice generally as relating to drills and auxiliary mining machinery. Reports of this survey are in preparation.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Iron and Steel E1-22. THE BRITISH CAST IRON RESEARCH ASSOCIATION. A pamphlet just received describes the objects of this recently organized association as (1) to promote coöperation among firms engaged in the various allied industries connected with the production and utilization of cast iron in Great Britain, with a view to the establishment of a scheme for scientific and industrial research; (2) the distribution among its members of technical and other information relating to the production, treatment, manufacture and utilization of cast iron. This necessitates the efficient coördination of the existing means of research and their further development.

The work of the Association will include the investigation of problems arising in the manufacture of pig irons, gray-iron castings, malleable-iron castings, semi-steel castings, chilled rolls, cast-iron hollowware, cast-iron pipes, light castings, etc., in such a way as to cover and include all branches of the cast-iron industry. Successful and economic production of these materials is very intimately bound up with the questions of melting, annealing, furnace design and construction, refractory materials, molding sands, the economical utilization of fuel, and the engineering aspect of foundry work. All these and other subsidiary operations will be dealt with by the Association, either directly, or in collaboration with other research bodies.

For further information address Mr. H. B. Weeks, F.I.C., care of Vickers, Ltd., Barrow-in-Furness, England.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on activities and policies of the Society in Research and Standardization.

The Accuracy of Boiler Tests

TO THE EDITOR:

The writer desires to express his gratification that the main object of his Spring Meeting paper on The Accuracy of Boiler Tests has been so amply fulfilled by the masterly discussion of leading authorities. This discussion has been so thorough that it is impossible to reply to it fully without writing another paper.

Replying to Mr. Bell, the writer prefers to have all test reports accompanied by heat balances. They indicate the value of the reports. Serious unbalance shows inefficiency of observation or of operation. Reports of a series of tests wherein the "unaccounted for" was consistently over 20 per cent were recently submitted to the writer, who had reason to believe that much more coal was leaving the fire in a non-gaseous state than was proper and than the ash analysis suggested.

The value of the heat balance as a statement of what has happened to the heat is really not open to question. But many engineers who are not skilled in boiler testing are impressed with the heat balance; and the writer therefore feels justified in repeating that it is not a *balance* and that it adds nothing to the accuracy of the test. It is usually less of a check on the efficiency than on the other items.

The writer appreciates Mr. Bradshaw's remarks on the determination of dust in blast-furnace gas, and its similarity to the determination of water dust in steam. That the velocity of the gas sample entering the tube should be the same as that of the bulk agrees with the writer's views; as also does the use of a sampling tube pointing upstream.

Mr. Burke suggests using the draft loss through the fuel bed to determine the condition of the fire at start and stop. This is a step in the right direction; but the presence of clinker must be reckoned with, and variation in the size of coal in some cases, as these would increase the draft loss for the same amount of fuel in the bed.

His caution about the rate of feed at start and stop is very important. It is probable that many engineers would be surprised at the error which can result in this way. It is more accurate to calculate the deficiency at the end of the run than to pump rapidly up to the mark as the test is coming to an end.

The importance of having conditions as well as quantities the same at both ends of the trial cannot be stressed too much.

The difficulty of getting even an approximate idea of the proportion of fuel sent to the ashpit may be the cause of considerable error in the heat balance, as has also been pointed out by Mr. Bell.

It is questionable whether it would be agreeable to rate all superheaters at 10 sq. ft. to the horsepower. Should Mr. Bell's Radiant Heat Absorption Superheater be rated at this figure?

Replying to Mr. Davidson, it cannot be too strongly urged that the present method of reporting boiler tests is not strictly honest. It is not even sufficient to say that the power used by auxiliaries should be noted and that any one interested can find the net efficiency, or that conscientious engineers always instruct their clients to pay no attention to the efficiencies they have reported. If a test report does not openly show the net efficiency, it is not a straightforward report. It may be that a simple system does not show as high an efficiency as a more elaborate one, while the more elaborate one loses more than the apparent gain by the power required to operate it. Both efficiencies should be clearly shown thus:

	Simple System	Elaborate System
Gross efficiency	75.0	79.0
Net efficiency after deducting power consumed by parasites	74.0	72.0

We then clearly see that the more elaborate system is more efficient in combustion, heat transfer or what not; but that in the final analysis the simpler system is the more economical. It is to be hoped that the new Boiler Test Code will prescribe a form of report in which these facts are not obscured.

Replying to Mr. Funk, the writer's reasoning on the reliability of steam sampling is based very largely on experience with other apparatus. Experimental investigation is highly desirable.

Messrs. Hirshfeld, Berry, Thompson, and Carter have done a valuable work in pointing out that many lawsuits have followed this false conception of accuracy. These would be avoided by our admitting that we cannot guarantee the accuracy of boiler trials to be within some given percentage, and then setting definite tolerances to be allowed. This naturally refers to commercial tests. Research tests have little or nothing to do with guarantees, and nothing to do with lawsuits.

Research tests are made at home, so to speak, and under conditions which cannot usually be duplicated profitably with commercial tests. The writer believes that when these gentlemen, who have devised and frequently operate highly developed testing methods and means in the same plants, place the accuracy of these precision tests at about plus or minus 1.5 per cent, they virtually confirm the writer's proposed allowance of plus or minus 3 per cent on a commercial test. He does not believe it is generally recognized that such research tests may be out 1 per cent.

There is another kind of research test, the kind made by the ambitious engineer of the small plant, without much apparatus or abstruse knowledge. The writer recently saw a case where such an engineer had raised the "actual" evaporation per pound of coal "as fired" about 15 per cent as averaged from a large number of tests. These tests were scarcely worth the name and probably carried large errors, but the fact remains that his employer is buying less coal than he used to.

The use of the boiler as a gas-flow meter in connection with the pressure drop through the fuel bed is excellent in checking the thickness of the fuel bed, and may reduce this error very materially.

The writer did not in his Par. 17 refer to drying the coal *to be fired*, but to drying samples to ascertain the moisture while the test was in progress.

He entirely agrees with Mr. Kreisinger that the really important thing is not a single test, but a load-efficiency curve, drawn through a group or groups of tests. The accuracy of such a curve may easily be within 1 per cent. But such multiple testing is not always possible with commercial trials.

To emphasize the care necessary in taking samples, it may be well to mention that the coal analyzed in the laboratory is of the order of 1/10,000,000 of the coal burned and that about 1/100,000,000 of the flue gases are analyzed. The serious feature of errors in the heating value of the fuel is that they are in no wise reduced by increasing the duration of the test. Unless the heating-value error can be made very small, a point is soon reached where little is gained by increasing the duration of the trial. Mr. Kreisinger's broad discussion on the reliability of the heating value is rendered the more authoritative by his long experience.

The writer feels prompted to add the following recent analyses of fuel oils:

	B.t.u. per Pound Boiler test number		
Analyst	4	7	8
A	..	..	17,803
B	..	..	18,600
C	17,081	17,261	17,199
D	..	17,295	..
E	..	16,980	..
F	..	..	..
G	17,334	16,968	17,256

In test No. 4, analyst G is 1.48 per cent above analyst C, while in No. 7, C is 1.72 per cent above G. In No. 8 they agree very closely, but analyst B gets a result 2.35 per cent above C.

The "boiler horsepower" dies slowly. If we were to express the load in all future test reports as B.t.u. per sq. ft. of heating surface per hour as Mr. Kreisinger suggests, as well as in "percentage of rating," it is probable that we could become reconciled to the loss of the boiler hp. more quickly.

Mr. Moultrop mentions handhole leakage as one of the unknowables. The writer believes that during the trials made about 25 years ago by the British Admiralty to determine the relative merits of Belleville, Scotch and other boilers, the water loss in the Belleville ran about 5 per cent of the evaporation in some instances, but this is only from memory.

He does not agree with Mr. Moultrop that the manufacturer and customer should settle upon a tolerance. The first manufacturer who does this is very liable to be looked upon as having little faith in his own product. Such tolerances must be settled and recommended by the Boiler Test Code Committee if at all, and it is to be hoped that this will be done.

The writer is glad to find Mr. Tenney in agreement with him that all conditions surrounding the test should always be reported. This is not done very often, and some important conditions are scarcely ever reported. It is obvious that a certain efficiency attained with the coal Mr. Tenney burns might be much more creditable than a little higher efficiency with a much better coal.

In reply to Mr. Vennum, the present boiler efficiency shows what proportion of the heat in the fuel was used to make steam, but it is reasonable that an efficiency should also be reported which shows how much heat was used of that which it was possible to use. This proposed efficiency would be mainly for research purposes, not for commercial tests.

Mr. Vennum says that we want to know what proportion of the heat in the fuel is made available for mechanical use, and it is obvious that this is just what our present efficiency does *not* show us, until after we have deducted the auxiliaries.

Speaking generally, the discussion confirms the writer's opinion that the inaccuracies at present inherent in commercial boiler testing are sufficient to warrant the introduction of tolerance in the performances of guarantees as a recognized engineering custom. In research testing the errors can be reduced to about one-half of those of commercial tests, and to still less than this as the number of the tests is increased and rendered into a load-efficiency curve.

Alfred Cotton.

St. Louis, Mo.

Compounding the Combustion Engine

To the Editor:

Referring to the discussion of a paper by Mr. E. A. Sperry on Compounding the Combustion Engine which appeared in the August number of Mechanical Engineering, I would like to submit the following comments.

I have carefully followed the subject in question for some years and wish to say that while Mr. Sperry's contribution to the art should by no means be minimized, it should not be judged by the paper he presented nor by the extravagant claims and references he makes in his closure. The fact that he started considerable discussion of this promising subject among the engineers concerned, however, is evidence enough that he "is to be commended for his research along this line," as Mr. J. C. Shaw expressed it.

In his paper Mr. Sperry utterly disregarded established technical terminology and employed such expressions as "persisting" pressures, "hanging on to pressures," "chilled perimeter," "modern two-stage method of compression," etc. These may mean something to him, but they have been rightfully objected to by his commentators, Mr. J. C. Shaw at the meeting, and Mr. James Richardson in (London) *Engineering*.

If Mr. Sperry's "special adaptation of cushioning," meaning the compression of part of the exhaust gases trapped in the low-pressure cylinder (which he claims as new and which Diesel used on his compound engine in 1897), was adopted to restore them to a temperature equal to that of the gases coming from the high-pressure cylinder, then he stopped too soon when he equalized the pressures, because at that time there is of course still over 1000 deg. fahr. difference in favor of the incoming gases.

In his closure he proceeds to use the same misleading language: "The compound combustion cylinder handles a great many times the weight of air compared with the simple Diesel, not only many times the weight of air but many times the fuel with more complete combustion than in any simple engine." Later it develops that "a great many times" means "from four to six times," which is rather modest for such an ambiguous term, but the "more complete combustion" is left on the conscience of the inventor to prove.

I also question his assertion that a "compound engine of any kind" invariably develops back pressure on the piston" of the next higher stage. Steam engines do and Sperry's engine does, and that is the only thing that may make them akin; but, generally speaking, internal-combustion compounding and steam-engine compounding have nothing in common, not even back pressure, since that is avoidable in the combustion engine.

Mr. Sperry's discussion of reasons for using or not using a crosshead does not bear on the subject of compounding. However, he has only to visit the Brooklyn Navy Yard to see a 3000-hp. Diesel submarine engine of 21 in. bore without any crosshead in it.

His dismissal of "shocks, strains and heat troubles" as being "on a par with many other of the imaginary troubles," or his "there is no such thing as a previous compound engine to compare with," lead me to ask you to reprint for his information, as well as for that of many other engineers, the appended translation of Dr. Diesel's statement regarding his own efforts in compounding, published in 1913.

In conclusion, I would say that in spite of the defects of Mr. Sperry's paper, grave as they are, and the fact that he did not invent "compounding," he claims that he built an engine that runs economically, and that is an achievement well worth claiming.

Washington, D. C. E. C. Magdeburger.[1]

[The translation of Dr. Diesel's statement regarding his efforts in compounding, to which Mr. Magdeburger refers in his communication, immediately follows.—Editor.]

The Compound Engine[2]

The German patent D.R.P. 67,207 of February 28, 1892, contained a figure (Fig. 73) of the compound engine. From the text of this patent application the following is quoted:

"Compression of air as well as the expansion of the exhaust gases could be undertaken in steps, as in a representative construction shown in Fig. 73. In this sketch the valves are shown only schematically. The housing, the connecting rod, the flywheel, etc., are omitted. In such a construction two internal-combustion cylinders *C* are perfectly identical with the cylinder of any one-cylinder motor. These cylinders are connected by means of mechanically operated valves *B* on the two sides of one larger middle cylinder *B;* also mechanically operated valves *A* connect the internal-combustion cylinders with the air container *L*. The new process with this construction is as follows:

"Piston *Q* moving upward draws in atmospheric air through valve *d*, compresses it up to a certain pressure, and delivers it through valve *g* into the air container *L*. The lower part of the middle cylinder henceforth serves only as an air compressor to precompress the air necessary for combustion. At *g* are water-injection nozzles through which it is possible to inject water during the precompression. The cycle can be run with or without water injection. The cycle in the cylinders *C* is exactly the same as in the single-cylinder motor already shown, except that the piston *P* moving downward draws in the air not from the atmosphere but out of the air container *L* where the air is already under certain pressure. Moving upward the piston *P* completes the second stage of the compression up to a given pressure. Both dead-center positions of piston *P* are shown dotted and marked with figures 1 and 2. After that, piston *P* again goes downward with oil being injected continuously for a certain part of the stroke. In the position 3 of the piston the oil injection stops and the gases expand further. When the piston is in the lower position 1 the valves *b* open. The piston *Q* at that moment is exactly opposite since the cranks are 180 deg. apart. Continuing, piston *P* goes up and piston *Q* down, and further expansion of the exhaust gases up to the volume of the cylinder *B* takes place. After that the valve *b* closes and *p* opens, so that with the next upstroke of the piston *Q* the exhaust gases can be expelled into the atmosphere through valve *F*."

Already in my paper delivered in Kassel in June, 1897, I maintained that in a compound engine the thermodynamic efficiency will be very much higher than in a single-cylinder engine. The constructional drawings of such a compound engine were made to my order by Mr. Nadrowski, of

---

[1] Aide on Diesel Engines, Bureau of Engineering, Navy Department. Mem. Am.Soc.M.E.

[2] Translation of a chapter from a book by Dr. Rudolf Diesel, entitled The Development of the Diesel Engine (Die Entstehung des Diesel Motors), Julius Springer, Berlin, 1913

Berlin, during the year 1894-1895. This engineer later came to Augsburg where he improved these drawings as the results from the single-cylinder engines had indicated. The first detail drawings for the frame and bedplate reached the pattern shop late in December 1895. Inasmuch as the tests on the single-cylinder engines had been producing new results continuously, the building of a compound engine was not rushed. Several patterns were completed at the close of 1896 and it took another six months before the assembly could begin. My assistant, R. Pawlikowski, was entrusted with the supervision of the assembly and the conducting of tests which began in September 1897. He was assisted in that work by Messrs. Böttcher and Reichenbach whenever these gentlemen were not otherwise employed.

The construction of details of the compound engine, as far as the internal-combustion cylinder is concerned, is exactly the same as that of the single-cylinder and since the whole construction never attained practical importance I do not think it of sufficient interest at this time to publish the detail drawings. However Figs. 74 and 75 are photographic reproductions of both sides of this engine, and 76 shows it on the test stand next to the single-cylinder engine.

The dimensions of this engine were as follows: High-pressure cylinder bore, 200 mm.; low-pressure cylinder bore, 510 mm.; stroke for both cylinders, 400 mm.; connecting-rod diameter, 80 mm.; number of revolutions, 150 per minute.

The tests themselves can be now summarized. First of all they showed that the air in the intermediate container between the low-pressure and high-pressure cylinders cooled off too quickly, and a steam-heated coil was built in as shown in Fig. 77, following which at the end of September, 1897, the first ignitions took place. Fig. 78 shows the series of the first high-pressure diagrams. After that the air out of the low-pressure cylinder was taken to the high-pressure cylinder direct without first going through the intermediate air container. This showed the desired result and the heating coil for the precompressed air was done away with. After about eight minutes of running, good smokeless and regular ignitions in the high-pressure cylinder were produced without preheating of the air with steam. Preheating of the air or of the engine itself henceforth would be only necessary when starting similar to the preheating of the cylinders in steam engines.

Later the engine ran quite regularly, as shown by the diagram Fig. 79, which is a superimposition of 30 ignitions. Soon, however, different mistakes showed up on the engine: the high-pressure cylinders got very hot; the cooling water boiled; the uncooled piston knocked; the transfer valves warped, etc. We succeeded in overcoming these mistakes, and for hours the engine ran on no load without any mishap. The diagram, Fig. 80, is an example of this. Here the air out of the compressor cylinder was delivered direct into the high-pressure cylinder without going through the intermediate air container. The tests showed a considerable pressure drop at the point of transfer of the exhaust gases from the high-pressure into the low-pressure cylinder. To lessen this drop a part of the exhaust gases was trapped in the low-pressure cylinder and compressed up to 12 to 14 atmospheres, so that at the moment of opening of the transfer valve no drop in pressure could take place. This result was of course compensated for by a considerable negative work on the diagram. Fig. 81 in the upper right-hand corner, shows the average original diagrams taken on November 18, 1897. The average pressure of the compressor diagram (lower side of the low-pressure cylinder) was 2.40 kg. per sq. cm. The average pressure of the high-pressure cylinder to the right (the cylinder to the left was not in working order) was 19.4 kg. per sq. cm. The average pressure of the low-pressure cylinder was 2.71 kg. per sq. cm.

The main diagram shows the above-mentioned diagrams Rankinized, the lower part showing the details of actual construction of the diagram. In the table to the left the final results are given whereby all average pressures are referred to the upper part of the low-pressure cylinder to compare it directly with the results of a single-cylinder motor of similar dimensions. The process of figuring can be easily checked with the dimensions of the engine cylinders as given above.

The original diagrams in this manner give an average pressure of 4.39 kg. per sq. cm. The Rankinized diagram gives an average pressure of 4.48 kg., that is, only two per cent higher, hence an error of only two per cent. In this main diagram an ideal diagram is also shown which could be produced in the middle cylinder alone when precompression and after-expansion would not be employed, and that comparison shows the most disappointing result, namely, that in a compound engine only 54.4 per cent of the ideal diagram was converted into useful work.

The test results showed a no-load fuel consumption of 499 grams per horsepower-hour, which quite explains the inefficiency of the diagram.

The most important loss of the whole process is the heat loss through the transfer of the exhaust gases from the high-pressure into the low-pressure cylinder. At this point, as it is shown on Fig. 73 schematically, there was not a single transfer valve but two valves, one close to the high-pressure cylinder and the other close to the low-pressure cylinder, in order to isolate the considerable volume between those two cylinders from the cylinder volumes proper. These two valves were cooled and the heat absorbed by the cooling water of the valves could be measured very accurately. This heat loss to the cooling water of the valve amounted on one side of the engine to 5.9 per cent of the total available heat of the oil, and on both sides, therefore, to 11.8 per cent, or about half of the heat that was transferred into useful work in a single-cylinder engine. Each of these four valves absorbed about three per cent in round figures of the total available heat. How much heat was lost at the same time to the cooled walls of the transfer ducts themselves and how much besides was taken away by radiation, could not be definitely measured. However, it must be assumed that these losses were considerable, due to the fact that the surfaces of the ducts were large and were energetically cooled. These enormous losses could not be brought into harmony with the computed results of the heat transferred through walls according to the prevailing methods at that time. Quite naturally an effort was made to estimate beforehand these losses based on the prevailing assumptions of the coefficient of heat transfer, but these computations produced such small values for these losses that I did not worry about them. Zeuner, with whom I discussed this point long before the actual tests were conducted, did tell me that in his opinion considerable surprises might be expected with gases at such high velocities, but that was only a matter of opinion that he could not substantiate with figures. The results proved that these computations were a failure. This single loss was so great that practical application of compounding could not be thought of for this reason alone. In view of this fact it is probably superfluous to describe the other numerous losses encountered in tests which were due to the transfer of air out of one cylinder into the other both during its compression and expansion. The total losses doomed the compound principle. My great hopes to considerably improve the heat utilization of the single-cylinder engine had to be given up, however much I disliked to do it.

The above brief description of these tests and the scientific explanation of their failure will, I hope, save others from similar disappointments.

Second Revision of A.S.M.E. Boiler Code, 1922

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the Society in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be invited and where they may present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and the Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revision. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

In connection with the revision work, the lack of rules and specifications relative to pipe, pipe material and fittings for use in connection with steam boilers up to the flanges for the connection of the first valves, has been apparent. The Committee has endeavored, at the urgent request of many manufacturers, to supply this lack by rules and specifications which have been prepared in coöperation with the American Society for Testing Materials. These rules and specifications are here published and it is the request that they be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

RULES FOR PIPE, PIPE MATERIAL AND FITTINGS USED ON STEAM BOILERS

X-1 Piping and Fittings. The piping and fittings used on boilers up to the flanges for the connection of the first valves from the boiler on steam outlets, feed lines and blow-off lines shall conform to the rules given in *X-1* to *X-6*, and it is desirable that all piping, valves and fittings used on steam and exhaust lines, including the vacuum system and drain lines; all water lines, including boiler-feed suction and discharge lines; and all boiler blow-off lines shall conform to them.

X-2. Steam Pipe. Piping for steam mains carrying saturated or superheated steam may be of welded or seamless pipe made of wrought iron or steel. For sizes above 3 in. in diameter the steel

pipe shall be of open-hearth steel. All pipes shall be straight and free from blisters, cracks, laminations and other injurious defects. Liquor marks and lap-seam lines incidental to the manufacture of pipe will not be considered defects. Each length of pipe is to be inspected separately for defects on the inside and outside, noting particularly the character of the cross-section when cutting off crop ends. Pipe up to 3 in. in diameter may be butt-welded or lap welded while that above 3 in. in diameter shall be lap-welded. Pipe material shall correspond with that required by the specifications of wrought-iron and steel pipe included in Par. *X-9,* et seq.

X-3. Thickness of Steam Pipe. In determining the thickness to be used for pipes at different pressures and for temperatures not exceeding 700 deg. fahr. the following formula is to be used:

$$P = \frac{2\ S(t - 1/16)}{D}$$

where

P = the working pressure in lb. per sq. in. above atmosphere
t = thickness of wall in inches
D = inside diameter of pipe in inches
S = 3500 lb. per sq. in. for seamless steel pipe
= 3200 lb. per sq. in. for lap-welded steel pipe
= 2500 lb. per sq. in. for butt-welded steel pipe
= 2500 lb. per sq. in. for lap-welded iron pipe
= 2000 lb. per sq. in. for butt-welded iron pipe
= 2000 lb. per sq. in. for brass pipe
= 2000 lb. per sq. in. for copper pipe.

X-4. Feed Lines. High-pressure hot-water and cold-water lines may be made of welded or seamless pipe of wrought-iron or steel as called for under *X-2.* Where the water contains corrosive material or air, brass or copper tubing may be used. In determining the thickness of water pipe the following formula will be used:

$$P = \frac{2\ S\ (t - 3/32)}{D}$$

where: P = water pressure in lb. per sq. in.
t = thickness of pipe in inches
D = inside diameter of pipe in inches
S = 2625 lb. per sq. in. for seamless steel pipe
= 2400 lb. per sq. in. for lap-welded steel pipe
= 1875 lb. per sq. in. for butt-welded steel pipe
= 1875 lb. per sq. in. for lap-welded iron pipe
= 1500 lb. per sq. in. for butt-welded iron pipe
= 1500 lb. per sq. in. for brass pipe
= 1500 lb. per sq. in. for copper pipe.

Where brass pipe is desired for finish or for any other reason it may be used. The brass and copper pipes used shall correspond to the specifications given under Pars..... and the brass pipe shall be half-annealed in order to leave it in proper condition for use in feed-water piping.

X-5. Blow-off Piping. Blow-off pipe is to be of extra strong size and to be made of genuine wrought iron or steel as preferred.

X-6. Pipe Bends. Pipes when bent may be made of steel or wrought iron and after bending are to be free from buckles and blisters and practically circular in cross-section. They are to be bent before being threaded or flanged, and where flanged they are to be refaced to dimensions so that they may be bolted or faced without forcing. Where possible, the tangent length of pipe at the end of each bend should be of a length equal to at least twice the nominal diameter of the pipe, although tangents may be used with lengths which are equal to the nominal diameter of the pipe. The advisable radius to which pipe should be bent should be five or six times the nominal diameter of the pipe, although pipe may be bent to a radius equal to four times the diameter of standard pipe and three and one half times the diameter for extra strong pipe up to 12 in. The thickness of the pipe is to be determined by the formula given in *X-3.* The boiler-feed-line bends are to conform with the above, while for blow-off lines the rules are to be applied to extra strong pipe.

SPECIFICATIONS FOR WELDED AND SEAMLESS STEEL PIPE

X-7. These specifications cover "standard" and "extra strong" welded and seamless steel pipe, but not "double extra strong" pipe. Pipe ordered under these specifications are intended for bending, flanging and other special purposes.

I—Manufacture

X-8. (*a*) The steel for welded pipe shall be of soft weldable quality made by the bessemer or open-hearth process. The steel for seamless pipe shall be made by the open-hearth process.

(*b*) Welded pipe 3 in. or under in nominal diameter may be butt-welded, unless otherwise specified. Welded pipe over 3 in. in nominal diameter shall be lap-welded.

II—Chemical Properties and Tests

X-9. Open-hearth steel shall conform to the following requirement as to chemical composition:

Phosphorus....................not over 0.05 per cent

III—Physical Properties and Tests

X-10. (*a*) The material shall conform to the following minimum requirements as to tensile properties:

	Welded		Seamless
	Bessemer	Open-hearth	Open-hearth
Tensile strength, lb. per sq. in.	50000	45000	48000
Yield point, " " "	30000	25000	26500
Elongation in 8 in., per cent	18	20	18

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

X-11. (*a*) Welded pipe shall be tested at the mill to the hydrostatic pressures specified in Table I.

TABLE I HYDROSTATIC PRESSURES FOR WELDED STEEL PIPE
(Black and galvanized. Pressures expressed in pounds per square inch.)

	"Standard" Pipe			"Extra Strong" Pipe		
Size, (nominal inside diameter), in.	Weight of pipe per linear foot, threaded and with couplings, lb.	Butt-weld	Lap-weld	Weight of pipe per linear foot, plain ends, lb.	Butt-weld	Lap-weld
1/8	....	700	....	....	700	....
1/4	....	700	....	....	700	....
3/8.....	....	700	....	....	700	....
1/2.....	....	700	....	....	700	....
3/4.....	....	700	....	....	700	....
1.......	....	700	....	....	700	....
1 1/4.....	....	700	1000	....	1500	2500
1 1/2.....	....	700	1000	....	1500	2500
2	....	700	1000	....	1500	2500
2 1/2.....	....	800	1000	....	1500	2000
3.......	....	800	1000	....	1500	2000
3 1/2.....	....	...	1000	....	....	2000
4.......	....	...	1000	....	....	2000
4 1/2.....	....	...	1000	....	....	1800
5.........	....	...	1000	....	....	1800
6.......	....	...	1000	....	....	1800
7.......	....	...	1000	....	....	1500
8.......	25.00	...	800	....	....	....
8.......	28.81	...	1000	43.39	....	1500
9.......	34.19	...	900	48.73	....	1200
10.......	32.00	...	600	....	....	....
10.......	35.00	...	700.	....	....	....
10.......	41.13	...	900	54.74	....	1000
11.......	46.25	...	800	60.08	....	1000
12.......	45.00	...	600	....	....	....
12	50.71	...	800	65.42	....	1000

For pipes over 12 in. in inside diameter, the test pressures should be calculated by the formula $P = 2St/D$, in which P = pressure in pounds per square inch; S = fiber stress = 12,000 lb. per sq. in.; t = thickness of wall in inches; D = inside diameter in inches.

(*b*) Seamless pipe shall be tested at the mill to hydrostatic pressures not exceeding that required by the formula:

$$P = \frac{2\ S\ t}{D}$$

in which P = pressure in pounds per square inch; S = allowable fiber stress = 16,000 lb. per sq. in.; t = thickness of wall in inches; and D = inside diameter in inches.

X-12. (*a*) For lap-welded pipe over 2 in. in diameter, a section of pipe 6 in. long shall be flattened between parallel plates until the distance between the plates is one-third the outside diameter of the pipe with the weld located 45 deg. from the line of direction of the applied force, without developing cracks.

(*b*) For butt-welded pipe over 2 in. in diameter, a section of pipe 6 in. long shall be flattened between parallel plates until the distance between the plates is 60 per cent of the outside diameter of the pipe with the weld located 45 deg. from the line of direction of the applied force, without developing cracks.

X-13. For pipe 2 in. or under in diameter, a sufficient length of pipe shall withstand being bent cold through 90 deg. around a cylindrical mandrel the diameter of which is 12 times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld.

X-14. (*a*) Test specimens shall consist of sections cut from a pipe. They shall be smooth on the ends and free from burrs.

(*b*) Tension test specimens shall be longitudinal.

(*c*) All specimens shall be tested cold.

X-15. One of each of the tests specified in Pars. *X-10*, *X-12* and *X-13* may be made on a length in each lot of 500 or less, of each size. Each length shall be subjected to the hydrostatic test.

X-16. If the results of the physical tests of any lot do not conform to the requirements specified in Pars. *X-10*, *X-12* and *X-13*, retests of two additional pipes shall be made, each of which shall conform to the requirements specified.

IV—Workmanship and Finish

X-17. For pipe $1^1/_2$ in. or under in inside diameter, the outside diameter at any point shall not vary more than $^1/_{64}$ in. over nor more than $^1/_{32}$ in. under the standard size. For pipe 2 in. or over in inside diameter, the outside diameter shall not vary more than 1 per cent over or under the standard size.

X-18. Unless otherwise specified, pipe shall conform to the following regular practice:

(*a*) Each end of standard welded pipe shall be threaded.

(*b*) Extra strong welded pipe and standard and extra strong seamless pipe shall be furnished with plain ends.

(*c*) All threads shall be in accordance with the American Standard and cut so as to make a tight joint when the pipe is tested at the mill to the specified internal hydrostatic pressure. The variation from the standard, when tested with the standard working gage, shall not exceed a maximum of one and one-half turns either way.

(*d*) Each length of threaded pipe shall be provided with one coupling, having clean-cut threads of such a pitch diameter as to make a tight joint. Couplings may be made of wrought iron or steel.

X-19. The finished pipe shall be reasonably straight and free from injurious defects. All burrs at the ends of the pipe shall be removed.

V—Inspection and Rejection

X-20. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector, free of charge, all reasonable facilities to satisfy him that the pipe are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Each length of pipe which develops injurious defects in shop working or application will be rejected, and the manufacturer shall be notified.

SPECIFICATIONS FOR WELDED AND SEAMLESS WROUGHT-IRON PIPE

X-21. These specifications cover "standard" and "extra strong" welded wrought-iron pipe, but not "double extra strong" pipe.

X-22. All pipes to be used on locomotives and cars shall be of coiling or bending quality.

I—Manufacture

X-23. (*a*) The iron shall be made from muck bars, made from puddled pig iron, free from any admixture of iron scrap or steel.

(*b*) All pipe 3 in. or under in nominal diameter may be butt-welded, unless otherwise specified. All pipe over 3 in. in nominal diameter shall be lap-welded.

X-24. *Iron Scrap.* This term applies only to foreign or bought scrap and does not include local mill products, free from foreign or bought scrap.

II—Physical Properties and Tests

X-25. (*a*) The material shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	40,000
Yield point, lb. per sq. in.	24,000
Elongation in 8 in., per cent	12

(*b*) The yield point shall be determined by the drop of the beam of the testing machine. The speed of the cross-head of the machine shall not exceed $^3/_4$ in. per minute.

X-26. All pipe shall be tested at the mill to the hydrostatic pressures specified in Table I.

X-27. A section of pipe 6 in. in length shall be flattened until broken by repeated light blows of a hammer or by pressure; the fracture developed shall have a fibrous appearance.

X-28. For pipe 2 in. or under in diameter, a sufficient length of coiling or bending pipe shall withstand being bent cold through 90 deg., around a cylindrical mandrel the diameter of which is 15 times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld.

X-29. (*a*) Test specimens shall consist of sections cut from a pipe. They shall be smooth on the ends and free from burrs.

(*b*) Tension-test specimens shall be longitudinal.

(*c*) All specimens shall be tested cold.

X-30. One of each of the tests specified in Pars. *X-25*, *X-27* and *X-28* may be made on a length in each lot of 500 or less, of each size. Each length shall be subjected to the hydrostatic test.

X-31. If the results of the physical tests of any lot do not conform to the requirements specified in Sections *X-25*, *X-27 and X-28*, retests of two additional pipes shall be made, each of which shall conform to the requirements specified.

III—Workmanship and Finish

X-32. (*a*) For pipe $1^1/_2$ in. or under in inside diameter, the outside diameter at any point shall vary not more than $^1/_{64}$ in. over nor more than $^1/_{32}$ in. under the standard size. For pipe 2 in. or over in inside diameter, the outside diameter shall vary not more than 1 per cent over or under the standard size.

X-33. Unless otherwise specified, pipe shall conform to the following regular practices:

(*a*) Each end of standard pipe shall be threaded.

(*b*) Extra strong pipe shall be furnished with plain ends.

(*c*) All threads shall be in accordance with the American Standard and cut so as to make a tight joint when the pipe is tested at the mill to the specified internal hydrostatic pressure. The variation from the standard, when tested with the standard working gage, shall not exceed a maximum of one and one-half turns either way.

(*d*) Each length of threaded pipe shall be provided with one coupling, having a clean-cut thread of such a pitch diameter as to make a tight joint. Couplings shall be of wrought iron.

X-34. The finished pipe shall be reasonably straight and free from injurious defects. All burrs at the ends of the pipe shall be removed.

IV—Inspection and Rejection

X-35. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector, free of charge, all reasonable facilities to satisfy him that the pipes are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

X-36. Each length of pipe which develops injurious defects in shop working or application will be rejected, and the manufacturer shall be notified.

Koninklijk Instituut van Ingenieurs Celebrates 75th Anniversary

The congratulations of The American Society of Mechanical Engineers are extended to the Koninklijk Instituut van Ingenieurs which celebrated its seventy-fifth anniversary on September 8, 1922. A commemorative medal of this anniversary, which was presented the Society, bears on one side the inscription of the Institute and on the other 1847–1922 To the American Society of Mechanical Engineers.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie
Ralph E. Flanders John T. Wilkin
O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Our Future Lumber Supply—A Challenge to Engineers

THE United States Forestry Service is authority for the statement that at the present rate of lumbering, the forests of the United States will disappear in between fifty and sixty years. The full significance of this situation challenges the attention of the engineer, who best knows the power and irrigation needs of the country and who understands the dependence of water power and water supply upon forest maintenance.

Charles H. MacDowell

Furthermore the engineer is directly interested in the maintenance of a supply of timber for construction, mining and maintenance purposes. He wants this timber produced in sections tributary to efficient transportation and near consuming points, that its cost may be kept within reasonable limits. He knows that the timber he is now using comes a longer distance and bears an average transportation charge much higher than it did a few years ago. As he looks ahead, he anticipates still higher costs, greater transportation difficulties and a definite shortage of supply. As his training is more impersonal than that of the business man, as he deals with known facts and actual materials, as he is not an opportunist dealing mostly with the present, he is naturally concerned over the problems of the future and gives thought to their solution before they become acute.

He knows that efficient, low-cost mining of fuel and other materials is favorably influenced by a supply of cheap timber. He appreciates that railway sleepers, piling and bridge timbers must constantly be renewed, that other old construction must be kept usable and that new work will call for more and more timber notwithstanding the increasing use of steel, concrete, brick, tile and stone. He is informed on the wood-pulp needs of the country. He studies the wasteful, improvident methods of the past in tillage clearing, in lumbering and in swamp reclamation—and its continuance in many sections today. He reads almost daily of vast damage to growing timber from forest fires, often kindled by careless campers or hate-everybody vandals, and he reaches the conclusion that a tree has little present-day standing in its community, that the public generally has small conception of the service the tree has rendered and must continue to render, if all is to go well. He knows that we are destroying and not replanting and he appreciates where that policy leads to.

Upon a realization of the responsibility of the engineering profession, the American Engineering Council appointed a Committee on Reforestation which has studied the situation and is working out a policy. The problem is severe and has many ramifications leading into the social, economic, and legislative phases which demand that, to be effective, the Committee must coöperate fully with other bodies who have spent much effort on the subject. All of this requires time to accomplish thoroughly. In the meantime, however, the Forestry Service has the facts and statistics and the engineering profession can immediately assist in their publication and interpretation to the public.

The engineer has a vision of the future of American industry, his profession is that of building and constructing, and he knows that a crop of trees cannot be grown in less than thirty years. If our civilization is to develop, we must have timber and water, and trees must be planted now that our children may live. Trees must be saved, and in forest districts local engineering societies can be of great assistance in developing campaigns for the prevention of forest fires. Activity should not be limited, however, to forest districts. Every local engineering group may, with great benefit to the community and to posterity, discuss the problem as related to the state and nation and stir the public to a realization of the need for a policy that will perpetuate our lumber supply.

Charles H. MacDowell.[1]

The Potential Flying Man Power of America

THE following figures may throw some light on one of the problems facing the further development of the aeronautical industry. They refer chiefly to the human material available for service as pilots of commercial passenger-carrying machines of the present types.

The combined experience of the Air Services of the United States and the Allies goes to show that twenty-five years is about the upper limit of age for fliers, although in a number of instances much older men have done excellent service.

As regards the lower age limit, it may be said that while in war service, boys of eighteen have shown splendid courage, it is nevertheless believed that for commercial service none younger than twenty-one ought to be employed. The same war experience has developed the fact that roughly only one out of every one hundred young men possesses sufficient mental development and satisfactory physique to stand the strain of flying. The registration in the first draft showed that there were ten and a half million men in the United States between the ages of twenty-one and thirty-one, or, roughly, one million for each year of age, which would mean four million between the ages of twenty-one and twenty-five. Adding another million to allow for possibilities in the way of exceptionally well-preserved older men, we have five million as our source of flying-man-power material. However, from this number about one million would have to be eliminated to cover unavailable colored population and aliens only temporarily located in the country, leaving a remainder of four million, which, with the ratio of one in a hundred referred to above, gives 40,000 as the apparent maximum number of young men available for service as pilots of commercial passenger-carrying machines.

The experience of the Air Service has shown, however, that college men and men coming from the upper-middle classes of society, due to their better training and better home living conditions, form the majority of those acceptable as pilots. Of course only comparatively few such men would take up the driving of commercial aeroplanes as a regular occupation, and it would therefore be reasonable to assume that at best not more than one-half of the men available for this service would actually go into it, which reduces the number to 20,000. At an average load of six persons per machine, we therefore have a potential transportation capacity of

---

[1] Chairman Reforestation Committee of the F.A.E.S. and President of the Western Society of Engineers.

120,000 passengers, which would be materially cut down by the fact that a pilot cannot fly every day.

In fact, with but 20,000 men engaged in the service it would be difficult to keep more than 10,000 machines in the air at any one time, and this, with the average load mentioned, would mean only 60,000 passengers. If we take into consideration the fact that it was only when the automobiles in the country began to be numbered by millions that they became a factor in transportation, we are led to believe that the time when aerial transportation will attain the dignity of an essential industry is still quite distant, unless, of course, the present aeroplane shall be so rebuilt that it will either carry a far larger number of passengers than it does today, or like the automobile, can be driven by any man of ordinary intelligence and average physical qualifications

The Engineer in Government

[An extract from an interview with Edwin Ludlow, Past-President of the American Institute of Mining and Metallurgical Engineers, which appeared in various forms in the *New York World*, the *New York Tribune* and the *Boston Globe*.—Ed.]

"We have an engineer's civilization and a lawyer's government. Although George Washington, our first president, was an engineer, there have been very few engineers in the Government since, and until Mr. Hoover's selection none has held a cabinet position. This is not by way of complaint. It is a simple statement of fact which, if properly understood, may do much to clear up some of the difficulties which confront America today.

"Engineers do not want a government of engineers. They want a government in which engineers can function on jobs that require engineering, while other services will be performed by those who have the peculiar training which is required for them.

"Engineers do not aspire to the bench, although they could do much to prevent crime and make life move along so smoothly that the courts would not be overworked, as they are at present. I am not one of those who think that government can dispense with lawyers. We need to keep track of precedents. We cannot scrap a whole society as we would rebuild a boilerhouse, for the reason that it takes a generation or two to do the job and a whole people must live in that society while it is being scrapped.

"But government must adopt engineering standards if it is not to become so divorced from the people as to be eventually intolerable. It must adopt them because life has adopted them, because the voter no longer lives merely in his voting precinct, but in his industrial connections, which extend in infinite ramifications throughout the country.

"We don't want a government by any one group, but we do want a government in which the knowledge acquired by every group shall be utilized for the public interest."

"A Healthy State of Change"

REFERRING to the hydraulic turbine in a paper published in this issue of Mechanical Engineering, Mr. H. Birchard Taylor and Lewis F. Moody say that after having reached what was considered for a number of years nearly standardized design, this prime mover "is again in a healthy state of change."

It is not always realized how vigorous and general is this state of flux throughout the world of engineering. In the words of a divine of the 16th century, "Nothing is sacred, not even things sanctified by the usage of centuries."

Nothing that has been in use for centuries or decades is sacred to the modern engineer, who is at all times looking for better ways, with the cheerful expectation that they, in turn, will be discarded for something still better as time goes on.

The Survey of Engineering Progress published in the present issue gives numerous examples of this situation. A British company has developed a new high-resistance alloy of high melting point and ability to withstand the action of acids. The Ford Motor Company is busy completing a process for making iron castings direct from the ore, and in this connection uses a mixer with vacuum walls.

In the glassware industry a device for pressing glassware has been developed which is sensitive enough to act in accordance with the degree that the mold is filled with molten material, thus doing mechanically what the brain of the worker had to do formerly.

In the field of prime movers a Diesel engine has been built in which the cylinder heads acting also as pistons are stationary while the cylinders reciprocate, an arrangement which would have been considered as the height of foolishness ten years ago, but which today operates at a mechanical efficiency of sixty-five per cent.

New materials for making cutting tools are appearing all the time, of which iron is no longer the essential constituent; for example, stellite is made up of cobalt and chromium, and copperite of nickel and zirconium. This young family of non-ferrous cutting alloys has now been joined by the Diamond alloy, composed mainly of chromium, molybdenum and tungsten.

In the power-plant field, Ljungström, the designer of the turbine of the same name, presents an air preheater, the remarkable part of which is that it is so built that there is no transference of heat through metal.

Even the staid and conservative locomotive and marine-propulsion industries have not escaped the universal tendency toward "a healthy state of change." Only five years ago the steam locomotive held undivided sway on the rails. Today a large British railroad is employing gasoline locomotives for switching purposes, while a Canadian railroad is going a step further by equipping its switching locomotives not only with a gasoline engine but with a hydraulic drive. In the marine field where paddle wheels and the Ericsson screw propeller have thus far been the beginning and the end, vane wheels and contrary-turning coaxial screw propellers are being tried out with apparently great promise.

There is undoubtedly a state of change, and the welcome thing about it is that it is generally recognized as a healthy one.

The First World Power Conference

The British Electrical and Allied Manufacturers' Association in coöperation with technical institutions and other trade associations in Great Britain has arranged to hold the First World Power Conference in connection with the British Empire Exhibition in the summer of 1924. The purpose of this conference will be to consider how the industrial and scientific sources of power may be adjusted nationally and internationally. The purpose is to be accomplished by considering the potential resources of each country in hydroelectric power, oil and minerals, by conferences of engineers and authorities on industrial research, by consultations of the consumers of power and the manufacturers of the instruments of production, by discussions on the financial and economic aspects of industry, nationally and internationally, and by conferences on the possibility of establishing a Permanent World Bureau for the collection of data, the preparation of inventories of the world's resources, and the exchange of industrial and scientific information through representatives who will be appointed in the various countries.

The officers and advisory committees are made up of outstanding engineers and industrialists in the British Empire and plans are under way for developing, to a similar extent, coöperation in other countries.

Engineers Elected to Assist Eyesight Conservation Council

Two engineers have been elected to the Board of Councilors of the Eyesight Conservation Council of America. They are Prof. Joseph W. Roe, head of the Department of Industrial Engineering in New York University, and Dr. F. C. Caldwell, professor of electrical engineering in Ohio State University.

Professor Roe is a member of the Executive Board of the American Engineering Council of The Federated American Engineering Societies, and president of the Society of Industrial Engineers. Professor Caldwell is chairman of the Committee on Education of the Illuminating Engineering Society. L. W. Wallace, executive secretary of The Federated American Engineering Societies, is president of the Eyesight Conservation Council which is planning surveys in industrial centers and in city and rural schools to determine the economic and physical damage being caused through failure of parents, teachers and factory managers to correct faults which can be remedied.

Engineering and Industrial Standardization

Approval of Existing Standards by the American Engineering Standards Committee

FOR some time the unification and approval of existing standards will necessarily form an important part of this Committee's work. Its Rules of Procedure (Section R-4) provide that "any standard adopted or in process prior to January 1, 1920, may be approved by the Main Committee, if, in its opinion, the standard has been developed by an organization and procedure substantially in conformity with these Rules, or it has, by actual practice, proven its right to become a standard," without the standard having gone through the machinery of a Sectional Committee. While the most satisfactory way of determining the status which a standard has in industry is to submit it to a regularly organized sectional Committee, there are cases in which such a full procedure would be considered a hardship. Hence this provision.

Before acting upon the approval of a standard submitted under Rule R-4, a notice of its submission to the A.E.S.C. is sent to the technical press, and to the industrial association and technical bodies interested, requesting information as to how the standard is meeting the needs of industry. The standard is then referred to a special committee for investigation.

Special Committees

In order to carry out the spirit of the Sectional Committee method, these special committees contain representatives (accredited for the purpose or regular members of the A.E.S.C.) of those bodies most concerned with the standard under consideration, including the organization submitting the standard. Each special committee must contain, however, at least three members of the A.E.S.C. Usually only organizations most directly interested have representation. This permits these special committees to be small, and hence better fitted for prompt action than they would be if made as large and broadly representative as is the case of regularly organized Sectional Committees.

If the special committee finds that "the standard has been developed by an organization and procedure substantially in conformity" with the Sectional Committee method, approval by the A.E.S.C. is immediately recommended.

In the case of the great majority of existing standards, however, this is not true, and hence the special committee must determine the status which the standard has reached in the industry concerned, and the attitude taken toward it by the principal organizations concerned. Generally, each member of the special committee is able, either formally or informally, to reflect the attitude of the organization he represents. This information is supplemented by that secured from the correspondence resulting from the formal publicity statements mentioned above, and by data and information made available to the Committee from other sources. Of course, these special committees function in a way similar to that laid down for the Main Committee (A.E.S.C.), omitting all consideration of technical detail and confining their attention to personnel, procedure, and status. The special committee does therefore consider and report on the recommendation for the status of the standard as: American Standard, Tentative American Standard, or Recommended American Practice.

Interpretation and Revision

As part of their work of preparing recommendations to the A.E.S.C. on existing standards submitted for approval, special committees recommend the formal designation of one or more organizations as sponsors to provide for the interpretation and future revision of the standard. While the organization submitting a standard is usually found to be the most suitable one to assume the responsibility of a continuing sponsorship, this is not always the case, so careful consideration is always given to this part of the reports.

On June 15 the A.E.S.C. voted to withdraw thec lause in the Rules of Procedure (Section R-4) under which existing standards may be approved without going through the machinery of a Sectional Committee, such withdrawal to become effective January 1, 1924. Hence all standards submitted after that date will be considered by regularly organized Sectional Committees.

VENTILATING CODE SUBMITTED FOR APPROVAL BY A.E.S.C. UNDER RULE R-4

The code for the ventilation of public and semi-public buildings adopted by the American Society of Heating and Ventilating Engineers in 1915 has now been submitted to the American Engineering Standards Committee for approval as American Standard.

This code was prepared by a committee of the American Society of Heating and Ventilating Engineers in response to requests from state commissions, legislative bodies, public-health agencies and other organizations for suggestions to be used in the preparation of legislation and regulation regarding the heating and ventilation of buildings. An endeavor was made to formulate this code in such a manner as to make it cover the general features most essential to the maintenance of public health. It aims to protect the public with the least possible expenditure for equipment and without unnecessarily limiting the methods of obtaining the desired results. Section 1 of the code relates to general matters pertaining to all classes of buildings; the remaining three sections cover the ventilation of schools and colleges, factories, and theaters.

Among the states that have utilized parts of the ventilating code in their regulations are: Illinois, Indiana, Kansas, Massachusetts, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Utah, Virginia and Wisconsin.

A thoroughly representative special committee, including all the important organizations interested in the subject, has been appointed by the American Engineering Standards Committee to investigate the status of this code and the desirability of approving it. Mr. Sidney J. Williams, Chief Engineer of the National Safety Council, is chairman of this special committee. The American Engineering Standards Committee would, therefore, be very glad to learn from those interested the extent to which they make use of this code, and to receive any other information regarding the way the code is meeting the needs of industry.

A. I. E. E. Holds Pacific Coast Convention

The eleventh annual Pacific Coast Convention of the American Institute of Electrical Engineers was held at Vancouver, B. C., August 8 to 11, 1922. Technical papers presented at the opening session were: Power Development on the Colorado River and Its Relation to Irrigation and Flood Control, by O. C. Merrill, secretary of the Federal Power Commission, and 220-Kv. Transmission of the Southern California Edison Company and Some 220-Kv. Researches, by R. J. C. Wood, engineer for the Southern California Edison Company.

Three papers on the subject on high-tension insulators were presented at the morning session on August 9 and four papers on technical education at the afternoon session. The official convention dinner was held Wednesday evening.

H. B. Dwight, electrical engineer for the Canadian Westinghouse Company, Ltd., of Hamilton, Ont., and C. H. Holladay, engineer for the Southern California Edison Company, Los Angeles, Cal., spoke Thursday morning on the subject of transmission systems. A paper entitled Exciter Instability, by R. E. Doherty, designing engineer for the General Electric Company, Schenectady, N. Y., was also presented at this session. The electric propulsion of battleships was discussed by Commander A. M. Charlton, *U. S. S. Tennessee*, at the afternoon session, and in the evening a pictorial symposium of power plant comparisons was delivered by R. J. C. Wood, of the Southern California Edison Co., and Joseph Mini, Jr., of the Pacific Gas & Electric Co.

Among the papers presented at the final technical session on Friday morning were: Electrical Engineering Features of the Electrical Precipitation Process, by G. H. Horne, engineer for the Western Precipitation Company, and Electrical Precipitation of Solids from Smelter Gases, by R. B. Rathbun, of the Research Department of the American Smelting & Refining Co.

F.A.E.S. Report States Facts on Twelve-Hour Shift

Committee on Work Periods in Continuous Industries Presents Report, Entitled Twelve-Hour Shift in American Industry, Embodying Investigations by Horace B. Drury and Bradley Stoughton

AT THE meeting of the Executive Board of the American Engineering Council in Boston on September 8 and 9, the Report of the Twelve-Hour Shift in American Industry was received and ordered to be published. The complete Report will be on sale probably by the middle of October. Its particular appeal to engineers lies in its being a simple statement of facts.

This Report is the result of definite investigations and surveys inaugurated by the Committee on Work Periods in Continuous Industries of The Federated American Engineering Societies. The personnel of this Committee is: Dr. H. E. Howe, Chairman, J. Parke Channing, Fred J. Miller, L. P. Alford, L. W. Wallace, Dwight T. Farnham, R. B. Wolf, and Morris L. Cooke. The Report is in three sections. Part 1, prepared by the committee, is a summary of the field reports contained in Part II and Part III and appears in full below, together with excerpts from Part II. Part II is a report by Horace B. Drury on Two-Shift and Three-Shift Operation in the Continuous Industries. Part III, by Bradley Stoughton, is a Comparison of Two-Shift and Three-Shift Operation in the Iron and Steel Industry.

Mr. Drury's investigations of the twelve-hour shift problem in the steel industry and the progress made in this industry in changing from the two-shift day are well known. He is the author of Scientific Management: A History and Criticism, and of Marine and Dock Labor: Work, Wages, and Industrial Relations during the Period of the War. He was senior examiner in industrial relations for the U. S. Shipping Board and for a number of years was in the Department of Economics and Sociology at Ohio State University.

Bradley Stoughton, formerly secretary of the American Institute of Mining and Metallurgical Engineers, has been connected with various steel companies and was at one time Prof. H. M. Howe's assistant at Columbia University. He has been vice-chairman of the engineering division of the National Research Council, and is the author of the Metallurgy of Iron and Steel, a standard work on the subject. He is the inventor of a convertor for making steel castings and a process for oil melting in cupolas. Since his resignation as secretary of the American Institute of Mining and Metallurgical Engineers he has devoted his time to private consulting work.

I—The Twelve-Hour Shift in Industry

Introduction

IN 1920 members of the engineering profession began an organized study of the twelve-hour shift or "long day" in the operation of continuous process industry. The spirit of the investigation reflected the firm faith of the engineers in facts, and the method adopted was that of fact finding and fact using. Such a study is within the purview of engineering activities, for engineering includes "the art of organizing and directing human activities" in connection with "the forces and materials of nature."

The first engineering meeting devoted to this subject was held in October of the year mentioned at the Engineers' Club of Philadelphia. The topic considered was the technique of changing from the two-shift to the three-shift system in continuous-process industries.[1] The papers and discussions at this meeting gave experiences in changing the basis of operation in the manufacture of paper, heavy and light chemicals, oil and cement, and in mining, in supplying water and in several other industries. There was a common technique throughout all these experiences. The record of this meeting, however, did not show to what extent these successful though isolated cases had influenced the respective industries to which they belonged.

Shortly after this meeting an investigation was conducted to determine the progress made in the steel industry in changing from the two-shift day. This study was made possible by a grant from the Cabot Fund. The work was done by Horace B. Drury who reported at a joint meeting of engineering societies held in New York in December, 1920.[1] In this report were listed upward of 20 small steel plants which had changed from the two-shift to the three-shift system with more or less success. It was recognized and stated that the problem of working a like change in the plants of the U. S. Steel Corporation and the large independents, such as Jones & Laughlin and the Bethlehem Steel Company, was quite different from that encountered in the smaller plants.

Early in 1921 the Taylor Society requested the International Labor Office at Geneva to inquire into the status of two-shift work in countries other than the United States. A report was recently issued from the Washington office in memorandum form.[2] It is to the effect that the shorter day is now completely established in the 15 foreign countries answering the questionnaire. Early in 1921 Mr. Drury completed an inquiry into the twelve-hour shift problem of the larger steel manufacturers in the United States. This report was issued in 1922 by the Cabot Fund Trustees. Also in 1921 the Cabot Fund made a grant to The Federated American Engineering Societies to carry on the two studies forming this report. The committee on Work Periods in Continuous Industry was appointed to direct the investigation. To Mr. Drury the committee assigned the task of ascertaining:

1 The extent of two-shift work in continuous-process industries other than the manufacture of iron and steel;

2 The experience of those manufacturers who had changed from two-shift operation to the three-shift or some other system.

To Bradley Stoughton the committee assigned the task of studying and reporting upon the technical aspects of changing from a two-shift to a three-shift system in the iron and steel industry.

There is no direct relationship between the question of abandoning the twelve-hour shift system and the question of adopting the eight-hour shift system. In a sense it is accidental that most employers in changing from the long day have been forced by the mathematics of the situation to adopt a system of three shifts of eight hours each. Certainly the change itself has involved no judgment as to the relative merits of a working day of eight hours as compared with a working day of any other length shorter than 12 hours.

Relatively only a small part of industrial work, 5 per cent to 10 per cent, is on processes which require continuous operation and the number of workers is relatively few. The desirability of abandoning the two-shift system lies not in its extent but in the fact that the 12-hour shift day is too long when measured by twentieth-century ideas as to the proper conduct of industry. Decisions are influenced today by humanitarian considerations as well as the economic, which demands that length of a day which will in the long run give maximum production.

This declaration the Committee believes is not controversial.

Further, there is practical unanimity of opinion in industry as to the desirability of the change provided the economic loss is not too great. The weight of evidence indicates that the change can usually be made at a small financial sacrifice on the part of the workers and of the management. Under proper conditions no economic loss need be suffered. In certain instances, indeed, both workers and stockholders have profited by the change.

Facts developed by our investigation definitely prove that there is no broadly applicable way of striking a balance between the losses and gains inherent in the change from the two-shift system of operation. If any one fact stands out above the others it is that the change cannot advantageously be made by fiat. Our judgment is that to effect the change suddenly or without adequate preparation is sure to result in lowered production. It is also our opinion that when the change is preplanned and the coöperation of every one is enlisted gains will accrue to every one concerned—to workers, management, owners and the public.

---

[1] See *Journal* of the Philadelphia Engineers' Club.

[1] For summary see *Iron Age*, vol. 109, no. 20, May 19, 1922.

[2] See *Bulletin* of the Taylor Society, vol. VI, no. 1.

II—Continuous-Process Industries

The Drury report is a general survey of all industries operating continuously twenty-four hours a day, with special consideration to industries other than iron and steel.

There are few continuous industries which do not have twelve-hour plants. Of some forty or fifty continuous industries a number are overwhelmingly on three shifts. The majority are partly on two shifts and partly on three shifts with three-shift operation in the preponderance. There are a half-dozen industries in which two-shift operation is so nearly universal that it is difficult to find an exception. Outside the steel industry the total number of employees on eight-hour shifts is now considerably larger than the total number of employees on twelve-hour shifts. Taking into consideration all continuous industries, between one-half and two-thirds of all workers on continuous operation are on shifts averaging twelve hours.

The leading continuous industries are:

Group I:
- Iron and steel
- Non-ferrous metals
- Glass
- Portland cement
- Lime
- Brick
- Pottery

Group II:
- Heavy chemicals
- Fertilizers
- Explosives
- Dyes
- Industrial alcohol
- Wood distillation
- Refined corn products
- Soap
- Glue
- Drugs, etc.
- Electrochemical industries
- Sugar
- Table salt
- Petroleum
- Cottonseed oil
- Other oils

Group III:
- Paper
- Flour
- Rubber
- Breakfast foods
- Automobiles
- Textiles
- Mines

Group IV:
- Power
- Gas
- Water supply
- Ice
- Shipping
- Railroads
- Street railways
- Telegraph and telephone
- Mails and express
- Policemen, firemen
- Watchmen

Non-Ferrous Metals. The three-shift system prevails in the non-ferrous metal industries. The change took place during the War, spreading from the West to the East and South.

Glass and Cement. Until recently (1922) the twelve-hour shift was the rule for glass-furnace workers. Other employees about a glass plant are on eight-hour day work. At one window-glass plant, out of 1,300 employees 175 were on a twelve-hour basis. About six years ago the Pittsburgh Plate Glass Co. went to three shifts. Three years ago the majority of other producers went on three shifts.

The cement industry is the second most important industry predominantly on two shifts. In 1920 the largest and third largest companies changed to three shifts.

Lime. About 15 per cent of the men in the plants investigated were on shift work. In most parts of the country the lime industry is uniformly on two shifts.

Brick and Tile, Etc. There are more than 100,000 men in the United States employed in this industry, of whom about 11,000 are on shift work—for the most part on two shifts. In some Philadelphia plants men are on duty 36 hours at a stretch. In Illinois many plants have changed to the three-shift system.

Chemical Industries. Most of the producers of heavy chemicals are on three shifts. Acid-plant employees in fertilizer works are almost universally on twelve-hour shifts. Most continuous-process workers employed in explosive, industrial alcohol and soap plants are generally on this shift. Drug plants are on three shifts. The Niagara Falls electrochemical industries are on three shifts.

Sugar, Salt, Petroleum, Cottonseed Oil, Etc. The Louisiana sugar mills are for the most part on twelve-hour shifts. One sugar refinery in Texas tried three shifts and later reverted to two. The American Sugar Refining Co. changed to three shifts in 1918. Nearly all the beet-sugar plants are on twelve-hour shifts, 210 out of the 225 employees at one Michigan plant being so employed.

In the salt plants the twelve-hour day was formerly almost universal. In Michigan half the men are on shift work—mostly on three shifts.

No examples of two-shift work were found in the petroleum industry. The plants of the Standard Oil group are uniformly on three shifts. Cottonseed crushing presents one of the largest twelve-hour shift problems during the months in which the plants are in operation. Nearly all employees are shift workers in this industry.

Paper, Flour, Rubber, Etc. There are about 88,000 persons in the paper industry, most of whom are on continuous-operation work, although the tendency is toward less shift work. Most of the plants operate on three shifts. Thirty per cent of the workers in Massachusetts were in 1912 on twelve-hour shifts and 70 per cent on eight-hour shifts. In 1921 one of the large associations of paper manufacturers reported 20 per cent of the workers still on two shifts.

Practically all the large flour mills are on three shifts. Most rubber plants have operated under the three-shift system since their establishment.

Automobile plants are for the most part on eight-hour shifts, of which they usually operate two or three shifts per twenty-four hours.

The preparation of cereal foods is usually on three shifts. Some plants use the three-shift operation for women and the two-shift for men. In the textile industry the three-shift plan is used to some extent in the North, but in the plants in the South two shifts are employed, the length of the shifts varying greatly. The hours of work in mines, because of the influence of trade unions, and the nature of the work are fixed at about eight hours per day, with some exceptions in auxiliary occupations, as for engineers, firemen and pumpmen.

Power, Gas, Water Supply, Etc. Work periods in power plants are usually arranged for overlapping shifts of different lengths to provide for variations in the degree of activity. The power departments of factories have been run on the twelve-hour shift down to the last few years. At present there is a tendency to put engineers and firemen on three shifts. The proportion of shift workers in gas works is large. There has been a retention of the system of nine or ten-hour overlapping shifts. In Philadelphia and outlying districts the ten-hour shift is used in conjunction with the eight-hour shift. Water-works plants require less labor for continuous operation than any other public utility. Most plants are now on eight-hour shifts.

Conclusions

1 As to the extent of continuous work in American industry, there are upward of forty continuous industries operating more or less completely upon a shift system. They employ between 500,000 and 1,000,000 wage earners on shift work. Their families constitute from 1,500,000 to 2,000,000 persons, who are dependent upon earnings from shift work.

There are 300,000 wage earners working on twelve-hour shifts. They and their families number more than one million persons.

2 The logical alternative to the two twelve-hour shift system is the three eight-hour shift system, and this is the usual procedure. Nevertheless, other shift systems have been resorted to in a limited way, in changing from the twelve-hour shift. Among these are:

a Operation for a period shorter than twenty-four hours in each calendar day, permitting of a cessation of work from two to four hours, thus establishing two shifts of ten or eleven hours each

b Arranging the work on a nominal twelve-hour shift, so that it can be completed in ten or eleven hours

c Arranging overlapping shifts, thus securing three nine-hour or three ten-hour shifts in twenty-four hours

d Arranging nine- and ten-hour shifts on the five-shift plan.

3 No technical difficulties have been encountered by an overwhelming majority of the plants which have changed from two- to three-shift operation.

There is usually no relationship between the duration of the proc-

ess and the length of the shift, whether the latter is twelve hours long, or a shorter period.

The seeming disadvantage of having three men instead of two responsible for a given product, process, or equipment is overcome by standardizing procedure and establishing control through precision instruments.

4 It is not possible to give inclusive data as to the effect upon the number of shift workers of the change from two- to three-shift operation, because of variations in conditions. In many small plants the number of shift workers has increased in proportion to the increase in number of shifts. In many large plants the number of shift-workers has remained substantially constant when changing from two- to three-shift operation

5 The following factors should be considered in changing from two- to three-shift operation

- *a* The readiness, or unreadiness of the men to do more work per hour under the shorter shift
- *b* The responsibility of management as expressed in planning, supervision and control, which must be of a higher quality than usually prevails under two-shift operation
- *c* The fluctuations in individual earnings and labor costs
- *d* General industrial and economic conditions to determine the time for making the change
- *e* The relationship of work periods for shift and for day workers
- *f* The relationship of wage rates for shift and for day workers
- *g* Number of working days in a week
- *h* Rotation of shifts.

6 The effect of the eight-hour as compared with the twelve-hour shift operation on the quantity and quality of production, absenteeism and industrial accidents has been satisfactory where good management and coöperation of labor have been secured. In practically every major continuous industry there are plants which have increased the quantity of production per man as much as 25 per cent. In a few exceptional cases the increase has been much higher. Evidence shows also an improvement in quality of production following the reduction in the length of shifts.

7 A comparison of wage rates under the eight-hour-shift operation with the rates under the ten-hour shift indicates a general tendency to increase the rate per hour under the eight-hour shift, so that the daily earnings will be the same as they were before the change. In some instances a compromise was made whereby the rate per hour was increased sufficiently to make the daily earnings equivalent to a ten-hour day. In other cases a 25 per cent increase in the rate per hour met with the approval of the men.

8 There is a natural divergence of opinion as to the advantages and disadvantages of the three-shift operation, but the weight of the evidence and the most positive statements are in favor of the three-shift operation.

9 The evidence is conclusive that the extra leisure time of the men under the shorter working day is used to good advantage. It is spent in gardening, truck farming and in doing odd jobs which otherwise would have to be paid for or would not be done at all.

10 A few plants have reverted to the two-shift operation after a trial of the three-shift system. This proportion to the number continuing operation on three shifts is so small as to be negligible. The weight of evidence shows that when a plant changes to three-shift operation it is very unlikely to revert to the former system.

III—The Iron and Steel Industry

The report of Mr. Stoughton deals with the change from the twelve-hour shift to the eight-hour shift in the iron and steel industry from the technical viewpoint. It deals with the practicability of making the change, its effect and the most economical method of changing.

In 1919 the United States Steel Corporation employed approximately 70,000 twelve-hour employees. Altogether, there are perhaps 150,000 wage earners in the entire steel industry on twelve-hour shifts.

A wise executive policy takes into full consideration the importance of the intellectual, the psychological and the physical well-being of labor, realizing that an immediate saving secured by over pressure inevitably becomes a loss in the long run. A refusal to coöperate on the part of the workers is an economic loss. Furthermore it is obviously of no permanent benefit to the men if their hours are shortened beyond the point where the industry can survive under competitive conditions.

The factors to consider in determining the economic number of working hours for a worker are:

- *a* His productivity
- *b* His skill, carefulness, endurance, alertness, intelligence, judgment, regularity, morale and goodwill
- *c* His attraction to the work—so that the industry may benefit from the maximum supply of labor of the highest type
- *d* His persistence in the work so that once he is trained and his qualities known to the management he will remain as an asset to the industry.

Situation in the Iron and Steel Industry. The twelve-hour day is strongly established in the iron and steel industry by long custom and by its unusual adaptability to production requirements.

Recent progress, however, has been in the direction of a shorter day as well as in the reduction of the proportion of men on duty seven days a week. This is shown by the following tabulation which gives the percentage of men so employed.

	Seven days per week		Working 12 hours	
	1910	1920	1910	1920
Blast furnaces	75%	29%	69%	63%
Bessemer mills	18%	12%	65%	75%
Open hearth	24%	17%	76%	50%

Recent improvements in equipment and the adoption of electrical appliances have greatly decreased the frequency and the duration of interruptions of the different processes due to breakdowns, especially in the rolling mills. Also mechanical and other labor-saving devices have lessened the severity of peak loads due to the processes themselves, both in respect to physical endurance and heat exposure. For instance:

1 Oxygen is used to open the tap hole, and mud gun to close it.

2 The cast house with its severe manual labor has been replaced by an arrangement which allows the liquid pig iron to run directly into ladles supported on railroad cars. Under this arrangement a former crew of twenty-one men is reduced to five—sometimes to three men.

3 Ore and the materials formerly piled, shoveled, and wheeled by hand are now handled from railroad cars to the furnace hopper entirely without manual labor. Six handle 2,000 tons when previously it required twenty-three to handle 800 tons. This enables the fillers to work continuously.

4 At the Ford plant (which is a blast-furnace only), instead of allowing the fillers to rest occasionally as is usual in the twelve-hour plants, with consequent lowering of the stock-line level in the furnace and of the furnace efficiency, an automatic record is kept of the level of the stock line in the furnace, of the temperature of the top gases and of the time at which the charging skip makes its trips. Continuous adherence to the standards set can be insisted upon and the rest periods and furnace inefficiency eliminated because of the high wages and the eight-hour day. This condition affects the men in front of the furnace as well as the fillers.

These changes in blast-furnace operation have made possible:

- *a* Reduction in number of workmen
- *b* Increase in overall efficiency
- *c* Elimination of floating gang
- *d* Reduced absence, tardiness, labor turnover
- *e* Greater regularity of operation and loss of time
- *f* Fewer accidents and breakdowns
- *g* Less costly repairs
- *h* Decreased cost of production.

It is emphatically asserted by blast-furnace managers working the eight hours that the higher grade of labor attracted by the shorter hours, the greater care and alertness, better work, and more skillful operation are all reflected in a saving in cost of production as enumerated in the last five items above. Cost figures are confidential but furnace operators working under the eight-hour day assured the investigator on more than one occasion that the cost of producing pig iron is less on the eight-hour than on the twelve-hour day.

At the Ford plant, although the men are paid 75 cents and upward per hour and work only eight hours—as compared with 27 to 30 cents per hour at various twelve-hour plants visited; nevertheless

they make pig iron cheaper than it can be bought. This is attributed to the greater efficiency of labor and of operation.

In the case of open-hearth furnaces:

1 The charging machine has greatly reduced the work of the crew on the charging platform
2 Electric appliances for raising furnace doors, mechanical appliances for changing valves, etc., have reduced labor
3 Oxygen is used in tapping and compressed air for repairing the hole. A mechanical appliance has replaced hand shoveling of recarbonizer into the ladle. Repairs are made with the mud gun.

Economical open-hearth operation is dependent upon the care, expertness, and loyalty of the men. The shirking of duty is costly. Carelessness is more likely to occur on a twelve- than on an eight-hour shift.

In the case of rolling mills, eight-hour-shift operation produces a decided increase of efficiency in the case of the lever men, manifested in:

a Increased output
b Less "cobbles" or spoilage
c Less repairs
d Elimination of "spell hands."

Method of Procedure. To successfully change from the twelve- to the eight-hour shift certain definite preparations must be made:

1 The equipment must be in satisfactory condition to respond to increased intensity of operation
2 The coöperation of the workmen must be secured
3 Necessary labor must be available
4 The technical staff must be prepared to furnish full information regarding available labor-saving appliances
5 Existing "bottle necks" must be eliminated and probable ones avoided
6 Peak loads must be studied with special reference to the installation of mechanical appliances
7 The change must not be made during a period of labor unrest
    a After strife
    b When bitterness exists
    c When mutual confidence is lacking
    d When labor is arrogant or elated by the defeat of the management
8 The change must not be made too suddenly
9 Management must be able to influence thoroughly against
    a Tardiness and absence
    b Deliberate shirking
    c Misuse of extra hours of free time.

10 Where possible, make time studies of the work to determine how much more the twelve-hour crew could produce per hour if it worked with greater efficiency. Pay the same hourly rate for eight hours as for twelve and add a bonus which will enable the men by becoming more efficient to maintain their daily income.

The Economic Situation. The United States has the most profitable iron and steel industry in the world, making more money and more output than all the rest of the world put together and exporting its product in successful competition with foreign countries. The majority of managers and executives with whom the matter was discussed believe that the good of the industry can be better served by eliminating the twelve-hour day than by increasing dividends, provided by means of labor-saving devices and in other ways this step can be taken without serious injury to the industry.

The fact that already many plants operate successfully on the three-shift system indicates that profits need not suffer if the change is made with wisdom. The cost of all labor on either system at the blast furnace is less than $1 per ton of pig. Judge Gary testified before the Lockwood Committee in June, 1922, that the U. S. Steel Corporation could produce at $2 per ton less than its competitors. This shows what low overhead and technical skill can accomplish.

The operating labor in the case of pig iron is from 5.8 to 8 per cent of the total manufacturing cost. Only a part of the labor in the industry is working the twelve-hour day. If that labor was changed to the eight-hour day and paid as much per day as it is now getting for twelve-hour work even without securing any compensating advantages through increased efficiency, morale, etc., the total manufacturing cost of the product would be increased only from 3 to 15 per cent. This is in most cases less than the variations in cost already experienced by competing plants, due to difference in efficiency of equipment, technical skill, purchasing, location, capital resources, overhead expense and advantages due to good management.

As a matter of actual experience, it is known that some plants have changed from the twelve-hour to the eight-hour day and reduced their labor costs. Others have reduced their total manufacturing costs. Others are operating on the eight-hour day with satisfaction to management and stockholders.

Results in such plants may be summarized as follows:

a Although the plants which have adopted the three-shift system are paying wages a little less than is paid in corresponding plants working twelve-hour shifts, the three-shift plants have sufficient labor, both skilled and unskilled.

b The management believes that the shorter hours attract a better class of labor.

c Every executive interviewed stated that the labor turnover is less on the three-shift system than on the two-shift system.

d Sufficient skilled labor can be trained in the plant if the change is made with the coöperation of the men, and if it is made gradually.

e It is unnecessary to pay a full twelve-hour wage to skilled labor to secure a sufficient number to work the eight-hour day.

Advantages of the Eight-hour Day. The change from the twelve to the eight-hour day has secured results sufficient to compensate in whole or in part for the extra cost:

1 Increased efficiency manifested in increased production per man per hour and per machine per day due to:
    a Better physical and mental condition of the men
    b Better class of men attracted
    c Better conduct of operation
    d More uniform operation
    e Better quality of product
    f Less fuel used
    g Less waste
    h Less repairs to equipment
    i Longer life of apparatus.
2 Better morale resulting in:
    a Less absence and tardiness
    b Less shirking
    c Better discipline due to:
        Better spirit of the men
        Greater pressure which foremen can and will exert because they do not have to hold back out of sympathy for tired men.

3 Elimination of the "floating gang" which is maintained to give twelve-hour men a day off a week.

4 Greater prestige with the public—which is invaluable in time of strife.

GENERAL CONCLUSIONS

There are certain outstanding conclusions in regard to the change from the twelve- to the eight-hour day which occur in both reports:

1 The tendency throughout the world is toward the abolition of the twelve-hour shift.

2 In almost every continuous industry there are plants which are operating on an eight-hour-shift basis in competition with twelve-hour-shift plants.

3 To make the change from the three-shift operation successfully and economically it is necessary that:
    a The majority of the workmen appreciate the value of the extra leisure
    b The workmen be willing to concede something in the way of daily income. The plan which divides the extra labor cost equally between the men and the company has been acceptable in a number of cases.
    c A survey of the field be made for labor-saving equipment and methods of management which will facilitate the work after the change is made
    d The plant management study equipment and methods of operation and make every change in the plant and in the organization possible to facilitate operation under the three-shift system

e All equipment be in condition to respond to increased intensity of operation

f The workmen be instructed in their duties under the new system and the coöperation of the whole organization be secured

g The extra trained labor required be available

h The time for the change be selected with great care. Periods of labor unrest must be avoided, the success of each step assured before another is taken.

5 In a number of plants where the change has been made with success the management reports these results:

a Better physical and mental condition of workmen

b Improvement in class of workmen

c Less shirking, tardiness, absenteeism and labor turnover and industrial accidents

d Improved spirit and cooperation of workmen

e More exact adherence to instructions as to working methods

f More uniform methods with consequent attainments of standards, etc.

g Better quality of product

h Increased output per man per hour

i Less material used

j Wastes eliminated

k Longer life of equipment and less repairs

l Greater prestige with the public.

Excerpts from Mr. Drury's Report

Mr. Drury's conclusions are reproduced in the foregoing pages. His report gives the results of his investigations in forty-four centers of forty-two continuous industries. A reproduction of the findings in these industries is out of the question in these pages but three short excerpts from the facts relating to cement, soap and sugar refining are of interest and are reproduced here.

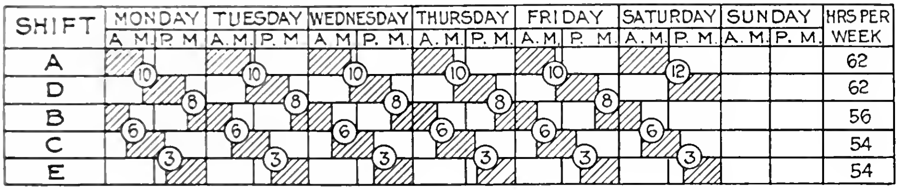


FIG. 1 FIVE-SHIFT SYSTEM, PROCTOR & GAMBLE COMPANY

TABLE I COMPARATIVE LABOR EFFICIENCY, 86 PORTLAND CEMENT PLANTS, 1920 (Data supplied by the Committee on Conservation, Portland Cement Association)

		Man-hours to produce one barrel		
Shift system	Number of plants	Average all plants in group	Most efficient plant in group	Least efficient plant in group
Two-shift group	51	1.035	0.551	1.940
Three-shift group	22	0.823	0.466	1.540
2–3 shift group	13	0.756	0.470	1.140

CEMENT

Table I shows comparative labor efficiency in eighty-six plants in the cement industry. In 1920, the year this table was compiled, these eighty-six plants made up between fifty and sixty per cent of the cement-making capacity in the country. The small quantity of man-hours required per barrel of cement when using a combination of two or three-shift systems is especially noteworthy. This combination provides for the use of two-shifts in departments where conditions of temperature and supervision are not so severe.

SOAP

In the manufacture of soap the general sentiment in the industry is against continuous operation. However, about twenty-five per cent of the employees of the Proctor & Gamble Company are on continuous work. In the spring of 1921 this company installed a modification of the three-shift system called the five-shift system. This scheme gives shift workers daily turns of nine or ten hours. The number of shift workers is constant throughout the twenty-four hours and each man reports for duty the same hour each day of the week. This is shown in Fig. 1. The conspicuous feature of this plant is the introduction of two interweaving series of shift workers.

The five-shift system as thus outlined has two important characteristics other than its even succession of nine and ten-hour shifts:

First, never more than half of the men are relieved at any one time, obtaining thereby a greater continuity in the work.

Second, a man does not continue today the work which he did yesterday, but takes up what his neighbor on the parallel shift had been doing. This makes it necessary to teach men to serve in two positions. It will be observed that no shift begins or ends work between 12 midnight and 6 a.m.

At the end of the first six months of operation under this system, the company expressed satisfaction with the plan. The production per hour was as much as under the three-shift system. The results were decidedly better than under the two twelve-hour shift system. The five-shift arrangement meant some more work to teach workmen two different jobs.

REFINING OF SUGAR

More than usual importance attaches to the question as to whether a sugar refinery can operate on three shifts without increasing cost. The industry in manufacturing and retailing is an example of a tremendous business done on a moderate and indeed close margin of profit. Competition is intense. It would be impossible for one company to assume a manufacturing cost substantially higher than others. So it is worth while to give special attention to the experience of the American Sugar Refining Company which went to three shifts in the spring of 1918.

There are two elements in the question of cost: (1) The extra compensation due to increased hourly rates and number of men; and (2) productive efficiency.

In the case of the American Sugar Refining Company the first of these two elements was so favorable on three-shift operation as to practically solve the problem of cost.

At the time of the change in the spring of 1918 there was no demand for a reduction in hours, but general conditions were such as to make it likely at any time. It was also expected that an increase in wages would be demanded. In view of the general conditions and the long desire to change to three shifts, the men seized an opportunity to put hours and wages on such a basis as to avoid friction. The management therefore reduced the hours from 12 to 8 and increased the hourly wage rate 50 per cent. The men thereby suffered no appreciable loss in weekly earnings. The company on the other hand did not face any extra wage cost due to the change, for wages in competing plants on a twelve-hour basis were soon increased 50 per cent.

Nevertheless, the change to three shifts also worked out favorably as respects the second aspect of the cost question, the productive efficiency. The company has no exact figures covering the subject but it is the judgment of the men in charge both in the general office and in the largest of the refineries that the efficiency of employees is 15 per cent higher than it was on two-shift operation. The management knows, for instance, that on jobs where the work has remained substantially unchanged, the men are doing more now than their predecessors were doing ten years ago. The figure quoted does not have reference to the output of equipment, but that has

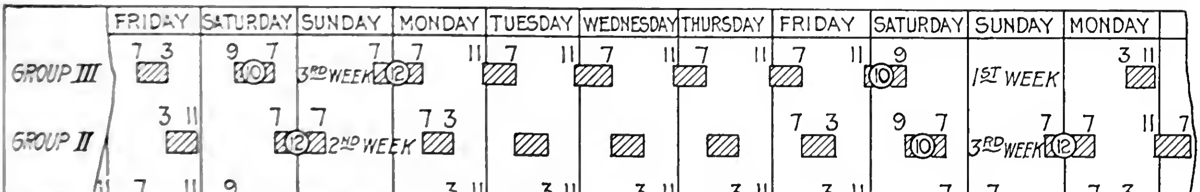


FIG. 2 ONE DAY'S REST IN SEVEN AS WORKED OUT IN THE BROOKLYN PLANT OF THE AMERICAN SUGAR REFINING COMPANY

apparently improved. In 1921 the Brooklyn Refinery broke output records for many years past. The management says that absenteeism and labor turnover have decreased.

According to the schedule, the groups work 54, 50 and 52 hours per week, or 52 hours per week average. Overtime is paid for any work done between 7 a.m. Sunday and 7 a.m. Monday, so as to make the average number of hours pay per week amount to 54. But ordinarily the work stops at 6 a.m. rather than 7 a.m. Sunday morning giving an actual weekly average of $53\frac{2}{3}$ hours pay.

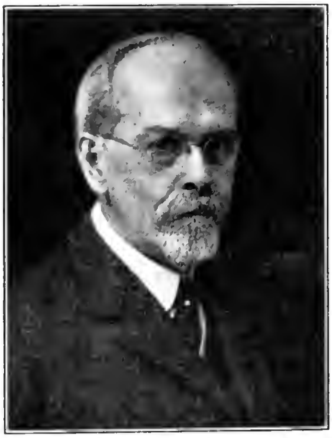
It will be observed that two Sundays out of three the men get 24 hours off, the third Sunday 54 hours. One week end, a given group works one 10-hour shift; the next week end, it works one 12-hour shift; and the third week end it works a 10-hour shift before and a 12-hour shift after the period off. Through the week all shifts are 8 hours. The minimum rest period between shifts is 16 hours.

The plant itself operates all but 12 hours, or in practice 13 hours, out of the week.

Fig. 2 illustrates an interesting feature of the three-shift system as worked out at the Brooklyn Refinery. It is a plan for providing one day's rest in seven (as required by the New York State Law) without the introduction of relief men. The day-workers of the American Sugar Refining Company are on a 50-hour week, with a few on 60 hours. On Sunday about 200 men (in the one refinery) work on repair work which can not be done during the week. These men are given a week-day off.

Coleman Sellers, Jr., Former A.S.M.E. Manager, Dies

Coleman Sellers, Jr., was born in Cincinnati, Ohio, September 5, 1852 and died after an acute illness of several months in Bryn Mawr, Pa., on August 15, 1922. Mr. Sellers' health became impaired as a result of his heavy duties during the war as head of the draft board in his district.


Coleman Sellers, Jr.

After an early education received in the private schools of Philadelphia, Mr. Sellers entered the University of Pennsylvania, where he was a first-honor man throughout his course. He was graduated in 1873 with the degree of Bachelor of Science, and three years later received his Master's degree for shop tests and a thesis relating to steam-boiler injectors. He entered the employ of William Sellers & Co. in November, 1873, and from 1886 to 1902 was assistant manager. In 1902 he was appointed engineer, and on the death of William Sellers was made president of the company. He continued in these capacities until the time of his death.

Mr. Sellers was of the sixth consecutive generation of a family engaged in the mechanical arts. His father, Coleman Sellers, a Past-President of The American Society of Mechanical Engineers, had a long career as an inventor. The sound judgment, ingenuity and experience of Coleman Sellers, Jr., contributed in full measure in maintaining the high reputation of his company as a designer of machine tools and appliances in its special field.

From 1890 to 1893 Mr. Sellers served The American Society of Mechanical Engineers on its Board of Managers; he was among the earliest to join the Society, having become a member in 1882. He was also a member of the American Philosophical Society, the American Society of Naval Architects and Marine Engineers, the American Academy of The Fine Arts, the University Club of Philadelphia, the City Club, Contemporary Club, Pennsylvania Society of Sons of the Revolution, and the New England Society of Pennsylvania. He was one of the founders of the Philadelphia Engineers' Club, had served on the Board of Managers and later as vice-president of The Franklin Institute, was a former president of the Chamber of Commerce of Philadelphia, and from 1908 until his death was one of the three State Commissioners of Navigation for the Delaware River.

Book Notes

Les Applications Elémentaires des Fonctions Hyperboliques a La Science de L'Ingénieur Electricien. By A. E. Kennelly. Gauthier-Villars et Cie, Paris, 1922. Paper, 6×9 in., 153 pp., diagrams.

Dr. Kennelly spent the academic year 1921–22 as an exchange professor in France, where he delivered a course of lectures in universities and engineering schools upon the applications of hyperbolic functions to electrical engineering problems. This monograph, based upon these lectures, places before the French student, in abridged form, the material already published in English by the author.

Chain Stores. By Walter S. Hayward and Percival White. First edition. McGraw-Hill Book Co., New York, 1922. Cloth, 6×8 in., 411 pp., illus., \$3.50.

This book sets forth the principles of the operation, organization, management and control of chain stores, and is intended for the executive at headquarters, the branch manager and his assistants. The authors hope it will also prove stimulating to independent retailers and others interested in methods of distribution.

Crain's Market Data Book and Directory of Class, Trade and Technical Publications. Second edition, 1922. G. D. Crain, Jr., Chicago. Cloth, 6×9 in., 456 pp., \$5.

This is a reference book for advertisers. An account of trade, industry and profession is given which presents the statistical and marketing data necessary to give the advertiser or merchant a picture of the field as a whole. Each account is supplemented by a full list of American trade journals devoted to that industry, with their addresses, circulation, advertising rates, etc. A list of important foreign trade journals is included.

Elektrische Behandlung Von Gasen. Herausgegeben von Henri Silbermann. Dr. Max Janecke, Leipzig, 1922. Paper, 6×8 in., 348 pp., illus., diagrams, \$3.20.

This work is a summary of information upon the effect of electric discharges upon gases, especially the atmosphere, as disclosed by an examination of the German patent records. The subjects discussed are the activation of oxygen (preparation of ozone), the separation of solid or liquid particles from gases (purification by dust and mist removal) and the double decomposition of reaction masses containing at least two elements (synthesis of nitric oxid, ammonia, cyanogen, etc.). The book is a convenient record of the present state of these arts.

Elements of Radio Telephony. By William C. Ballard. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Fabrikoid, 5×7 in., 132 pp., illus., plates, diagrams, \$1.50.

This book gives a simple discussion of what happens when messages are sent and received by radio, of the apparatus required to produce these effects, and of its method of operation. It also gives practical unbiased information for the experimenter who wishes to learn what apparatus is necessary to produce certain results. Being intended for non-technical readers, the use of mathematics is avoided almost entirely.

The Gantt Chart. By Wallace Clark. Ronald Press Co., New York, 1922. Cloth, 6×9 in., \$2.50.

This book explains the principle of this chart, the method of making and reading it, and shows its application to machine, man, planning, load and progress records. One chapter describes their use by the Shipping Board during the war. It will enable those interested to apply this method of charting their records to their own activities.

High-Voltage Power Transformers. By William T. Taylor. Sir Isaac Pitman & Sons, Ltd., London and New York, 1922. (Pitman's technical primer series.) Cloth, 4×6 in., 117 pp., illus., diagrams, \$0.85.

A general practical survey of the characteristics, construction, installation, operation and troubles of modern high-voltage power

transformers. Intended for station operators and general electric engineers and so does not treat problems of fundamental design, details of construction and similar topics which chiefly concern manufacturers.

Hydraulics with Working Tables. By E. S. Bellasis. Third edition. E. P. Dutton & Co., New York, 1922. Cloth, 6×9 in., 348 pp., tables, illus., $8.

In this edition the book has been brought thoroughly up to date and subjected to careful and drastic revision. The chief object is, as before, to deal thoroughly with the facts, laws and principles of hydraulics, and to keep always in view their practical aspects. Fresh discussions on all the most important coefficients are now given and specific recommendations are made. A new set of coefficients for pipes is given.

Fresh matter has been added on weirs and weir-like conditions, on discharge measurement by means of pipe diaphragms, on standing waves and on the laws governing silting and scour. The book is intended to meet all the requirements both of the student and of the engineer.

Hydro-Electric Installations of India. By Shiv Narayan. The Author, Poona, India, 1922. Cloth, 6×10 in., 302 pp., illus., 9 rupees.

This book presents in popular form the principal facts concerning the hydroelectric plants and projects of India. It also explains the hydraulic and electrical principles involved, the general design and installation of plants and the economic factors to be considered. The work is intended to direct attention to the water-power resources of the country and to serve as a guide to engineers and capitalists interested in the utilization of them.

Industrial Physics Mechanics. By L. Raymond Smith. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 5×8 in., 226 pp., illus., diagrams, $1.75.

The present trend in education has created a demand for textbooks in which the material presented is closely connected with the every-day life of the student. This volume is an attempt to meet this demand by providing an elementary, practical textbook on mechanics, suitable for use in high schools and vocational schools.

Marine Power Plant. By Lawrence B. Chapman. First edition. McGraw-Hill Book Co., New York, 1922. Cloth, 6×9 in., 320 pp., illus., diagrams, $4.

The purpose of this book is to bring before the student the thermodynamics of the marine power plant, the types of machinery used for ship propulsion, and to give him a comprehensive idea of the layout and purposes of the auxiliary machinery. It is intended as a first book in marine engineering for students of naval architecture, marine engineering and ship operation, but should prove useful also to sea-going engineers and shipowners.

Mechanical Testing. By R. G. Batson and J. H. Hyde. Vol. 1. E. P. Dutton & Co., New York, 1922. (Directly-useful technical series.) Cloth, 6×9 in., 413 pp., plates, illus., diagrams, $9.

The object of this book is to place before the engineer, the manufacturer and the student the conditions governing modern testing, the particulars of standard testing-plant equipment and its limitations and the information necessary to appraise the results obtained at their true values. Volume one is confined to materials of construction, metals, timber, stone, brick, concrete, limes, cements and road materials.

Modern Practice in Heat Engines. By Telford Petrie. Longmans, Green and Co., New York, 1922. Cloth, 6×9 in., 264 pp., illus., plates, diagrams, $5.

A concise treatment of the subject of power from heat engines which attempts to show how far theory may be applied to the design of modern types. The book is divided into three sections, steam, prime movers, and internal-combustion engines. Each section contains chapters descriptive of late types and on the principles of design. The results of a number of reliable modern tests are given.

Modern Pumping and Hydraulic Machinery. By Edward Butler. Second edition, revised. Charles Griffin and Co., Ltd., London, 1922. Cloth, 6×9 in., 475 pp., illus., diagrams, $9.

The author has attempted to present in a clear, concise form information specially useful to engineers, designers and others engaged in the construction or application of pumping and hydraulic machinery to various purposes. The whole range of pumping appliances, as well as the machinery used in hydraulic transmission and power generation, is treated systematically and exhaustively.

Practical Wireless Telegraphy. By Elmer E. Bucher. Revised edition. Wireless Press, New York and London, 1921. Cloth, 6×9 in., 336 pp., illus., diagrams, $2.25.

The author endeavors to give non-technical students and practical telegraphers an understanding of the working of modern commercial apparatus. Stress is laid upon the construction of apparatus and the methods of manipulating it, without attempting a complete account of the scientific principles underlying it.

Principles of Leather Manufacture. By H. R. Procter. Second edition. E. & F. N. Spon, Ltd., London, 1922. Cloth, 6×10 in., 688 pp., illus., 32 s.

This treatise deals with the general scientific principles of the industry, without describing in detail its practical methods, although many practical points are discussed. The second edition, issued after an interval of eighteen years, has been thoroughly revised, so that the new points of view occasioned by the advances in physical and colloidal chemistry are covered. The volume is intended for chemists and practical tanners.

Principles of Interchangeable Manufacturing. By Earle Buckingham. First edition. Industrial Press, New York; Lond., Machinery Publishing Co., Ltd., London, 1921. Cloth, 6×9 in., 254 pp., illus., diagrams, $3.

In this treatise the author first takes up the general principles involved in interchangeable manufacturing, and then devotes a chapter to the definition of the terms used. The influence of interchangeable processes on machine design and the purpose of models are then dealt with, and followed by a detailed discussion of the dimensioning of drawings for use in interchangeable manufacturing. This is followed by an account of the principal elements that govern economical production, the equipment required, the gage equipment and the principles of inspection and testing. Special chapters treat manufacturing for selective assembly, small-quantity methods and the service factor in interchangeable manufacturing.

Steam Turbines. By William J. Goudie. Second edition. Longmans, Green and Co., London and New York, 1922. Cloth, 6×9 in., 804 pp., plates diagram., illus. $10.

This book has been written primarily to suit the requirements of engineering students, but the author hopes that the methods of calculation outlined in it will be useful also to engineers engaged in the design or operation of steam turbines. The first portion of the text is devoted to detailed descriptions of commercial representatives of the various types now on the market. The second portion treats what may be termed the "technical" part of the subject; nozzles, blading, rotors, gearing, steam consumption, proportions, governing, etc. This edition has been completely rewritten and enlarged.

Uber die Festigkeitsberechnung von Schiebetoren und Ahnlichen Bauwerken. By Adolf Eggenschwyler. H. A. Ludwig Degener, Leipzig, 1921. Paper, 6×9 in., 148 pp.

This monograph discusses the problems in statics involved in the design of sliding sluice gates, floating docks, movable weirs and similar hydraulic structures composed of steel plates and frames. The statical problems that they present are, according to the author, midway between those of bridge building and shipbuilding; and have until now been much neglected. In consequence, the calculations of designers have been based on false assumptions, which have frequently led to an extravagant use of material and to lack of the necessary strength.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Nomenclature. Grinding Wheel Nomenclature, H. A. Plusch. Machy. (N. Y.), vol. 28, no. 12, Aug. 1922, pp. 979–980, 1 fig. Brief description of various types of wheels.

ABRASIVES

See EMERY PAPER.

ACCOUNTING

Industrial. Present-Day Problems in Industrial Accounting, Stanley G. H. Fitch. Jl. of Accountancy, vol. 34, no. 1, July 1922, pp. 1–10. Balance-sheet and its connection with profit-and-loss statement; gives various other features of industrial accounting.

AERONAUTICAL INSTRUMENTS

Air-Speed Indicators. Air-Speed Indicators, Franklin L. Hunt. Nat. Advisory Committee for Aeronautics, Aeronautic Instruments Section III, Report no. 127. Description of typical instruments; altitude correction charts; wind-tunnel, static and flight tests; ground-speed measurements.

AIR COMPRESSORS

Centrifugal. Centrifugal Compressors (Les compresseurs centrifuges), Robert Huguenin. Technique Moderne, vol. 14, no. 6, June 1922, pp. 241–250, 10 figs. Characteristics of centrifugal compressors for mines. Tests with compressors at Orange-Nassau mines.

High-Pressure. Calculation of High-Pressure Compressors (Berechnung von Hochdruck-Kompressoren), P. Ostertag. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 25, June 24, 1922, pp. 649–650, 3 figs. Gives entropy diagram of a multiple-stage piston compressor for a given final pressure for finding pressure, temperature and volume conditions; calculates cylinder dimensions.

Intercooling. Compressor Intercooler Complication, Frank Richards. Power Plant Eng., vol. 26, no. 13, July 1, 1922, pp. 669–670, 2 figs. Moisture in air at different stages of compression.

Transformers. Air Transformer Shows Remarkable Efficiency, D. M. McLean. Power House, vol. 15, no. 11, July 20, 1922, pp. 25–26, 5 figs. Description of device for blowing forge fires and similar purposes.

[See also TURBO-COMPRESSORS.]

AIR CONDITIONING

Air Purifier. The "Vigoratair" System of Air Purification Eng. Production, vol. 5, no. 95, July 27, 1922, p. 82, 1 fig. Description of details of "portable" air purifier for factory ventilation See also Machy. (Lond.), vol. 20, no. 510, July 6, 1922, pp. 437–438, 2 figs.

Cooling Buildings. Cooling of Theatres and Public Buildings, Fred Wittenmeyer. Ice & Refrigeration, vol. 63, no. 1, July 1922, pp. 13–14. Capacities for and methods of cooling theaters; test on air-cooling apparatus at Blackstone Hotel; costs.

AIRCRAFT

Structural Strength. Structural Strength of Aircraft. Flight, vol. 14, no. 27, July 6, 1922, pp. 385–386. English certificates of airworthiness to be granted only to design meeting specifications in tables shown for general class and for commercial class.

Testing to Destruction. Testing Aircraft to Destruction, Wm. D. Douglas. Aeronautical Jl., vol. 26, no 138, June 1922, pp. 195–222 and (discussion) 222–230, 36 figs. Examples of certain types of defects which are revealed by strength tests. Necessity for supplementing calculations. Description of present methods.

AIRPLANE ENGINES

Air-Cooled Radial. The Siddeley Air-Cooled Radial Engines. Aeroplane, vol. 23, no. 3, July 19, 1922, pp. 43–44 and 46, 8 figs. 7- and 14-cylinder engines developing respectively 160 and 320 hp.; gives data of tests.

The Armstrong-Siddeley "Jaguar" Radial Aero Engine. Flight, vol. 14, no. 29, July 20, 1922, pp. 407–410, 10 figs. 14 cylinders disposed in two rows; outfit rated 350 hp.; cylinders have aluminum heads and steel barrels.

Wright. New Wright Engines for Naval Aviation. Aviation, vol. 13, no. 5, July 31, 1922, pp. 124–125, 2 figs. Brief description and data of tests of Wright model E2, 180-hp. engine, and Wright model T2 525-hp. heavy-duty engine.

Wright-Navy Twelve Reflects Progress in Aircraft Engine Design, Herbert Chase. Automotive Industries, vol. 47, no. 2, July 13, 1922, pp. 57–61, 5 figs. Dependability over long periods of operation is combined with low fuel consumption and unusual degree of accessiblity. Engine develop 525 hp. but has same overall length as Liberty-twelve. Open end sleeve used and babbitt bearings eliminated.

AIRPLANES

De Havilland. The D. H. 37. Aeroplane, vol. 23, no. 4, July 26, 1922, pp. 65–67, 12 figs. Three-seater tractor biplane; Rolls-Royce "Falcon" engine.

Bleriot Spad 45. The Bleriot Spad 45 Four-Engined Airliner, John Jay Ide. Aviation, vol. 13, no. 1, July 3, 1922, p. 13, 1 fig. French airplane fitted with four 275-hp. Hispano-Suiza engines accomodates 17 passengers and crew of 3; high speed, 124 m.p.h.

Commercial. The Bellanca CF 5-Seater Cabin Airplane. Aviation, vol. 13, no. 7, Aug. 14, 1922, pp. 183–185, 2 figs. Commercial airplane designed to carry 5 people with fuel for 600-mile flight.

The Design of a Commercial Aeroplane, G. De Havilland. Aeronautical Jl., vol. 26, no. 139, July 1922, pp. 204–211 and (discussion) 211–218. Consideration of this type of engine; construction; stability; passenger accomodations; gasoline systems; controls.

Handasyde Monoplane. The Handasyde Monoplane, Type H. 2. Flight, vol. 14, no. 29, July 20, 1922, pp. 412–416, 16 figs. Describes new cantilever-type machine with novel wing construction.

Landing. Landing of Airplanes (L'atterrissage des Avions), Philippe. Aerophile, vol. 30, no. 7–8, Apr. 1–15, 1922, pp. 101–103, 2 figs. Discusses landing operations and makes calculations of forces in question.

Sport. The Entler All-Metal Sporting Cantilever Biplane. Flight, vol. 14, no. 26, June 29, 1922, p. 375, 2 figs. Product of Entler Works, Wilhelmshaven, Germany. Characteristics: Span (top) 23 ft., (bottom) 19 ft. 6 in.; chord (top) 4 ft., (bottom) 3 ft. 3 in.; length 16 ft. 9 in.; height 7 ft. 9 in ; weight empty, 375 lb.; area main planes, 150.6 sq. ft.; designed speed 80 m.p.h.

The Heath Sport-'Plane. Flight, vol. 14, no. 27, July 6, 1922, p. 381, 3 figs. Single-seater tractor biplane fitted with 20-hp. 2-cylinder Thor air-cooled motorcycle engine.

The Udet Sporting Single-Seater. Flight, vol. 14, no. 28, July 13, 1922, pp. 394–394, 4 figs. Single seater German monoplane of cantilever type equipped with 30–40-hp. Haacke engine.

Strength Calculator for Details. A Strength Calculator for Aeroplane Details. Flight, vol. 14, no. 23, June 8, 1922, p. 330, 2 figs. Description of slide rule for quickly determining sizes of wiring lugs, bracing attachments, bolts, pins, etc.

AIRSHIPS

Stability. The Stability of Airships: Trials with the R33. Indian Eng., vol. 71, no. 23, June 10, 1922, pp. 326–328, 2 figs. Head-on flight; curvilinear flight and results from model attached to a whirling arm and rotated in water.

[See also PARACHUTES.]

ALLOY STEELS

Decomposition of Martensite in. The Decomposition of Martensite Into Troostite in Alloy Steels, Howard Scott. Forging & Heat Treating, vol. 8, no. 7, July 1922, pp. 296–299, 3 figs. Only manganese, silicon and chromium show marked effect; first increased intensity of transformation, last two raised its temperature in certain percentages.

Tests. Heat Tests with Special Steels (Warmversuche mit Sonderstählen), H. Edert. Stahl u. Eisen, vol. 42, no. 25, June 22, 1922, pp. 961–968, 18 figs. Results of tests made with refined, low-percentage chrome-nickel, chrome-vanadium and non-rustable steels. Investigation includes chemical composition, tensile tests, measurements up to maximum temperature of 800 deg. cent., bending tests up to 600 deg., Brinell tests up to 300 deg. and notched-bar tests up to 700 deg.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Diamond. Diamond Alloy—A New Cutting Metal. Machy. (N. Y.), vol. 28, no. 12, Aug. 1922, pp. 958–959, 2 figs. Alloy composed mainly of chromium, molybdenum and tungsten used for making cutting tools.

High-Resistance. Lecfurite—High Resistance Alloy. Machy. (Lond.), vol. 20, no. 511, July 13, 1922, pp. 452–455, 5 figs. Description of new alloy metal fusing at 1,550 deg. cent. and intended for use as resistance wire.

Magnesium. See MAGNESIUM ALLOYS.

[See also BEARING METALS; MONEL METAL.]

ALUMINUM

Casting. Aluminum Casting and Metal Spraying (Vom Aluminium- und Spritzguss). Zeit. für die gesamte Giessereipraxis, vol. 43, no. 28, July 22, 1922, pp. 393–395. Operations in production of aluminum castings and metal for metal spraying.

ALUMINUM ALLOYS

Properties. Improving Aluminum Alloys (Studien an vergütbaren Aluminiumlegierungen), W. Fraenkel and E. Scheuer. Zeit. für Metallkunde, vol. 14, nos. 2 and 3, Feb. and Mar. 1922, pp. 49–58 and 111–118, 15 figs. Processes of improving aluminum alloys with magnesium content; measuring their conductivity, elasticity, e.m.f., velocity of dissolution; determination of density; experiments with alloys containing Mg; change of tensile strength on prolonged heating; effect of tempering; corrosion.

AMMONIA

Synthetic. New Processes and Proposals for the Production of Synthetic Ammonia (Neue Verfahren

Note.—The abbreviations used in indexing are as follows
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

und Vorschläge zur synthetischen Gewinnung des Ammoniaks), A. Sander. Zeit. für komprimierte u flüssige Gase, vol. 22, nos. 1, 3 and 4, 1922, pp 1-3, 29-32 and 41-43, 2 figs. No. 1: Discusses Haber and Claude processes, and the Hyper-compressor, with which pressures of 1,000 atmos are reached. No. 2: Discusses Claude process as stated in German patent 341,230, and describes apparatus. No. 3: Production of synthetic ammonia in England, America and other countries.

The Synthesis of Ammonia by Means of High Pressures (La Synthèse de l'Ammoniaque par les Hyperpressions), Georges Claude. Société Industrielle de l'Est, Bul. No. 165, Apr.-June 1922, pp 46-63, 13 figs. partly on supp. plates. Discusses Haber process, simple way of producing high pressures, work of Linde.

AUTOMOBILE ENGINES

Carburetors. See CARBURETORS.

Chain Front-End Drive. Marked Increase in Use of Chains for Front End Drives, J. Edward Schipper. Automotive Industries, vol. 47, no. 1, July 6, 1922, pp. 8-10, 8 figs. New and original drive layouts permit easy adjustment and cause extensive use of this system.

Crankcase-Oil Dilution. The Crankcase Oil Dilution Problem and Its Solution, Wm. F. Parish. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 33-47, 14 figs. Incompletely vaporized fuel leaks into crankcase and dilutes oil thereby decreasing its viscosity; carbon-forming properties of oils and effect of heavy oil on engine efficiency; crankcase oil regeneration.

Crankshafts. See CRANKSHAFTS.

Cylinders. See CYLINDERS.

Manufacture. Manufacturing Practice on Light Motor-Car. Power Units. Machy. (Lond.), vol. 20, no. 512, July 20, 1922, pp. 473-477. Methods of Hotchkiss et Cie, Coventry, deals with heat treatment, case-hardening and refining of steels used.

Oil Regeneration. New Plan Regenerates Motor Oil Continuously as Automobile Runs, William F. Parish. Nat. Petroleum News, Vol. 14, no. 27, July 5, 1922, pp. 49-50, 3 figs. Gross crankcase refiner for automatically removing fuel and water dilutions and filtering out foreign substances. From paper read before Soc. Automotive Engrs.

Piston Rings. See PISTON RINGS.

Radiators. Seam Lock is Feature of New Radiator Construction, B. M. Ikert. Automotive Industries, vol. 47, no. 2, July 13, 1922, pp. 66-67, 5 figs. Sections held together by lock; solder acts merely as seal, brass or copper used in making up core is not stretched during construction. Novel machinery utilized in manufacture. Core specially adapted to motor-truck use. Not injured by freezing.

Sleeve-Valve. 10-Hp. Sleeve-Valve Motor-Car Engine. Engineering, vol. 113, no. 2942, May 19, 1922, p. 618, 3 figs. Two-cylinder, horizontally-opposed type made by Vulcan Motor and Eng. Co. which develops 15 b.hp. at 2000 r.p.m.

Straight-Eight Type. The Lessons of Indianapolis, Autocar, vol. 48, no. 1392, June 24, 1922, pp. 1082-1084, 3 figs. Straight-eight engine proves capable of very high sustained speeds. Remarkably high compression ratios adopted.

AUTOMOBILE FUELS

Alcohol-Benzol Tests. Testing Alcohol-Benzol Fuel, W. F. Bradley. Motor Transport, vol. 35, no. 905, July 3, 1922, pp. 29-30, 3 figs. Results obtained by Paris Omnibus Co. with over a thousand buses running on 50 per cent mixture.

Detonation. Measuring the Tendency of Various Fuels to Knock, Thos. Midgley, Jr., and T. A. Boyd. Automotive Industries, vol. 47, no. 1, July 6, 1922, pp. 23-27, 5 figs. Relative effectiveness of alcohol, benzol and other substances in preventing detonation are determined by more precise methods than used in earlier tests. Results indicate some conclusions reached by Ricardo are in error. Xylidine effective in small amount.

Fractional Distillation. Fractional Distillations of Fuel and How to Make Them, P. S. Tice. Automotive Industries, vol. 47, no. 3, July 20, 1922, pp. 120-126, 5 figs. Shortcomings of present standard apparatus and development of new type which fulfills desirable characteristics.

Preparation. The Hot-Spot Method of Heavy-Fuel Preparation, P. C. Mock and M. E. Chandler. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 27-32 and 48, 7 figs. Investigation of means for preparing kerosene and mixtures of heavier oils with alcohol and benzol for fuel in manifold.

Tetralite Benzol. Recent Development in Automobile Fuel (Die neuere Entwicklung der Motorkraftstoffe), Wa. Ostwald. Zeit. für angewandte Chemie, vol. 35, no. 46, June 9, 1922, pp. 278-280. Development of explosion and Diesel engines; combustion and mixing of fuels, detailed description and analyses of Reichskraftstoff or tetralite benzol, a mixture of 50 per cent benzol, 25 per cent tetralin and 25 per cent spirits.

AUTOMOBILES

Bodies. European Efforts to Reduce Car Weights Bring Radical Body Construction, W. F. Bradley. Automotive Industries, vol. 47, no. 1, July 6, 1922, pp. 11-12. Extreme reduction of weight and noise features Weymann system of body building. Lends itself to production at low cost. Lancia builds a four-passenger, 122-in. wheelbase car weighing 1650 lb. complete. Chassis frame members used as body frame members.

Lumber Situation Demands Utilization of New Woods for Bodies, Geo. J. Mercer. Automotive Industries, vol. 47, no. 1, July 6, 1922, pp. 13-15, 1 fig. Increase in number of closed bodies forces use for less expensive woods. Quality not diminished. Scientific study of substitute woods necessary. Cables to supplement strength of wood possible.

Bow "V." The "Bow V" Car. Auto, vol. 27, no. 28, July 13, 1922, pp. 575-577, 7 figs. Light vehicle with air-cooled engine, 4-speed gear, clutch and starter of motorcycle design, and automobile transmission mechanism.

Brake and Clutch Practice. European and American Automotive Brake and Clutch Practice, H. G. Farwell. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 67-80, 27 figs. Analysis of types used on 165 cars exhibited at London Automobile Show 1920, and discussion of best known types in United States and Europe.

Creeper Track Car. Good Going over Bad Ground. Motor Transport, vol. 35, no. 906, July 10, 1922, p. 62, 3 figs. Remarkable performance in this country by Citröen-Kegresse creeper track car.

German Postal Administration. Auto Service of the German Postal Administration (Der Kraftwagenbetrieb der Reichspostverwaltung unter besonderer Berücksichtigung des Postreiseverkehrs), Hering. Archiv für Post und Telegraphie, no. 6, June 1922, pp. 173-197, 10 figs. Development of suburban and long-distance postal omnibus service, freight-transportation service, and telegraph construction service; describes automobiles used.

G. W. K. The G. W. K. Car. Auto, vol. 27, no. 29, July 20, 1922, pp. 595-598, 11 figs. Light car with friction drive.

Hotchkiss 18-22 Hp. The 18-22 Hp. Hotchkiss Car. Auto, vol. 27, no. 27, July 6, 1922, pp. 553-556, 13 figs. New model of Parisian vehicle; some modifications from previous design; transmission mechanism.

Light Cars. The Temperino Light Car. Auto, no. 26, vol. 27, June 29, 1922, pp. 533-535, 11 figs. Novel design combined with simplicity, lightness and low fuel consumption; 8-hp. twin-cylindered air-cooled engine.

Nazzaro. The 18-30 Hp. Nazzaro Car. Auto, vol. 27, no. 30, July 27, 1922, pp. 617-620, 11 figs. Italian model with overhead valve gear having supplementary rocker and spring, making operation noiseless.

Springs. See SPRINGS, Manufacture.

Streamline. Streamline Autos (Der Stromlinienwagen), P. Jaray. Motorwagen, vol. 25, no. 17, June 20, 1922, pp. 333-336, 7 figs. New type of construction to reduce air resistance; results of experiments made with it in Zeppelin wind tunnel; fuel consumption, etc.

The New Rumpler Chassis. Automobile Engr., vol. 12, no. 165, July 1922, pp. 194-203, 20 figs. Critical examination of new design; streamline type; six-cylinder engine, cylinders being cast in pairs and grouped fanwise above two-throw crankshaft.

Transmission Gears. Practical Difficulties in Automatic Transmission Gear Design, P. M. Heldt. Automotive Industries, vol. 47, no. 4, July 27, 1922, pp. 164-165, 1 fig. Describes Andreau gear consisting essentially of internal-type planetary gear with operation controlled by pair of centrifugal weights.

Wheels. Camber and Gather Relationships in Front-Wheel Alignment, J. C. Sproull. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 91-92 and 116, 4 figs. Effect of tilting of wheel spindles so that wheels lean outward at top, and so as to bring front part of wheels nearer together than rear, and mathematical formulas for determining their proper values.

How Pressed Steel Wheels are Made, J. Edward Schipper. Automotive Industries, vol. 47, no. 2, July 13, 1922, pp. 71-74, 14 figs. Recent machine-tool developments add to manufacturing efficiency; varied nature of presswork shows wide possibilities in pressed-steel production; disk of tapered section is employed.

AVIATION

Aerial Navigation and Instruments. Aerial Navigation and Navigating Instruments, H. N. Eaton. Nat. Advisory Committee for Aeronautics, Report No. 131, 1922, 44 pp., 26 figs. Description of dead-reckoning method; natural and artificial horizons and radio direction finder.

Newfoundland and Labrador. Aviation in Newfoundland and Labrador. Aviation, vol. 13, no. 2, July 10, 1922, pp. 41-43, 3 figs. Practical demonstration of value of aerial mail and passenger transport in Arctic countries.

Safety. Safety in the Air. Aeroplane, vol. 22, no. 26, June 28, 1922, pp. 463-464. Dangers incident to starting, flying, and landing, and suggestions for minimizing same.

B

BALANCING

Rotating Parts. Balancing Rotating Parts (Sur l'équilibrage des pièces tournantes), C. Feru and J. Labouret. Révue Générale de l'Électricité, vol. 11, no. 25, June 24, 1922, pp. 919-926, 12 figs. Balancing on one and two bearings, determination of angle ϕ.

BALLISTICS

Exterior. Exterior Ballistics in Anti-Aircraft Firing and Their Industrial Applications (La balistique extérieure du tir aérien, applications industrielles), Gustave Lyon. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 134, no. 4, Apr. 1922, pp. 327-380, 32 figs. Discusses progress made during war in measuring and determination of trajectories, and describes in detail instruments used. Includes two appendices by Maurie Garnier.

BEAMS

Reinforced-Concrete. Chart for Rapid Calculation of the Minimum Iron Cross Section in Reinforced-Concrete Beams Under Flexure and Compression or Tension (Graphique puor l'obtention rapide des sections de fer minima, dans une poutre en béton armé, soumise à des efforts composés de flexion avec compression ou tension), E. Gardiol. Bul. Technique de la Suisse Romande, vol. 48, no. 10, May 13, 1922, pp. 113-119, 5 figs. Develops formulas and explains use of chart.

T-Beams, Calculation. Charts for Calculating T-Beams Under Flexure (Abaque pour le calcul des poutres en T soumises à flexion simple), R. Coppee. Annales de l'Association des Ingénieures Sortis des Écoles Spéciales de Gand, vol. 12, no. 1, 1922, pp. 49-53, 2 figs. partly on supp. plate. Develops formulas and explains use of chart.

BEARING METALS

Car and Power-House. Metals for Car and Power House Bearings, H. H. Buckman. Elec. Ry. Jl., vol. 60, no. 2, July 8, 1922, pp. 47-48. Some essential characteristics of satisfactory bearing metal; advantages of using lead base metal. (Abstract.) Paper read before Central Elec. Ry. Assn.

BEARINGS

Casting. Foundry Practice (La Pratique du Régulage), M. Verneret. Fonderie Moderne, nos. 4 and 5, Apr. and May 1922, pp. 97-99, and 143-152, 15 figs. Apr.: Operations connected with casting anti-friction metals direct on to bearing surfaces; nature and choice of anti-friction metals and alloys. May: Utilization of scrap; remelting of metal; fluxes and oxidizing agents; casting; etc.

BEARINGS, BALL

Design. Load on Ball Bearings (Kugelagrets Belastning), F. Symanzik. Teknisk Ukeblad, vol. 69, no. 23, June 9, 1922, pp. 216-218, 3 figs. New method for determining size of ball bearings; examples and calculations.

Flour-Mill Equipment. Saving Power in Minnesota Mill. Am. Miller, vol. 50, no. 7, July 1, 1922, pp. 719-720, 5 figs. Ball-bearing equipment of Hubbard Milling Co., Mankato; installation of SKF ball bearings on lineshafts which accomplished estimated saving of $3,250 first year.

Roller and. Ball and Roller Bearings in Street-Car Operation and Small Factories (Kugel- und Rollenlager im Strassen- und Kleinbetrieb), Carl Tobias. Zeit. des Österr. Ingenieur- u. Architekten-Vereines, vol. 74, nos. 11-12 and 15-16, Mar. 17 and Apr. 14, 1922, pp. 55-56, and 69-71, 5 figs. Mar. 17: Experiments with ball and roller bearings for railway rolling stock; lubrication and its relative cost. Apr. 14: Discusses advantages in saving of lubricants and attention.

BEARINGS, ROLLER

Design and Construction. Rolling Contact Bearings, Tobias Dantzig. Steam, vol. 30, no. 1, July 1922, pp. 3-7. Important requirements of efficiency, capacity, long life, operation at high speed, self-alignment, and ability to maintain permanent clearance. Means of attaining each. Read before Cincinnati Section A.S.M.E.

BLAST FURNACES

Sulphur Excess in Slag. Blast Furnaces Difficulties Due to Excessive Sulphur in Slag (Ueber noch wenig bekannte Schwierigkeiten im Hochofen durch "Schwefelelend"), A. Killing. Stahl u. Eisen, vol. 42, no. 25, June 22, 1922, pp. 968-971, 3 figs. Practical observations with sulphur-rich slag. Injurious effect of sulphur on blast-furnace process. Remedies.

BLOWERS

Blast-Furnace Centrifugal. Centrifugal Blast-Furnace Blowers. Iron & Coal Trades Rev., vol. 104, no. 2833, June 16, 1922, pp. 896-897, 5 figs. Turbo-blowers producing pressures up to 40 lb. per sq. in. and turbo-compressors for higher pressures both transform for energy, half into direct compression and half kinetic energy. Many blast-furnace requirements.

BOILER FEEDWATER

Treatment. A Criticism of the Various Methods of Purifying Feedwater (Kritik der verschiedenen Methoden der Reinigung von Kesselspeisewasser), B. Preu. Dinglers polytechnisches Jl., vol. 337, nos. 1 and 2, Jan. 14 and 29, 1922, pp. 1-4 and 11-13. Jan. 14: Reviews efficiency of lime-soda method, the permutite method, Neckar method, and others. Jan. 29: Describes new method by Ph. Müller and the apparatus, and calculates its efficiency.

Continuous Blowdown and Water Purification Process, M. Kestner. Power Plant Eng., vol. 26, no. 13, July 1, 1922, pp. 647-652, 10 figs. Method of precipitating impurities outside of boiler without loss of heat. (Abstract.) Paper read before British Inst. Mech. Engrs.

Softening of the Boiler Feedwater (Enthärtung des Kesselspeisewassers), P. Martiny. Archiv für Wärmewirtschaft, vol. 3, no. 6, June 1922, pp. 103-110, 7 figs. Action of carbonic acid and oxygen; formation of incrustation and its remedy; describes principal processes of treating water.

BOILER OPERATION

Firing With Low-Grade Fuels. Hints on Firing

With Low-Grade Fuels and Adapting Furnaces for Such Fuels (Winke zur Verheizung von minderwertigen Brennstoffen und zur Umstellung der Feuerungen auf solche Brennstoffe), Schnell. Zeit. des Bayerischen Revisions-Vereins, vol. 26, no 12, June 30, 1922, pp. 95–98. Temporary and permanent adaptation of furnaces of steam boilers of various types; ratio of grate surface to heating surface, mixture of fuels

Grate Charge. Dependence of Grate Charge on Moisture Content of Fuel (Die Abhangigkeit der Rostbelastungen vom Wasserstoffgenalt des Brennstoffes), W. Viebahn. Braunkohle, vol. 21, no. 13, June 30, 1922, pp. 258–262, 3 figs. Discusses so-called grate load, i.e., number of kg. of fuel burned per hr. per sq. m. of grate surface, and discusses this load for lignite and coal containing different percentages of water.

Humidity and Barometric-Pressure Effects. Effect of Humidity and Barometric Pressure on Boiler Efficiency (Der Einfluss der Luftfeuchtigkeit und des Barometerstandes auf den Kesselwirkungsgrad), L. Finckh. Wärme, vol. 45, no. 23, June 9, 1922, pp. 283–285. Quantity and temperature of air for combustion for lignite, coal and peat; gives table of comparative figures.

[See also PEAT; PULVERIZED COAL, Boiler Firing.]

BOILERS

Electrically Heated. Regulating Electrode Steam Boilers (Die Leitsungsregelung von Elektrodendampfkesseln), Edgar Zeulmann. Elektrotechnische Zeit., vol. 43, nos. 22 and 23, June 1 and 8, 1922, pp. 759–762 and 784–788, 27 figs. Describes best-known types of electrode steam boilers in which boiler water itself forms electric resistance, and gives their advantages and disadvantages, methods of regulation, etc.

Report on an Investigation of an Electric Boiler Installation (Bericht uber die Untersuchung einer Elektrokesselanlage). Zeit. des Bayer. Revisions-Vereins, vol. 26, no. 10, May 31, 1922, pp. 85–86, 3 figs. Detailed description of boiler installation of a textile spinning and weaving establishment at Blaichach, working on 1000-kw. polyphase current at 510 volts, which has given entire satisfaction.

Maintenance. Recommendations on Boiler Maintenance, A. G. Pack. Ry. Jl., vol. 28, no. 8, Aug. 1922, pp. 19–21. Data from practical experience and suggestions. Welding employed where other means of construction could be more profitably employed. Author is chief inspector of locomotive boilers for U. S. Government.

Testing. The Question of Accurate Boiler Tests, Alfred Cotton. Power House, vol. 15, no. 14, July 20, 1922, pp. 17–20, 2 figs. Attempt to establish accuracy of tests; discussion of various items involved.

BRAKING

Freight-Train. Application of the Continuous Brake to Freight Trains in Tunis (Une application du frein continu aux trains de marchandises en Tunisie), Louis Tronchère. Révue Générale dès Chemins de Fer et des Tramways, vol. 41, no. 1, July 1922, pp. 3–11, 4 figs. Describes tests made in 1909 by Gafsa Co. on Sfax-Redeyel line, and gives rules adopted for equipment and operation.

Regenerative. An Analysis of Regenerative Braking on Electric Locomotives, C. E. Fairburn and F. A. Harper. English Elec. Jl., vol. 2, no. 2, Apr.-July, pp. 68–77, 5 figs. Mathematical analysis, with curves.

BUILDING MATERIALS

Testing Machines. New Machines for Testing Building Material. Eng. Progress, vol. 3, no. 7, July 1922, pp. 157–158, 6 figs. Exhibition at last Spring Fair at Leipsic of testing machines for cement and other construction materials which have remarkable constructional features.

BUSES

Trolley. A New English Trolley Bus. Bus Transportation, vol. 1, no. 7, July 1922, pp. 379–380, 4 figs. Vehicle designed from experience with gasoline road vehicles; single motor is used and automatic control features are provided to facilitate quick acceleration. Easy coasting and safe operation generally.

Notes on Railless Electric Traction, E. M. Munro. Tramway & Ry. World, vol. 51, no. 29, June 15, 1922, pp. 287–295, 15 figs. Analysis of principles involved. Data from types of cars in daily service and comparison with tramcars and motor buses. Paper to be read at Congress of Tramways & Light Rys. Assn.

C

CAMS

Circumference Formula. Formula for Circumference of Portion of Cam. Machy. (Lond.), vol. 20, no. 513, July 27, 1922, pp. 524–525, 1 fig. Mathematical treatment.

CAR COUPLINGS

Screw, Railway. Railway Screw Couplings. Ry. Gaz., vol. 37, no. 2, July 14, 1922, pp. 61–62, 1 fig. Test results of nickel-chrome steel coupling for Bengal Nagpur railway.

CAR LIGHTING

Electric. Principal Systems of Train Lighting (Les principaux systèmes d'éclairage électrique individual appliqués aux voitures de chemins de fer), M. Bougrier. Électrician, vol. 38, no. 1304, July 15, 1922, pp. 313–320, 7 figs. Describes electric systems by Stone, Vicarino, and Aichelé, and their apparatus and operation.

Train Lighting (L'Éclairage des trains), H. Guerin. Génie Civil, vol. 81, nos. 1, 2 and 3, July 1, 8 and 15, 1922, pp. 13–15, 36–40 and 59–63, 25 figs. Substitution of electric lighting for systems in use; development of train lighting and its general principles; Brown-Boveri, Dick-E. V. R., Vickers, Etat-E. V. R., Stone, Leitner, Electric Storage Battery Co., and Société de l'Éclairage des Vehicules sur Rails systems; various types of storage batteries.

CAR WHEELS

Chilled-Iron. Properties of Chilled Iron Car Wheels, George W. Lyndon. Elec. Traction, vol. 18, July 1922, no. 7, pp. 592–594, 2 figs. Association of manufacturers of chilled car wheels and Univ. of Ill. investigate wheel fit and static load strains. Bur. of Standards conducts tests on thermal stresses.

CARBURETORS

Adjustment by Gas Analysis. Carburator Adjustment by Gas Analysis, A. C. Fieldner and G. W. Jones. Jl. Indus. & Eng. Chem., vol. 14, no. 7, July 1922, pp. 594–600, 10 figs. Experimental work on determination of carbon dioxide in exhaust gas, which has direct bearing on carburetor adjustment.

Capac. A New Capac Carburetter. Autocar, vol. 49, no. 1397, July 28, 1922, p. 188, 1 fig. Instrument specially devised for sporting-car engine and to provide rapid acceleration.

CARS, FREIGHT

Gondola, C. M. & St. P. How the C. M. & St. P. R. R. Designed Their New Gondola Cars. Ry. Rev., vol. 70, no. 23, June 10, 1922, pp. 834–841, 11 figs. Analysis of functions of individual members and calculation of stresses involved.

Springs. Spring Assemblages for Freight Car Trucks, Geo. S. Chiles. Ry. Rev., vol. 70, no. 23, June 10, 1922, pp. 844–850, 8 figs. New side frame and bolster design provides higher spring capacity and lower truck weight.

CARS, PASSENGER

6-Wheel Cast-Steel Truck. The Latest Development in 6-Wheel Passenger Trucks. Ry. Rev., vol. 70, no. 23, June 10, 1922, pp. 831–833, 6 figs. Pullman Company adopts new design of commercial type with clasp-brake equipment.

CASE-HARDENING

Steels for. A Comparison of the Rate of Penetration of Carbon into Various Commercial Steels in Use for Case Carburizing, S. C. Spalding. Am. Soc. for Steel Treating Trans., vol. 2, no. 11, Aug. 1922, pp. 950–976, 136 figs. Investigation of straight carbon, chromium-silicomanganese, nickel, chromium, nickel and chromium-molybdenum steels. Curves and photomicrographs.

CAST IRON

Testing Methods. New Methods of Testing Cast Iron, E. V. Ronceray. Metal Industry (Lond.), vol. 20, no. 25, and vol. 21, no. 1, June 23 and July 7, 1922, pp. 586–588 and 13–18, 20 figs. Review of various methods and description of work of Fremont's transverse testing machine. Paper read before Inst. British Foundrymen.

New Methods of Testing Cast Iron, E. V. Ronceray. Foundry Trade Jl., vol. 26, no. 307, July 6, 1922, pp. 5–12, 19 figs. Fremont's transverse testing machine; shearing tests; M. Portevin's test; elastic limit, modulus of elasticity, sounding and ball tests.

CEMENT MANUFACTURE

Electric. Electric Cement, Henry J. Harms, Jr. Concrete, vol. 20, no. 6, June 1922, pp. 113–115. Description of French process for producing cement in an electric furnace; superiority of product.

Iron and Steel Application. Iron and Steel Application to the Cement Industry, W. R. Shimer. Eng. World, vol. 21, no. 2, Aug. 1922, pp. 93–96. Selection of steels for use in handling cement, particularly heat-treated steel for shovels, gyratories.

CENTRAL STATIONS

France. The Great Thermoelectric Central Station at Comines [La grande centrale thermoélectrique de Comines (Nord)], J. Reyval. Révue Générale de l'Électricité, vol. 12, nos. 2 and 3, July 15 and 22, 1922, pp. 55–68 and 93–105, 34 figs. July 15: One of the most modern stations; has three 25,000 kw. units giving normal power of 50,000-kw., one unit being spare; describes boiler house, machine room and equipment. July 22: Describes pumping station and water intake, 45,000-v. transmission lines, overhead equipment, and underground equipment.

Superpower. The Bavarian Works and Its Sources of Power (Das Bayernwerk und seine Kraftquellen), A. Menge. Elektrotechnische Zeit., special no. May 28, 1922, pp. 2–20, 30 figs. Object of this works is to supply whole of Bavaria with electric power as economically as possible and for this purpose a 110 kv. transmission line has been built, connecting up Munich, Meitingen, Nurenberg, Amberg, Regensburg and Landshut lines, describes masts, insulators, general line equipment, transformers, and switching systems.

The Gennevilliers Central Station [La centrale électrique de Gennevilliers (Seine)], Ch. Dantin. Génie Civil, vol. 81, no. 1, July 1, 1922, pp. 1–13, 33 figs. partly on supp. plates. Has 5 groups of turbo-alternators of 40,000 kw. each and 3 in reserve, making total of 320,000 kw. Describes buildings, boiler house, stoking, ash handling, turbines and alternators, high-tension cables, switchboards, etc.

CERIUM

Effect on Brass and Iron. Adds Cerium to Brass and Iron, L. W. Spring. Foundry, vol. 50, no. 13, July 1, 1922, pp. 542–544, 2 figs. Effect on red brass is to increase percentage of leaky castings and lower tensile strength and ductility. Shows marked effect on converter steel and causes gray iron to feed better. Paper prepared for convention of Am. Foundrymen's Assn.

CHROMIUM STEEL

Chromium Determination. Rapid Methods for the Determination of Chromium in Steel, A. S. Townsend. Forging & Heat Treating, vol. 8, no. 7, July 1922, pp. 304–305. Oxidation of chromium in acid solution to chromic acid; bibliography.

COAL

Briquetting. Briquetting of Dutch-Indian Coal and Lignite (Briketteering van Indische steen- en bruinkolen), A. Guyot van der Ham. Ingenieur, vol. 37, no. 27, July 8, 1922, pp. 515–523 and (discussion), 523–626, 1 fig. Methods and operations of Sawah Loento briquetting factory, using pitch as binding medium.

Drying. Hoyle Centrifugal Dryer at Tinsley Park Coke Ovens. Colliery Guardian, vol. 123, no. 3209, June 30, 1922, p. 1603, 2 figs. Apparatus in which coal flung outward by centrifugal force against screens passes down as thin film on inner surfaces of screen while moisture goes through.

COAL HANDLING

Ash and. Economical Handling of Coal and Ashes, Henry J. Edsall. Can. Manufacturer, vol. 42, no. 7, July 1922, pp. 23–26, 2 figs. Great savings made from installations and recent developments.

Modern Coal and Ash Handling Plant. Gas Engr., vol. 38, no. 554, June 15, 1922, pp. 155–158, 9 figs. Advantages and disadvantages of various types and general points for consideration.

Pneumatic. The Pneumatic Handling of Coal, H. Blyth. Gas Engr., vol. 38, no. 554, June 15, 1922, pp. 151–154, 5 figs. Conditions under which satisfactory results may be expected and details of successful installation.

COLD STORAGE

Research Laboratory. Cold Storage Research Laboratory. Ice & Refrigeration, vol. 63, no. 2, Aug. 1922, pp. 93–97, 6 figs. Description of laboratory at Canton, Pa., established for purpose of carrying on experiments and research work in storage of perishable products.

COKE

Analysis. The Analysis of Coke, Arthur Grounds. Iron & Coal Trades Rev., vol. 104, no. 2835, June 30, 1922, p. 977. Sampling, moisture, ash, sulphur, phosphorus, calorific value.

Economy for Steam Fuel. Economy of Coke for Steam Fuel. Gas Age-Rec., vol. 50, no. 4, July 22, 1922, pp. 107–108. Coke at $6 cheaper if properly burned for steam raising than coal at $7.

COKE MANUFACTURE

Metallurgical. Production of Metallurgical Coke (Die Erzeugung von Hüttenkoks aus nicht backenden Kohlen), M. Dolch. Glückauf, vol. 58, no. 25, June 24, 1922, pp. 772–776. Experiments for producing good coke from coal which cakes poorly or not at all.

Non-Coking Coals. Good Coke Now Manufactured from Non-Coking Coals of Illinois, with Saving of Byproducts, H. A. Patterson. Coal Age, vol. 22, no. 2, July 13, 1922, pp. 45–50, 5 figs. Seeks to coke coal before cementing material is oxidized; heat graduated to suit thickness of bed to be coked; coking time lowered to twelve hours; gas introduced at two levels. (Abstract.) Paper read before Ill. Min. Inst.

Theory. A Recent Theory of Coking, F. V. Tideswell. Fuel in Science & Practice, vol. 123, no. 3208, June 23, 1922, pp. 101–103. Discussion of theory underlying improved process which claims to include bituminous and non-bituminous non-coking coals in coking coals.

COKE OVENS

Heating with Blue Water Gas. Heating Coke Ovens with Blue Water-Gas, J. F. O'Malley. Chem. & Met. Eng., vol. 27, no. 2, July 12, 1922, pp. 75–78, 6 figs. Doubles surplus gas from ovens; eliminates carbon from heating flues and permits uniform oven operation without change of burners.

Path of Gas Travel. The Foxwell Theory of the Path of Travel of the Gases in the Coke Oven. Gas World, vol. 76, no. 1976, June 3, 1922, p. 10, 1 fig. Laws controlling path found to be similar to those for nest of capillary tubes. Discussion of application of theory.

COMBUSTION

Gas Distribution. Study of Distribution of Combustion Gases. Am. Gas Jl., vol. 117, no. 5, July 29, 1922, pp. 89–91, 7 figs. Description of new method of studying diffusion of heat in various apparatus and distribution of combustion gases by means of properties of colored smoke. Model tests compared with phenomena in apparatus in actual operation. From "High-Pressure Boilers" by H. Thoma, Berlin.

Spontaneous. Spontaneous Combustion, Walter L. Wedger. Safety, vol. 9, no. 7, July 1922, pp. 163–168, 1 fig. Various causes and attempts at prevention. Apparatus for testing tendency of cloth. From paper read before Mass. Safety Council of Nat. Safety Council

COMPASSES

Gyroscopic. Theory of the Gyroscopic Compass (Theorie du compas gyroscopique), P. Lemaire. Technique Moderne, vol. 14, no. 5, May 1922, pp. 202–205, 2 figs. Describes construction and operation and makes calculations in connection with it.

COMPRESSED AIR

Storage. Compressed Air Power Storage (Kraft-Speicherungs-Anlagen mittels komprimierter Luft), W. E. Trampler. Schweizerische Bauzeitung, vol. 79, no. 17, Apr. 29, 1922, pp. 222–224, 7 figs. Discusses pneumatic accumulation in place of hydraulic accumulation by compressing air into heat-insulated storage tanks ready for any power use.

CONDENSERS, STEAM

Design. Steam Condensing Plant, D. I. Hall. Beams, vol. 10, no. 6, June 1922, pp. 427–436, 4 figs. Items to which careful consideration must be given in designing surface condensers and jet condensers; air leakage and air pumps; condensate pump; plant arrangement.

CONVEYORS

Belt. Essentials of a Serviceable Belt Conveyor, Omega. Eng. & Indus. Management, vol. 7, no. 18, July 13, 1922, pp. 583–589, 9 figs. Notes on design and various elements.

Cotton Mill. Conveyors at Great Falls Manufacturing Company, Ernest Fallows. Textile World, vol. 62, no. 1, July 1, 1922, pp. 67 and 69, 5 figs. Equipment installed for mechanical handling of stock in new 3-story concrete cotton mill at Somersworth, N. H. Advantages are shown in labor saving and better condition of material during manufacture.

CORROSION

Prevention. Fighting Corrosion as a Major Source of Waste in Industry, R. H. Hubbed. Jl. Elec. & West. Industry, vol. 49, no. 1, July 1, 1922, pp. 9–11, 7 figs. Choice of proper coating; paints that injure metal.

Mechanism of Metallic Oxidation at High Temperatures, N. B. Pilling and R. E. Bedworth. Chem. & Met. Eng., vol. 27, no. 2, July 12, 1922, pp. 72–74. Rapidity due to combination of physical properties of oxide and its ability to absorb and diffuse oxygen rather than to any property of metal itself. Paper read before Am. Inst. Min. & Metallurgical Engrs.

Oxidation of Steels and Their Use in Degasification of Water (Sur l'oxydabilité des aciers et leur utilisation au dégazage de l'eau), G. Paris. Chaleur et Industrie, vol. 3, no. 25, May 1922, pp. 1259–1261, 1 fig. Discusses dependence of oxidation of steels on their crystalline structure, and proposes special alloys for fixing oxygen in water.

CRANES

Ship. The New Ship Crane for the Navy, A. F. Case. Tech. Eng. News, vol. 3, no. 3, June 1922, pp. 71, 85, 89 and 91, 2 figs. Contract has been awarded by Navy for construction of 250-ton revolving crane, to be mounted on U. S. battleship Kearsarge, largest sea-going crane ever constructed.

Slewing. Slewing Cranes (Grues roulantes et pivotantes sur portique). Bul. Technique de la Suisse Romande, vol. 48, no. 15, July 20, 1922, pp. 174–178, 2 figs. Describes electrically driven crane for dock purposes with 50-ton per hr. capacity and 4500 kg. load.

Traveling. Lifting Apparatus (Appareils de levage), Legrand-Ribet. Outillage, vol. 6, nos. 24 and 25, June 17 and 24, 1922, pp. 765–767, and 787–791, 9 figs. June 17: Calculations and specifications of an electric traveling crane of 10,000 kg. capacity at 20 m. radius of action, with hoisting speed of 6 m. per min. June 24: Describes framework of crane and calculations for it.

CRANKSHAFTS

Manufacture. Making the Marmon Crankshaft, Fred B. Jacobs. Abrasive Industry, vol. 3, no. 7, July 1922, pp. 199–204, 10 figs. Accuracy and quantity production are assured by modern grinding machines and abrasive wheels; shafts must be balanced accurately.

CUTTING TOOLS

See ALLOYS, Diamond.

CYLINDERS

Automobile, Casting. Casting Chevrolet Cylinders. Foundry, vol. 50, no. 14, July 15, 1922, pp. 565–569 and 579, 6 figs. Details of core making, venting, method of setting and adjusting cores, together with general features involved in making mold; equipment is adequate.

D

DIES

Self-Opening, Chasers for. Making Chasers for Self-opening Dies. Am. Mach., vol. 57, no. 5, Aug. 3, 1922, pp. 169–171, 16 figs. Milling blocks to form and use, cutting threads by means of hobs; hand and machine tapping methods.

DIESEL ENGINES

Design. Variations in Modern Diesel-Engine Design, Thos. Orchard Lisle. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 92–106, 36 figs. Unfavorable comments on tendency to depart from original Diesel designs.

Fuel Oil, High-Viscosity. Boiler-Oils for Diesel Power, L. B. Jackson. Motorship, vol. 7, no. 7, July 1922, pp. 528–530, 4 figs. Valuable development work in use of fuel oils for motorships carried out by Texas Co.

Valves. Care of Valves on Diesel Engines, L. R. Ford. Power, vol. 56, no. 6, Aug. 8, 1922, pp. 204–206, 4 figs. General discussion.

Werkspoor. British Construction of Werkspoor Diesel Engines. Motorship, vol. 7, no. 8, Aug. 1922, pp. 607–612, 8 figs. Motors built by North Eastern Mar. Eng. Co. for single-screw fruit-carrying vessels, Segona and Seville.

DIRECTION FINDERS

Navigation. Radio Direction Finding, F. W. Dunmore. Pacific Mar. Rev., vol. 19, no. 7, July 1922, pp. 404–407. Methods of radio direction finding as aid to navigation; relative advantages of locating finder on shore and on shipboard.

DRILLING MACHINES

Design. Effect of Design on Drilling Machine Efficiency, F. E. Johnson. Machy. (N. Y.), vol. 28, no. 12, Aug. 1922, pp. 964–967, 6 figs. Important factors in design and operation. Suggestions for improving operative conditions.

DUST

Collection. Designing a Dust-Collecting System, H. M. Nichols. Wood Worker, vol. 41, no. 4, June 1922, pp. 50–51. Principles which must be considered in planning efficient exhaust system for woodworking plant.

Explosions. Progress in Dust Explosion Prevention, David J. Price. Chem. & Met. Eng., vol. 26, no. 26, June 28, 1922, pp. 1203–1206. Flour-milling industry and dust explosions; Federal investigation of dust explosions; summary of dust-explosion losses in various industries; progress of dust collection and removal and adoption of methods of preventing explosions. Paper read at Millers' Federation Mass. Convention.

DYE INDUSTRY

Synthetic. Development of the Synthetic Dye Industry (Le développement de l'Industrie des colorants synthétiques), Eug. Grandmougin. Génie Civil, vol. 80, nos. 22, 23 and 24, June 3, 10 and 17, 1922, pp. 491–494, 517–520, and 543–546. June 3: Development in France; prime materials; intermediates and their production; production of dyes themselves. June 10: Short history of dye industry, production of dyes in various countries. June 17: Future of dye industry generally and of scientific research in connection with it.

DYNAMOMETERS

Brake. Measuring Electric Power by the Brake Dynamometer (Mesure de la puissance des moteurs électriques au moyen des dynamos dynamomètres), M. Marre. Électricien, vol. 53, no. 1300, May 15, 1922, pp. 222–227, 8 figs. Construction and operation of brake dynamometer, its application in testing, friction losses, etc.

E

ECONOMIZERS

Performance. Notes on Economizer Performance, A. W. Binns. Power Plant Eng., vol. 26, no. 14, July 15, 1922, pp. 694–697, 5 figs. Losses, methods of testing, obtaining standards and maintenance.

ELECTRIC FURNACES

Brass and Bronze. Electric Melting Furnaces for Brass and Bronze, Howard McLean and John M. Boyd. West. Machy. World, vol. 13, no. 7, July 1922, pp. 244–246, 4 figs. Commercial uses for electric furnace and description of various types; some considerations of comparative melting costs.

Enameling, Vitreous. Developments in 1921 in Electric Vitreous Enameling Furnaces, James W. Carpenter. Am. Ceramic Soc. Jl., vol. 5, no. 7, July 1922, pp. 409–419, 4 figs. Summary of new installations in 1921 and description of various types of furnaces; operating data.

Resistance. Wire and Ribbon Wound Resistance Furnaces, Charles C. Bidwell. Sibley Jl. of Eng., vol. 36, no. 6, June 1922, pp. 119–121 and 129. Temperature range determines choice of resistor refractory and thermal insulation; temperature distribution determines shape of furnace, manner of winding, heating elements and placing thermal insulation.

Single-Phase. Single-Phase Electric Furnace, H. P. Abel, A. A. Liardet and W. West. Iron & Steel of Canada, vol. 5, no. 7, July 1922, pp. 128–130. Advantages of single-phase furnaces; drawback of bad effect of power factors; details of construction and operation.

Steel. A New French Electric Furnace for Steel Foundry, R. Sylvany. Can. Foundryman, vol. 13, no. 7, July 1922, pp. 28–29. Constructed with idea of insuring good purification by direct passage and uniform distribution of current through metal and slag.

Fiat Electric Steel Furnace, Dr. Alfredo Stromboli. Chem. & Met. Eng., vol. 27, no. 1, July 5, 1922, pp. 28–30, 5 figs. Description of Fiat furnace of large output with tight roof maintained by special economizer.

The New Electric Steel Furnaces of the Fiat Works (Die neuen Elektrostahlöfen der Fiat-Werke), G. Vitali. Stahl u. Eisen, vol. 42, no. 24, June 15, 1922, pp. 921–924, 6 figs. General adoption of electric steel furnaces; principles of Fiat furnace, its construction, including electrodes, control of operations, and results of working.

Sweden. Electric Smelting and Blast-Furnace Installations in Porjus (Sweden) (De elektriska smältverks- och masugnsanläggningarna i Porjus), Gunnar Hetlin. Jernkontorets Annaler, vol. 106, no. 4, 1922, pp. 99–132, 22 figs. Detailed description of plant layout, buildings, electrical and other equipment, furnaces, etc.

ELECTRIC LOCOMOTIVES

Swiss. Single Phase Express Locomotives 2-C-1 With Individual Axle Drive of the Brown-Boveri Type (Einphasen Schnellzuglokomotiven 2-C-1 mit Einzelachsantrieb Bauart Brown Boveri). Schweizerische Bauzeitung, vol. 80, no. 2, July 8, 1922, pp. 13–17, 12 figs. partly on supp. plate. Describes locomotives of Swiss federal railways, including distribution of weight, individual axle drive, cog-wheel arrangement, etc.

2-8-2 Mikado. New Electric Locomotives of the Orleans Railway (Nouvelles locomotives électriques du chemin de fer d'Orleans). Industrie Électrique, vol. 31, no. 718, May 25, 1922, pp. 185–188, 2 figs. Describes new 2-8-2 or Mikado type; 2,000 hp., d.c. at 250 v.; constructed by Electro-Mecanique Co. for Paris-Orleans railway.

ELECTRIC RAILWAYS

Austria. Electric Working of Austrian Railways (Der elektrische Betrieb auf den Oesterreichischen Bundesbahnen), E. E. Seefehlner. Elektrotechnische Zeit., special no., May 28, 1922, pp. 11–14, 5 figs. Discusses hydroelectric developments and describes new single-phase a.c. locomotives 1C + C1.

Germany. Electric Long-Distance Trains of the German State Railways (Mitteilungen aus dem elektrischen Fernzugbetrieb der Deutschen Reichsbahn), W. Wechmann. Elektrotechnische Zeit., vol. 43, nos. 24, 25 and 27, June 15, 22 and July 17, 1922, pp. 805–810, 837–840, and 904–908, 33 figs. Reviews electric traction on German railways; type of current, economics of electrification; results of electric operating of Silesian mountain railways; standardization of locomotives and their control; describes various types of locomotives; compares performance of steam and electric locomotives.

Electric Railroad Communication in Bavaria (Die elektrische Zugförderung im bayerischen Abschnitt der Reichsbahn), B. Gleichmann. Elektrotechnische Zeit., special no., May 28, 1922, pp. 24–32, 14 figs. Discusses railroad agreement between Prussian, Bavarian and Baden roads, traffic conditions, and gives particulars as to electric locomotives used.

Napa Valley, California. The Napa Valley Route. Elec. Ry. Jl., vol. 60, no. 1, July 1, 1922, pp. 7–8, 5 figs. San Francisco, Napa & Calistoga Ry. is successful single-phase California electric system; in connection with boat line it offers through service to San Francisco.

Temperature Effect on Power Consumption. Relation Between Temperature and Power Used by Electric Cars, A. W. Baumgarten. Elec. Ry. Jl., vol. 60, no. 3, July 15, 1922, pp. 77–78, 3 figs. Tests indicate that more power is used during cold weather; present methods of lubrication appear to be responsible for large part of increase.

ELECTRIC WELDING

Electropercussive. Review of Electro-Percussive Welding, D. F. Miner. Am. Welding Soc. Jl., vol. 1, no. 7, July 1922, pp. 27–36, 36 figs. Description of process and examples of welding.

Theories. Theories of Electric Welding. Practical Engr., vol. 66, no. 1845, July 6, 1922, pp. 5–6. Electrodes of future; carbon; brittleness; harmful elements.

ELECTRIC WELDING, ARC

Cyc-arc. The "Cyc-arc" Process of Automatic Electric Welding in Ship Work, L. J. Steele and H. Martin. Electrician, vol. 89, no. 2306, July 28, 1922, pp. 98–99, 3 figs. Recent developments. Success in making mild-steel welds.

Monel Metal. Arc Welding Monel Metal, P. D. Merica and J. G. Schoener. Welding Engr., vol. 7, no. 7, July 1922, pp. 42–44 and 46, 6 figs. Use of metallic deoxidizers has resulted in sound, strong, and moderately ductile welds. From paper read before Am. Welding Soc.

EMERY PAPER

Manufacture. Improving Emery Paper (Metod för förbättring av smärgelpapper), C. Benedicks and E. Sörberg. Jerkontorets Annaler, vol. 106, no. 5, 1922, pp. 178–185, 10 figs. Describes production under pressure and gives results obtained.

ENGINEERING SCHOOLS

Curricula, Criticism of. Engineering Schools Fall Short of Modern Needs, John H. Dunlap. Eng. News-Rec., vol. 89, no. 6, August 10, 1922, pp. 224–226. Criticisms of present methods; suggests longer course for engineering degree. Author is secretary of Am. Soc. Civil Engrs.

ENGINEHOUSES

Concrete-Unit. Concrete-Unit Roundhouses on the Pennsylvania R. R. Eng. News-Rec., vol. 89, no. 3, July 20, 1922, pp. 110–112, 3 figs. Large buildings framed of precast members; walls of brick and steel sash; casting yard and unit erection methods.

Southern Pacific. Southern Pacific Builds Unique Engine Houses. Ry. Age, vol. 73, no. 3, July 15, 1922, pp. 105–106, 2 figs. Rectangular concrete structures are provided with lead tracks at each end to expedite use.

EVAPORATION

Problems. The General Problem of Evaporation, J. W. Hinchley. Soc. Chem. Industry Jl., vol. 41, no. 14, July 31, 1922, pp. 242T–246T, 3 figs. Study

of evaporation below boiling point of liquid evaporated and evaporation at boiling point.

EXTRUSION OF METALS

Process. Extrusion of Metals (Quelques lois expérimentales de l'écrouissage), L. Poitrinal. Technique Moderne, vol. 14, no. 5, May 1922, pp. 193–199, 6 figs. Different ways of deformation; determination of parameters required; extrusion by compression, traction, and compression and traction simultaneously.

F

FACTORIES

Location. Industrial Plants and Their Location, F. Theo. Gnaedinger. Eng. Inst. Canada Jl., vol. 5, no. 7, July 1922, pp. 354–358, 4 figs. General survey of principal features to be considered in locating, designing and constructing industrial plant.

Protection Against Loss and Theft. Protecting Industrial Plants and Contents Against Loss and Theft, Joseph Mayhew. Management Eng., vol. 3, no. 2, Aug. 1922, pp. 109–110. Loss and theft from within industrial organization; responsibility of management; example of systematic leakage.

FANS

Tests. Fan Testing (Undersökelse av Ventilatorer), Johan Grönningsaeter. Teknisk Ukeblad, vol. 69, nos. 18, 19 and 21, May 5, 12 and 26, 1922, pp. 159–163, 170–174 and 195–198, 26 figs. May 5: Results of tests of fans carried out at Norwegian Technical High School during 1919. May 12: Tests with torpedo-boat fan equipment. May 26: Tests with Sirocco fans.

FATIGUE

Industrial. Fatigue in Industry (Le Problème de la fatigue dans l'Industrie), Jean Waldsburger. Vie Technique et Industrielle, vol. 3, nos. 31 and 32, Apr. and May 1922, pp. 25–27 and 95–97, 5 figs. Apr.: Research work of Prof. Kent, in England, on study of fatigue in men and women workers, and instruments used for measurements. May: Research work of J.-M. Laby, in France.

FEEDWATER HEATERS

Locomotive. Practical Advantages of Locomotive Feed Water Heating. Ry. Rev., vol. 70, no. 23, June 10, 1922, pp. 825–830, 6 figs. Maintenance and operation of locomotive feedwater heaters on 14 railroads. Int. Ry. Fuel Assn. report.

FIRE FIGHTING

Chemicals for. Chemicals Met with in Fire Fighting, Raymond Szymanowitz. Fire & Water Eng., vol. 71, no. 22, May 31, 1922, pp. 987–988 and 1006. Showing forms, qualities and reactions under influence of heat and water of all such substances; knowledge needed to intelligently handle chemical fires.

FIRE PREVENTION

Water Works Coöperation. How the Water Works Should Aid in Fire Fighting, Clarence Goldsmith. Fire & Water Eng., vol. 72, no. 1, July 5, 1922, pp. 7–8. Suggestions as to active coöperation between water and fire departments; water-works employees should answer alarms; hydrant inspection; matter of adequate pressure.

FIRECLAYS

Eastern Kentucky. Fire Clays of the Eastern Coalfield of Kentucky, H. Ries. Am. Ceramic Soc. Jl., vol. 5, no. 7, July 1922, pp. 397–408, 6 figs. Flint, semi-flint and plastic clay of real commercial value and geological analysis of occurrence.

FLIGHT

Soaring. An Explanation of Soaring Flight, J. W. Miller. Aviation, vol. 13, no. 5, July 31, 1922, pp. 121–123, 5 figs. Elementary theory. Condensed outline of series of lectures before Northwest Aeronautical Soc.

Soaring Flight and Its Mechanical Solution, F. W. Ruben. Aviation, vol. 12, no. 26, June 26, 1922, pp. 750–752, 5 figs. Observation of bird flight discloses ability of birds to vary their wing area with changing wind pressure.

FLOUR MILLS

Diesel-Engine Drive. The Dittlinger Mills, John Pierce. Power Plant Eng., vol. 26, no. 13, July 1, 1922, pp. 652–655, 5 figs. Description of Diesel-engine plant in flour mill at New Braunfels, Tex. Engine 225 hp.

FLOW OF WATER

Measurement. Methods and Apparatus for the Photometric Gaging of the Flow of Water (Procédés et appareillage pour le jaugeage photometrique de faibles cours d'eau), Paul P. E. Papadopoulo-Santo Rini. Annales de l'Energie, vol. 2, no. 3, May-June 1922, pp. 97–101, 11 figs. Describes method consisting of introduction of liquid color at one point and photometric determination of color on water at a given distance at a certain time.

The California Pipe Method of Water Measurement, Blake R. Vanleer. Eng. News-Rec., vol. 89, no. 5, Aug. 3, 1922, pp. 190–192, 3 figs. Description of apparatus used and its operation; tables and charts employed.

FLUE-GAS ANALYSIS

Apparatus for. A New Flue Gas Tester, Max Moeller. Eng. Progress, vol. 3, no. 7, July 1922, pp. 151–152, 3 figs. Instrument based on variation in heat conductivity of flue gases produced by alteration of CO_2 content by electrical means.

Automatic Carbon Dioxide Indicator for Flue Gas, R. B. MacMullin. Jl. Indus. & Eng. Chem., vol. 14, no. 7, July 1922, pp. 628–629, 2 figs. Description of instrument accurate to 0.02 per cent, which will record continuously for two days or more without need of refilling scrubber or readjusting zero point.

FLUE GASES

Movement. New Theory on the Movement of Flue Gases (Etude théorique nouvelle relative au mouvement spontané des gaz d'un courant de chauffage), H. Tripier. Chaleur et Industrie, vol. 3, nos. 25 and 26, May and June 1922, pp. 1244–1250, and 1360–1367, 10 figs. Discusses draft in stack, and losses connected with it, on basis of Bernoulli formula. Develops other formulas and methods of practical calculation, which are more general and more exact.

FORGINGS

Brass. Brass Forgings, C. G. Heiby. Metal Industry (Lond.), vol. 21, no. 2, July 14, 1922, pp. 25–27. Description of process; sand-cast blanks; chill-cast blanks; composition of metal; physical properties.

Hammers, Pneumatic. "Single-Blow" Pneumatic Forging Hammers, W. H. Snow. Engineering, vol. 114, no. 2952, July 28, 1922, pp. 98–101, 9 figs. Discussion of efficiency of operation, special reference to weight and duration of blow.

Steel for. Scientific Selection of Materials for Forgings. Am. Mach., vol. 57, no. 6, Aug. 10, 1922, pp. 211–215, 10 figs. Selection of steel; its testing and heat treatment.

FOUNDRIES

Compressed Air in. Compressed Air in the Foundry, L. W. Schnitzer. Compressed Air Mag., vol. 27, no. 7, July 1922, pp. 185–188, 8 figs. Pneumatic devices perform many useful operations in foundry; reduce costs and increase production.

Layout. Modern Tendencies in Foundry Installation (Tendances modernes présidant à l'Installation des Fonderies), M. Thomas. Fonderie Moderne, no. 5, May 1922, pp. 129–141, 4 figs. Foundries for heavy, medium, and mechanical castings; foundry sand; etc.

Malleable-Iron. Brass Firm Makes Malleables, Pat Dwyer. Foundry, vol. 50, no. 13, July 1, 1922, pp. 523–528, 10 figs. Powdered-coal equipment for annealing and core ovens; 100,000 sq. ft. of floor space and all modern improvements in sanitation, safety devices, dust exhaust system, etc.

Planning a New Malleable Shop, E. Tonceda. Iron Trade Rev., vol. 71, no. 4, July 27, 1922, pp. 243–248, 3 figs. Consideration governing site selection and plant layout; design of equipment. (Abstract.) Exchange paper before Instn. British Foundrymen.

Safety. Safety Work in Foundries, R. W. Patmore. Metal Industry (Lond.), vol. 20, no. 25, and vol. 21, no. 1, June 23 and July 7, 1922, pp. 584–585 and 3–4. Also Foundry Trade Journal, vol. 25, no. 305, June 22, 1922, pp. 464–467. Analysis of causes of major and minor accidents in foundry and suggestions for campaign to reduce practice of same. Presented at Inst. British Foundrymen.

FRAMES

Kinematic Theory of. Kinematic Theory of Framework (Théorie cinématique du treillis), Léon Legens. Génie Civil, vol. 81, no. 2, July 8, 1922, pp. 40–43, 18 figs. Develops formulas and makes calculations.

FUEL ECONOMY

Power Plants. Fuel Economy in Steam Power Plants, John B. C. Kershaw. Beama, vol. 11, no. 1, July 1922, pp. 474–481, 3 figs. Composition and constitution of natural and artificial fuels, and chemistry of combustion process.

Fuel Economy and Production Expenses, Allen M. Perry. Elec. World, vol. 80, no. 3, July 15, 1922, pp. 115–118. Data given for electric plants burning coal, oil, gas and hogged fuel; careful analysis of data permits interesting comparisons between results obtained.

FUELS

Garbage. Burning Garbage Under the Boiler (Die Verwertung von Mull durch Verbrennung), H. Hermann. Gesundheits-Ingenieur, vol. 45, nos. 21 and 26, May 27 and June 30, 1922, pp. 274–278 and 339–343, 12 figs. May 27: Furnaces fired with garbage and other refuse, especially for hot water and heating purposes. June 30: Garbage incinerating plants, their operation and equipment.

Sawdust. Sawdust as Fuel. Elec. Rev., vol. 89, no. 2282, Aug. 19, 1922, pp. 236–238, 8 figs. Details of plant installed by John Sadd & Sons, Ltd., Maldon, Essex, for production of gas from sawdust.

[See also COAL; COKE; OIL FUEL; PEAT; PULVERIZED COAL.]

FURNACES, HEAT-TREATING

Continuous. Continous Furnaces and Their Application, P. J. Myall and L. A. Mekler. Forging & Heat Treating, vol. 8, no. 7, July 1922, pp. 322–326, 5 figs. Classification of continuous furnaces; type of furnace recommended for various operations; writers believe there should be ten continuous furnaces for one now in operation.

Scale Formation. Furnace Atmospheres and Their Relation to the Formation of Scale, George C. McCormick. Am. Soc. for Steel Treating Trans., vol. 2, no. 11, Aug. 1922, pp. 1006–1012, 3 figs. Experimental data and procedure during investigation of scaling activity of oxidizing, neutral and reducing atmospheres during heat treatment of steel.

FURNACES, BOILER

Air Preheaters. Air Preheaters for Boiler Furnaces. Engineering, vol. 114, no. 2949, July 7, 1922, pp. 24–27, 10 figs. Description of apparatus built by Ljungström Steam Turbine Co.

FURNACES, METALLURGICAL

Aluminum-Melting. Aluminum and Aluminum-Alloy Melting Furnaces, Robt. J. Anderson. Can. Foundryman, vol. 13, no. 7, July 1922, pp. 19–23, 3 figs. Review of work undertaken by U. S. Bur. Mines to decrease metal and fuel losses in melting.

G

GALVANIZING

Weight of Coating. Determination of Spelter Coating on Sheets, D. M. Strickland. Raw Material, vol. 5, no. 6, July 1922, pp. 227–228, 1 fig. Simple and accurate method which may be applied to all shapes and sizes of specimens. Portable equipment for field tests. Paper read at annual mtg. Am. Soc. for Testing Mtls.

GAS ENGINES

Blast-Furnace Gas. The Nurnberg Gas Engine (Die Nürnberger Gasmaschine), J. Schmidt. Elektrotechnischer Anzeiger, vol. 39, nos. 72, 73 and 74, May 6, 9 and 10, 1922, pp. 601–602, 613–614 and 619–620, 5 figs. Describes 4-stroke, two-cylinder tandem engine, 700 hp. at 125 r.p.m. (normal size 2,000 hp.), for more economic utilization of blast-furnace gas; consumes 2200 to 2400 German heat units per b.hp-hr., at full load; application of tandem gas engines for driving dynamos.

GAS PRODUCERS

Ash-Fusion. Ash Fusion Gas Producer, M. A. Fichet. Am. Gas Jl., vol. 116, no. 24, June 17, 1922, pp. 550–552, 2 figs. Producer resembling small blast furnace in which complete combustion is attained by burning coal to fusion of ash. From Journal des Usines à Gaz., 1922, pp. 1–7.

Brick Manufacture. The Use of Producers and Their Gas in Burning Brick (Ueber die Verwendung von Generatoren und ihrer Gase zum Brennen von Ziegeln), Hubert Hermanns. Wärme, vol. 45, nos. 22 and 23, June 2 and 9, 1922, pp. 271–273 and 286–289, 17 figs. June 2: Compares gas- and direct-firing and describes various types of producers comparing their heat balance. June 9: Annular furnaces fired with producer gas; drying of wet lignite gas.

Electric. Gasification of Fuels by Means of the Electric Current (Vergasung von Brennstoffen mit Hilfe des elektrischen Stromes), Gwosdz. Wärme, vol. 45, no. 20, May 19, 1922, pp. 247–250, 1 fig. Application of electric curent to gas producers; describes Stassano, Girod, Holengren, and other types of apparatus.

GASES

Hydraulic Compression. Production of Pure Gases by the Principle of Hydraulic Compression (Gewinnung reiner Gase unter Anwendung des hydraulischen Kompressionprinzips), C. Heirich. Zeit. für komprimierte u. flüssige Gase, vol. 22, nos. 1, 2 and 3, 1922, pp. 3–7, 21–22 and 43–44, 1 fig. Principles and operation of hydrocompressor; gives cost data of a plant; use of hydraulic compressors in Linde liquefaction and rectification process for production of liquid or gaseous oxygen.

GASOLINE METERS

Grandberg. An Accurate Gasoline Meter, A. J. Dickie. West. Machy. World, vol. 13, no. 6, June 1922, pp. 189–191, 204, 8 figs. Description of measuring device invented by Grandberg and which requires tooling for manufacture on quantitative production basis.

GEAR CUTTING

Bevel. Cutting Bevel Gears, Franklin D. Jones. Machy. (N. Y.), vol. 28, no. 12, Aug. 1922, pp. 968–971, 7 figs. Principal adjustments required in setting up Gleason bevel-gear generators and time required for cutting gears of different sizes and pitches.

High-Speed. Producing Gears in Quantity at High Speed, J. H. Rodgers. Can. Machy., vol. 28, no. 1, July 6, 1922, pp. 33–35, 4 figs. Modern gear cutters very efficient; multiple fixtures reduce non-productive time; automatic operation practically eliminates possiblity of error, special method for bevel gears.

GEARS

Gear-Tooth Comparator. A New Instrument for Checking Gear Tooth Profiles and Spacing. Automotive Industries, vol. 47, no. 4, July 27, 1922, p. 171, 3 figs. Describes odontometer for comparing uniformity or determining interchangeability of gears. Applicable to gears of any pressure angle; can be applied while gear is still in machine.

GIRDERS

Calculation. Calculation of Girders on Two Supports Partly Fixed (Calcul général des pièces à deux appuis à encastrement partiel), Louis Gellusseau. Génie Civil, vol. 80, nos. 14, 15, 16, 17, 18, 24 and 25, Apr. 8, 15, 22, 29, May 6, June 17 and 24, 1922, pp. 315–318, 335–339, 359–361, 375–378, 401–403, 546–548, and 564–567, 32 figs. Discusses reinforced-

concrete construction, detailed definition of "encastrement," develops formulas and makes calculations for string boards, rectangular frames, circular and parabolic arches, girders with constant and variable cross-sections, etc.

GLASS MANUFACTURE

Factories. The Modern Glass Factory, W. S. Mayers. Glass Industry, vol. 3, no. 7, July 1922, pp. 129-134, 3 figs. Location with consideration to power and water, buildings, auxiliary equipment, air ducts, railroad sidings, and various other features.

Movement in Pots and Tanks. Movement of Molten Glass in Pot Furnaces and Tanks, Henry W. Hess. Glass Worker, vol. 41, no. 40, July 1, 1922, p. 11. Changes of temperature affect movement of refined glass. Careful regulation of furnace conditions will eliminate most troubles. Production of cords and waves in pots.

Optical Glass. Manufacture of Optical Glass (Fabrication des Verres d'Optique), Paul Nicolardot. Nature, no. 2515, July 8, 1922, pp. 17-23, 9 figs. Prime materials used, refractories and furnaces, molding, annealing, coloring, etc.

The Manufacture of Optical Glass (Ueber die Herstellung von optischem Glas). Sprechsaal, vol. 55, nos. 17, 18, 19 and 20, Apr. 27, May 4, 11 and 18, 1922, pp. 195-198, 209-211, 221-222, and 233-235, 13 figs. Apr. 27: Methods developed in England during war. May 4: Coloring and testing, optical constants, scientific side of glass manufacture. May 11: Relation between composition of glass and refractory index. May 18: Relation between composition and durability, molecular composition and solubility.

Presses, Automatic. Balanced Toggle Aids in Getting Proper Degree of Pressure. Glass Worker, vol. 41, no. 43, July 22, 1922, pp. 11 and 29-30, 3 figs. Mechanism for pressing glassware by balanced toggle produces proper weight pressure at all times.

GRINDING

Bearings. Grinding in the Automotive Industry. Machy. (N. Y.), vol. 28, no. 12, Aug. 1922, pp. 946-951, 11 figs. Methods of grinding steel balls and ball-bearing races, grinding roller bearing cups, cones and rollers.

H

HANGARS

Cable-Suspended Roof. Cable-Suspended Roofs for Hangars, Workshops, Docks, Etc. (Toitures supportées par des fermes de suspension isostatiques en cables pour hangars, ateliers, docks, etc.), G. Leinekugel le Cocq. Bul. de la Societe d'Encouragement pour l'Industrie Nationale, vol. 134, no. 5, May 1922, pp. 396-417, 15 figs. Describes construction of Cherbourg and other hangars with very wide span in which roof is suspended from cables at either end.

HARDNESS

Testing. Hardness Testing Methods (Sur les Methodes d'essai de dureté des corps), Georges Moreau. Révue Générale de l'Électricité, vol. 12, no. 3, July 22, 1922, pp. 106-111, 3 figs. Describes new method of testing materials, being improvement on Brinell method, i.e., dynamic hardness which is defined as relation between pressure exerted by ball during penetration on surface of impression.

The Testing of Metals for Hardness, S. P. Rockwell. Am. Soc. for Steel Treating Trans., vol. 2, no. 11, Aug. 1922, pp. 1013-1033, 27 figs. Results of tests made on standard Brinell, scleroscope and Rockwell hardness-testing machines.

HEAT STORAGE

Apparatus. Heat Storage Apparatus, C. Boileau. Elec. Times, vol. 62, no. 1603, July 6, 1922, pp. 7-9. Raising of central-station load factors by electric heat storage. From L'Électricien.

HEAT TRANSMISSION

Non-Conducting Materials. The Transmission of Heat Through and the Efficiency of Non-Conducting Materials, Masao Kinoshita. Domestic Eng. (English), vol. 42, no. 42, June 1922, pp. 116-120, 5 figs. Mathematical consideration (1) in which distribution of temperature in system of bodies considered remains unchanged, and (2) in which temperature distribution changes from time to time.

Refractory Materials. The Thermal Conductivity of Refractory Materials at High Temperatures, A. T. Green. Gas World, vol. 77, no. 1905, July 1, 1922, pp. 13-14, 2 figs. Review of previous work; Fourier's linear-diffusion equation, measurement of rate of rise of temperature for isothermal plane at known distance from hot face, texture; porosity; results. Paper read before Instn. Gas Engrs.

HYDRAULIC TURBINES

Queenston-Chippawa Plant. 55,000-Hp. Turbines for the Queenston Power Station, Ontario. Engineering, vol. 114, no. 2950, July 14, 1922, pp. 31-35, 19 figs. Description of turbines of Queenston-Chippawa development with illustration.

HYDROELECTRIC DEVELOPMENTS

Canadian Progress. Hydro-Electric Progress in Canada. Universal Engr., vol. 35, no. 6, June 1922, pp. 24-27. Brief review of development work in individual provinces and of progress in investigation and plans.

Germany. South German Electric Economics (Die Süddeutsche Elektrizitätswirtschaft), H. Putz. Elektrotechnische Zeit., vol. 43, no. 27, July 17, 1922, pp. 901-904, 1 fig. Water-power resources of Bavaria, Baden and Württemberg, the question of equal distribution; consumption of energy, 110 kv transmission line.

India. The Hydro-Electric Survey of India, J. W. Meares. Beama, vol. 10, no. 6, June 1922, pp. 409-411. 350,000 hp. developed or under construction, 1½ million hp. investigated by Survey, 1½ million in known sites not yet investigated, probably 4 to 10 million more.

The Power Factor—India's Natural Resources. Indian Industries & Power, vol. 19, no. 9, May 1922, pp. 302-307, 3 figs. General consideration of value of power development to Indian industry. Table of investigated prospects.

Queenston-Chippawa, Canada. Queenston-Chippawa Developments of the Hydro-Electric Power Commission of Ontario, F. A. Gaby. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 7, July 1922, pp. 508-526, 29 figs. General description of entire development on Canadian side of Niagara River which will have ultimate capacity of approximately 650,000 hp.

Tugalo River. Water Power Development on the Tugalo River. Eng. World, vol. 21, no. 1, July 1922, pp. 7-8, 5 figs. Georgia Ry. & Power Co. 50,000-Kw. development costing $1,600,000 to be finished next year.

HYDROELECTRIC PLANTS

France. Hydroelectric Plant at Mouthier (L'usine genératrice hydroélectrique de la Loue, à Mouthier), J. Reyval. Révue Générale de l'Électricité, vol. 11, no. 19, May 13, 1922, pp. 691-714, 21 figs. Describes generating station at Mouthier on the Loue; total power 16,000 hp.; generating equipment; overhead lines; transformers; stations, etc.

Hydroelectric Plant of the Paul Girod Steel Works at Ugines, Savoie [Les Usines hydro-électriques de la Compagnie des Forges et Aciéries électriques Paul Girod a Ugines (Savoie)], V. Sylvestre. Houille Blanche, vol. 21, no. 65-66, May-June 1922, pp. 73-83, 10 figs. Describes civil-engineering work in connection with construction of dams and reservoirs; pressure piping; Pelton wheels; etc.

Germany. Concrete and Reinforced-Concrete Works at the Isar (Beton- und Eisenbetonarbeiten an der Mittleren Isar), Hans Stanglmayr. Bauingenieur, vol. 3, no. 11, June 15, 1922, pp. 334-342, 9 figs. Reviews number of hydroelectric power works on this river in vicinity of Munich, and gives details of construction work.

New Hydroelectric Plants in Bavaria and Thuringia (Neuere Wasserkraftanlagen in Bayern und Thüringen), Schwenk. Bauingenieur, vol. 3, nos. 8, 9, 10 and 11, Apr. 30, May 15, 31 and June 15, 1922, pp. 230-234, 267-273, 300-307 and 330-334, 40 figs. Apr. 30: Civil engineering features of Wisenttal power plant and electric equipment, including Francis double-spiral turbines by Escher, Wyss & Co., and d.c. generators by Siemens-Schuckert. May 15: Describes power plant at Ziegenruck, on river Saale, its constructional features and equipment. May 31: Describes power plant at Hausen; hydraulic features, turbine equipment, etc. June 15: Describes power plant No. 2 at Munich, South, and its equipment, including two units of two coupled Francis turbines each, having head of 4.4 m., 1760 hp. at 125 r.p.m., and 80 per cent efficiency.

Italy. Hydroelectric Plant of the Barbellino (L'impianto idroelettrico del Barbellino), F. Zanon. Industria, vol. 36, no. 11, June 15, 1922, pp. 201-208, 9 figs. Hydraulic construction work; dams and reservoirs of the lakes of Barbellino, Malgina and Valmorta; power piping; list of central stations drawing their water power from these lakes.

Sweden. Haugesund Electric Power Station (Haugesundhalvöens og Karmöys elektrisitetsforsyningsanlaeg), O. Aas-Jörgensen. Teknisk Ukeblad, vol. 69, no. 27, July 7, 1922, pp. 252-255, 9 figs. Construction work and equipment of this high-tension station with 60,000 volts capacity.

Switzerland. An Extra-High Head Hydro-Electric Plant. Engineer, vol. 134, no. 3474, July 28, 1922, pp. 88-90, 9 figs. Description of Fully plant in Switzerland, operating under head of 1650.7 m., or 5416 ft.

I

ICE MANUFACTURE

Clear Ice. Making of Clear Ice, John E. Starr. Refrig. World, vol. 57, no. 7, July 1922, pp. 11-12 and 14. Increase to ice-making capacity and cold-storage space obtained by remodelling and modernizing plant and equipment.

Development. Development in the Manufacture of Ice, Harry T. Whyte. Nat. Engr., vol. 26, no. 7, July 1922, pp. 290-293, 13 figs. Review of progress of industry; advantages and disadvantages of present types; economics of plant operation.

ICE PLANTS

Refrigerator Cars, for. Car Icing Station for the Belt Railway of Chicago. Eng. News-Rec., vol. 89, no. 6, Aug. 10, 1922, pp. 240-242, 4 figs. Refrigerator cars at transfer yard supplied with cake or crushed ice; conveyors, carts and portable chutes.

IGNITION

Angle of Cylinder Axes. Angle of Cylinder Axes for Uniform Ignition (Gabelwinkel für gleichmässige Zündfolge bei mehrreihigen Verkehrsmotoren), H. Schrön. Motorwagen, vol. 25, nos. 16 and 17, June 10 and 20, 1922, pp. 307-312 and 329-333, 107 figs. Describes angle of cylinder axes in connection with crankshaft arrangements for multiple cylinder motors. Concludes that construction with cylinders opposite each other leaves free choice of angle but complicates crankshaft, normal construction simplifies crankshaft.

High-Tension Spark. High-Tension Spark Ignition in Internal-Combustion Engines, J. D. Morgan. Instn. Mech. Engrs. Proc., no. 2, 1922, pp. 303-315, 6 figs. What is expected of spark generators and discussion of spark and conditions affecting its production.

IMPACT TESTING

Alloy Steels. Significance of the Impact Test, F. C. Langenberg and N. Richardson. Forging & Heat Treating, vol. 8, no. 7, July 1922, pp. 309-312. Typical test data on certain alloy steels and ordnance steels are recorded, illustrating author's conclusions and furnishing opportunity for comparison of static and dynamic tests. Paper from Symposium before Am. Soc. for Testing Matls.

INDUSTRIAL MANAGEMENT

Ford's Four Production Principles. Ford's Four Production Principles, Samuel Crowther. Factory, vol. 29, no. 1, July 1922, pp. 15-17. Never letting well enough alone; always apportioning responsibility definitely; holding foremen not for costs but for production; treating interest charges as decreased profit.

Forge Shops, Records. Miscellaneous Records, Statistics and Suggestions for Drop Forgers, Geo. H. Koskey. Forging & Heat Treating, vol. 8, no. 7, July 1922, pp. 317-320. Suggesting sliding scale upward, where production depends on human elements; in this case firm would make profit on more pieces, reduce cost and benefit worker.

Malleable Shop System. System Rules Malleable Shop, H. E. Diller. Foundry, vol. 50, no. 13, July 1, 1922, pp. 537-541, 8 figs. Records of progress of work in large foundry are kept on simplified forms; four men handle routine for more than 200 molders; how work is scheduled.

Stabilizing Profits by Charts. Charting as an Aid in Stabilizing Profits, Percy A. Bivins. Indus. Management, vol. 63, nos. 5 and 6, and vol. 64, no. 1, May, June and July 1922, pp. 257-265, 355-361 and 33-42, 29 figs. Enabling executives to apply graphic methods to problem of profit stabilization.

[See also TIME STUDY.]

INSPECTION

See OPTICAL INSTRUMENTS.

INSTRUMENTS

Scientific, Mechanical Design. The Mechanical Design of Scientific Instruments. Engineering, vol. 113, nos. 2945, 2946, 2947 and 2948, June 9, 16, 23 and 30, 1922, pp. 729-730, 763-764, 794, and 828-829, 24 figs. Consideration in design of qualitative and quantitative instruments used in many branches of physical, engineering and chemical sciences. Abstract of three Cantor Lectures delivered before Royal Soc. of Arts.

INTERNAL-COMBUSTION ENGINES

Marine, Still System. Still System of Internal Combustion Engine for Marine Purposes, F. L. Martineau. Inst. Mar. Engrs. Trans., vol. 34, Apr. 1922, pp. 37-47, and (discussion) 47-58, 2 figs. Discussion of Still system; any internal-combustion engine can operate on it by certain modifications and improve its results 20 per cent.

Maximum Pressures. Comparing Maximum Pressures in Internal Combustion Engines, Stanwood W. Sparrow and Stephen M. Lee. Nat. Advisory Committee for Aeronautics Tech. Notes no. 101, June 1922, 4 pp., 3 figs. Thin metal diaphragms form satisfactory means; diaphragm is clamped between two washers in spark-plug shell and its thickness is chosen such that when subjected to explosion pressure exposed portion will be sheared from rim in short time.

Price Horizontal Engine. The Price Horizontal Engine. Power Plant Eng., vol. 26, no. 14, July 15, 1922, pp. 707-708, 4 figs. Combustion at constant volume, solid injection of fuel in two sprays.

Sulzer Two-Cycle. Four Cylinder Two-Cycle Sulzer Engine. Mar. Eng. vol. 27, no. 7, July 1922, pp. 443-444, 1 fig. Designed to develop 2,000 b.hp. at 100 r.p.m.; turbo scavenging pumps used.

Sulzer 2-Cycle Marine Engine, L. J. LeMesurier. Inst. Mar. Engrs. Trans., vol. 33, Mar. 1922, pp. 723-776 and (discussion) 776-790, 45 figs. Discussion of relative merits of 4- and 2-cycle internal-combustion engines and reasons for adoption of 2-cycle for larger powers by Sulzers.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; IGNITION; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Puddled. Make Puddled Iron Mechanically, E. C. Kreutzberg. Iron Trade Rev., vol. 71, no. 6, Aug. 10, 1922, pp. 365-366, 9 figs. Description of puddler developed at Eastern plant producing 1500-lb. puddle balls at rate of one per hr.

IRON AND STEEL

Fiber in. Fiber in Iron and Steel, F. F. McIntosh. Am. Soc. for Steel Treating, Trans., vol. 2, no. 10, July 1922, pp. 856-863 and (discussion) 864-868, 9 figs. Importance of fiber in performance of iron or steel and factors which govern formation and character.

IRON CASTINGS

Manufacture Direct from Ore. Making High-Grade Castings Direct from the Ore, F. H. Bell. Can. Foundryman, vol. 13, no. 7, July 1922, pp. 17–18, 2 figs. Ore melted in ordinary blast furnace is kept in vacuum thermos container until chemical analysis is taken, after which it is mixed with cupola iron.

Rolls. Casting Rolls (Walzenguss), Carl Irresberger. Giesserei Zeitung, vol. 19, nos. 23, 24, 25 and 26, June 6, 13, 20 and 27, 1922, pp. 342–345, 354–358, 371–374 and 381–386, 55 figs. Processes of casting steel rolls, tempered and untempered cast-iron rolls; molds, annealing furnaces; hardening and depth of penetration; hollow rolls.

Typewriter Frames. Making Typewriter Frames in a Belgium Foundry, Joseph Leonard. Can. Foundryman, vol. 13, no. 6, June 1922, pp. 32–33, 8 figs. Method of molding and casting. Comparatively simple rigging designed to produce 35 to 40 frames per day.

J

JAPANNING

Methods. Japanning, S. R. Gerber. Metal Industry (N. Y.), vol. 20, nos. 6 and 7, June and July 1922, pp. 225–227 and 161–163, 5 figs. Description of methods by which rule-of-thumb operations of an old art were changed to standard operations.

K

KEROSENE

Vegetable and Animal Oils as Sources. Catalytic Transformation of Vegetable and Animal Oils Into Kerosene (Transformation catalytique des huiles végétales et animales en pétrole), Alphonse Mailhe. Annales de Chimie, vol. 17, May-June 1922, pp. 304–332. Concludes that it is easy to reduce hydrocarbons from animal and vegetable oils, and that resulting hydrocarbons are in nature of mixed kerosenes very much like Borneo kerosene which has similar composition.

L

LABOR

Craftsmen Councils. Brief History of Craftsmen Movement in Cleveland. Universal Engr., vol. 36, no. 2, Aug. 1922, pp. 42, 44 and 46, 1 fig. Organization of craftsmen councils by groups of masons engaged in same line of industry.

India. Inefficiency Offsets India's Cheap Labor, James Allen DeForce. Iron Trade Rev., vol. 71, no. 6, Aug. 10, 1922, pp. 368–369. General data with some information on labor regulation.

LABORATORIES

Electrotechnical. Technical Laboratories of the Postal Telegraph Office (Le laboratoire technique des postes et télégraphes), Jacques Boyer. Nature, no. 2512, May 27, 1922, pp. 325–330, 8 figs. Describes Paris official laboratory in which telegraph, telephone and other instruments of the service are tested.

Testing, Electric. A 500,000-Volt Testing Laboratory (Un laboratoire d'essais à 500,000 volts), H. de Raemy. Révue Générale de l'Électricité, vol. 11, no. 23, June 10, 1922, pp. 861–864, 6 figs. Describes new laboratory of Ateliers de Constructions électriques de Delle, at Villeurbanne, which is especially designed for testing of high-tension apparatus for transmission lines.

LADLES

Stopper. Development in Design of Casting Ladle Bungs. Metal Industry (Lond.), vol. 20, no. 26, June 30, 1922, pp. 621–622, 6 figs. Discussion of design which should make connection between bung rod and bung absolutely certain and easy to effect. From Stahl u. Eisen.

LIGHTING

Glareless. Light Without Glare, Ward Harrison. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 8, Aug. 1922, pp. 609–615, 8 figs. Discussion of features determining satisfactory illumination without glare. Includes tables from Illuminating Eng. Soc. Code of Indus. Lighting in which for first time light sources are modified.

Industrial. Good Lighting an Essential in the Efficient Conduct of Business, J. H. O'Hara. Elec. News, vol. 31, no. 13, July 1, 1922, pp. 36–39. Expenditure of one-half of one per cent of pay roll increases output five per cent. Saving equal to ten times expense. Practical example. Paper read before C.E.A. convention.

Rational Lighting (Considerations sur l'éclairage rationnel), R. Wolff. Électricien, vol. 37, no. 1290, Dec. 15, 1921 and vol. 38, nos. 1297, 1298 and 1299, Apr. 1, 15 and May 1, 1922, pp. 553–561, 145–151, 174–177 and 193–197, 38 figs. Dec. 15: Photometry; intensity; measurement of light. Apr. 1: Lighting of business establishments; direct and indirect lighting, reflective power of various paints; etc. Apr. 15: Describes reflectors of various types and their curves of luminosity. May 1: Extent to which light is used in various systems of direct, indirect, etc., lighting.

The Problems of Electric Lighting (Die Aufgaben der elektrischen Beleuchtung), H. Lux. Elektrotechnische Zeit., special no., May 28, 1922, pp. 32–40, 19 figs. The various types of direct and indirect lighting and description of apparatus.

Lecture and Drafting Rooms. Illumination of Lecture and Drawing Halls (Die Beleuchtung von Hör- und Zeichensalen), W. Wedding. Zeit. für Beleuchtungswesen, vol. 28, no. 11–12, June 15–30, 1922, pp. 73–76, 15 figs. Results of examination of number of halls. Finds that most of the arc lights have been replaced by half-watt lamps. Tabular statement of illumination data of halls inspected.

Office Buildings. Indirect Lighting in City Office Building, G. F. Evans & J. W. Morrison. Elec. World, vol. 80, no. 2, July 8, 1922, pp. 61–62, 6 figs. Dixie terminal building in Cincinnati uses system with 8 to 15 foot-candles; arcade illumination eliminates hanging fixtures; aids to maintenance included in design.

Safety. Illumination and the Worker, G. Bertram Regar. Safety, vol. 9, no. 7, July 1922, pp. 156–160, 4 figs. Value of correct use in making for safe conditions in industry.

LIGNITE

Carbonization. Modern Methods of Treating Lignite and Its Derivatives (Procédés modernes pour le traitement du lignite et de ses derives). Chaleur et Industrie, vol. 3, no. 25, May 1922, pp. 1274–1276, 2 figs. Discusses carbonization; Fischer rotary furnace.

Degasification. Comparative Experiments on Degasification of Lignite on a Technical and Laboratory Scale (Vergleichende Versuche uber Entgasung von Braunkohle im technischen und Laboratoriums-Massstabe), K. Bunte and Fritz Schwarzkopf. Gas- u. Wasserfach, vol. 65, nos. 21, 22 and 23, May 27, June 3 and 10, 1922, pp. 322–325, 340–343 and 355–357, 15 figs. Experiments carried out with dirty Luckenau lignite for purpose of obtaining better results as to behavior of material than can be obtained from elementary analysis and coking sampling. Methods used were those of Gruppel, Strache, and muffle furnace.

LIME

Plants. New Lime Plant is Last Word in Modern Efficiency, William B. Eastwood. Cement, Mill & Quarry, vol. 21, no. 2, July 20, 1922, pp. 35–41 and 44, 14 figs. Mining, crushing, screening, calcining, hydrating and shipping are continuous without waste or climatic interruption.

LIQUIDS

Inflammable, Storage of. Storing Inflammable Liquids (Lagerung feuergefährlicher Flüssigkeiten). Zeit. des Bayerischen Revisions-Vereins, vol. 26, no. 12, June 30, 1922, pp. 100–102, 1 fig. Bavarian safety regulations for storage of petroleum, benzene, gasoline, etc., especially use of protective gas.

LOCOMOTIVE BOILERS

Circulation Effect on Efficiency. Effect of Circulation on Locomotive Boiler Efficiency, F. G. Lister. Steam, vol. 30, no. 1, July 1922, pp. 7–10. Recent attempts to create more rapid and unrestricted circulation thereby attaining more nearly uniform temperature throughout and reducing equal expansion and contraction of all parts. Paper read before Int. Ry. Fuel Assn.

LOCOMOTIVES

Combat. The Design of Combat Locomotives, R. S. Twogood. Jl. Pacific Ry. Club Proc., vol. 6, no. 3, June 1922, pp. 9–12. Notes on design deduced from experiences with those sent to France during recent war.

Design and Construction. Report on Locomotive Construction. Ry. Age (Daily), vol. 72, no. 24d, June 21, 1922, pp. 1631–1639. Various developments of year and résumé of 11 reports including recommendations (A.R.A. Mech. Div. Proc.).

Drifting Valves. When a Locomotive Drifts. Ry. Jl., vol. 28, no. 8, Aug. 1922, pp. 21–22, 3 figs., Description of Ripken automatic drifting valve.

Electric. See ELECTRIC LOCOMOTIVES.

Failure Causes and Remedies. Why Engines Fail, Frank C. Packard. Central Ry. Club Proc., vol. 30, no. 3, May 1922, pp. 1187–1198 and (discussion) 1198–1217. Analysis of failure and causes; losses caused thereby and argument for placing of full responsibility.

Fuel Consumption. Effect of Tonnage and Speed on Fuel Consumption, J. E. Davenport. Ry. Age, vol. 73, no. 2, July 8, 1922, pp. 71–75, 8 figs. Ton miles per hr. affects fuel rate; economical tonnage for various speeds, effect of grade and car weight. (Abstract.) Paper read before Int. Ry. Fuel Assn.

Increasing Mileage of. Increasing Locomotive Mileage—A Chemical Problem First, W. H. Hobbs. Ry. Rev., vol. 71, no. 1, July 1, 1922, pp. 11–12. Why better boiler feedwater is essential to increase in productive time of locomotives.

Mikado. New and Interesting Mikado Type Locomotive Built at the Lima Locomotive Works for the Michigan Central. Ry. & Locomotive Eng., vol. 35, no. 8, Aug. 1922, pp. 199–201, 4 figs. Specifications: Total length, 82 ft.; cylinder 28 in. by 30 in.; weight exclusive of tender, 334,000 lb.; weight of tender, 199,700 lb. with capacity of 16 tons fuel and 10,000 gal. water; driving wheel diam., 63 in.

Mountain Type. A Mountain Type Locomotive for High Capacity. Ry. Mech. Engr., vol. 96, no. 7, July 1922, pp. 381–385, 11 figs. New Union Pacific locomotive is lightest per unit of power of any 4-8-2 yet built, weighing 345,000 lb. and having maximum tractive effort of 54,800 lb. See also Ry. Rev., vol. 70, no. 23, June 10, 1922, pp. 815–825, 16 figs. partly on supp. plate.

Oil-Burning. Oil Fuel for Locomotives on the Taltal Railway of Chile, W. H. Revill. Ry. Gaz., vol. 36, no. 26, June 30, 1922, pp. 1030–1034, 6 figs. Comparison of oil and coal as fuel; economies which have been effected by use of oil; design of oil-fuel apparatus burners.

Operation. Work of the Commission for the Utilization of Fuel—6th Report (Travaux de la Commission d'Utilisation du Combustible—Sixième Rapport). Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 134, no. 6, June 1922, pp. 565–599. Report of First Sub-Committee. Efficiency of locomotives; steam consumption and distribution; feedwater preheating; operation of locomotives.

Steam-Turbine. The Ljungström Turbine Locomotive (Ljungströms turbinlokomotiv), Fredrik Ljungström. Teknisk Tidskrift, vol. 52, nos. 21, 22, 23, and 25, May 27, June 3, 10 and 23, 1922, pp. 331–333, 348–351, 363–367 and 396–400, 31 figs. Experimental work, and construction and operation of locomotives driven by steam turbines. Particulars of saving resulting.

Turbo-Condensing. Turbo-Condensing Locomotive Development in Europe. Ry. Rev., vol. 71, no. 7, Aug. 12, 1922, pp. 201–207, 9 figs. Details of Ljungström turbine-condensing locomotive placed in service on Swedish State Railways.

LUBRICATING OILS

Analysis. Technical Examination of Lubricating Oil and Grease, F. W. Watson and H. D. Bell. Chem., Met. & Min. Soc. of So. Africa Jl., vol. 22, no. 11, pp. 211–219. Analytical methods and data. Results of tests.

Coolers for. Tubular Oil Cooler. Engineering, vol. 114, no. 2951, July 21, 1922, p. 89, 6 figs. Describes marine cooler having 250 sq. ft. cooling space, and which will deal with 1½ million B.t.u. per hr. Constructed by Serck Radiators, Ltd.

LUBRICATION

Mechanism of. The Mechanism of Lubrication, Robt. E. Wilson and D. P. Barnard, 4th. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 49–60, 11 figs. Presenting best available data to afford basis for predicting effect of different variables under any specified conditions.

Oil Drops. What Determines the Size of the Oil Drop, W. F. Osborne. Power, vol. 56, no. 7, Aug. 15, 1922, pp. 251–252. Discussion of conditions affecting size of oil drops going to engine cylinder.

M

MACHINE TOOLS

Gear Drive. Methods of Machine Tool Design, A. L. De Leeuw. Am. Mach., vol. 57, no. 6, Aug. 10, 1922, pp. 223–227, 12 figs. Comparative merits of cone and tumbler quick gear-change device.

MACHINING

Deformation During. Avoiding Deformation During Machining, A. Whitehead. Engineer, vol. 134, no. 3474, July 28, 1922, pp. 98–99, 3 figs. Discusses as example, chucking of a ball race, machining small piston, and holding small armature.

MAGNESIUM ALLOYS

Engineering Uses. Magnesium Alloys in Engineering. Practical Engr., vol. 65, no. 1844, June 29, 1922, pp. 404–405, 2 figs. Electron (containing 80 per cent magnesium) for automobile pistons; general physical characteristics and precautions in molding.

MALLEABLE IRON

Drilling Data. Malleable-Iron Drilling Data, H. A. Schwartz and W. W. Flagle. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 81–87, 12 figs. Drill tests of five factors that influence machining properties of malleable iron.

MARINE STEAM TURBINES

Low-Pressure Capacity. Capacities of Low-Pressure Marine Steam Turbines, W. G. P. Mech. World, vol. 71, no. 1852, June 30, 1922, pp. 466–467, 2 figs. Low- and high-steam velocity considerations in respect to turbine design and weight; mathematical development.

MATERIALS

Testing. Testing Materials for Shipbuilding, Leon Guillet. Engineering, vol. 114, no. 2950, July 14, 1922, pp. 57–58, 6 figs. Methods of testing. Tensile, falling weight, ball hardness, punching, wearing, alternating, and physical tests, and macrographic investigations.

MEASURING INSTRUMENTS

End Measurement. Accurate End Measurement on Measuring Machines Using a Screw, H. Baker. Engineer, vol. 134, no. 3474, July 28, 1922, pp. 81–83, 6 figs. Experiments relating to attempts to measure correctly to one ten-thousandth of a millimeter. Description of machine used and methods.

Hollow Membrane. Measuring and Regulating by Means of a Hollow Membrane (Messen und Regeln mit Hilfe der Hohlmembran), E. Stach. Glückauf, vol. 58, no. 26, July 1, 1922, pp. 807–813, 10 figs. Requirements of measuring and recording instruments as to construction and sensitiveness; shows that hollow metal membrane recorder gives better results than wet measuring instruments.

METAL SPRAYING

Metals for. Metals and Alloys Suitable for Spraying (Für Spritzguss geeignete Metalle und Legierungen), F. Reinboth. Metall-Technik, vol 48, no. 24, June 8, 1922, pp. 266-267. Gives composition of various alloys and rules for their choice for a given purpose which requires given physical or electrical properties.

Schoop Process. The Schoop Metal Spraying Process With Special Reference to Its Application to Shipbuilding (Das Schoopsche Metallspritzverfahren), M. U. Schoop. Schiffbau, vol 23, no. 38, June 21, 1922, pp. 1106-1107, 1 fig. Describes various uses of metallizing pistol for covering chains, anchors, etc., with zinc, ship bottoms and propellers with copper, etc.

METALS

Electroanalysis of Alloys and. Electroanalysis of Metals and Alloys, Kling and Lassieur. Chem. Trade Jl. and Chem. Engr, vol 71, no. 1835, July 21, 1922, pp. 73-74. Description of new rapid method of electrolytic analysis applicable to wide range of metals. Translated from Annales de Chimie Analytique, June 15, 1922.

Hardening. On the Theory of the Hardening of Metals, Kotaro Honda. Science Reports Tôhoku Imperial Univ. 1st series, vol 11, no 1, Apr 1922, pp. 19-28. Martensite being homogeneous solid solution, is hard principally because of nature of atomic forces; consideration of hardness due to crystalline structure of metals.

Spinning. Metal Spinning and Spinning Tools, Edward Heller. Machy (N. Y.), vol 28, no. 12, Aug 1922, pp. 972-976, 9 figs. Description of machinery and methods for various types of spinning.

MILLING MACHINES

Aligning and Inspecting. Aligning and Inspecting Milling Machines. Machy (Lond.), vol 20, no. 311, July 13, 1922, pp. 441-444, 6 figs. Methods employed by manufacturers of Cleveland milling machine.

MOLDING MACHINES

Types. Molding Machines (La staffatura a scosse ed alcuni tipi di staffatrici), P. A. Sordelli. Industria, vol. 36, no. 11, June 15, 1922, pp. 211-214, 9 figs. Describes various types of molding machines with pneumatic stripping arrangement, including that of Britannia Foundry, Coventry, and that of Leber & Brose, and their operation.

MONEL METAL

Tubular Uses. Monel Metal's Merits in Tubular Uses, J. L. Sussman. Raw Material, vol. 5, no. 6, July 1922, pp. 208-210, 6 figs. Manufacture in tube form is step toward solving problem of chemically resistant, non-fragile material.

MORTARS

Lime. Hardening of Hydraulic Binders—Quality and Acceptance of Lime (Le durissement des liants hydrauliques. Qualités et réception des chaux), E. Camerman. Annales de l'Association des Ingénieurs Sortis des Écoles Spéciales de Gand, vol. 12, no. 1, 1922, pp. 1-13, 1 fig. Discusses in detail question of colloidal solutions; silicate and its part in hardening of hydraulic binders; hydraulic lime; tensile strength, specifications.

MOTOR BUSES

Design and Operation. Principles of Motorbus Design and Operation, G. A. Green. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 13-26, 36 figs. Safety, comfort and convenience, minimum operating cost and subdivisions of each commented on. Trucks or automobiles cannot render as good service as buses.

Principles of Motor Bus Design and Operation, David Beecroft. Commercial Vehicle, vol. 26, no. 11, July 1, 1922, pp. 12-14, 3 figs. Principles that apply to big Fifth Avenue buses apply also to all buses, everywhere, why design is big factor in successful bus operation. Review of paper presented by Col. Green at semi-annual mtg. of Society of Automotive Engrs.

Developments. Characteristics of Present-Day Buses, R. E. Plimpton. Bus Transportation, vol. 1, no. 7, July 1922, pp. 375-378, 3 figs. Requirements for city, inter-city, and country service considered; comfort and convenience factors found in modern bodies, devices for fare collection now being installed. (Abstract.) Paper read before Soc. Automotive Engrs.

New York State. Turnpikes Turn to Bus Routes in Empire State. Bus Transportation, vol. 1, no. 7, July 1922, pp. 383-389, 2 figs. Maps and tables of statistics and résumé of bus routes and facilities of New York State.

MOTOR TRUCKS

Steam. A Steam Six-Wheeler. Motor Transport, vol. 34, no. 904, June 26, 1922, p. 781, 3 figs. Two-wheeled conversion attachment to Ransomes steam wagon which is said to afford enormous carrying capacity.

A Milestone in Steam Design. Motor Transport, vol. 34, no. 904, June 26, 1922, pp. 768-771, 8 figs. New 7-ton Yorkshire, employing steam power in conjunction with many of best features of gasoline-car practice.

Tipping Gears. Tipping Gears for Motor Lorry Bodies, W. Erskine Dommett. Eng. Rev., vol. 35, no. 12, June 1922, pp. 406-412, 15 figs. Manner in which mechanical and hydraulic types have accomplished speed of operation, angle of tilt, ease when manually actuated, lightness, reliability, and low cost.

N

NITRIC ACID

Manufacture, Saltpeter vs. Synthetic Ammonia. Nitric Acid from Saltpeter or Synthetic Ammonia, Guy B. Taylor. Chem. Age (N. Y.), vol. 30, no. 6, June 1922, pp. 244-246, 1 fig. Cost factors and conditions that will determine raw material of nitric acid manufacture.

NITROGEN

Fixation. The Fixed Nitrogen Research Laboratory. Chem. Age (N. Y.), vol. 30, no. 6, June 1922, pp. 266-267, 4 figs. Equipment and facilities of plant at American University, Wash., D. C., and government work carried on there.

Synthetic, Products. Synthetic Nitrogen Products and the Ammonia Obtained as By-Product in Coal Distillation (Les produits azotés synthétiques, et l'ammoniaque obtenus comme sous-produits de distillation de la houille), A. Grebel. Génie Civil, vol. 80, no. 25, June 24, 1922, pp. 567-570. Influence of different phases of recovery and treatment of ammonia on final yield of sulphate.

NON-FERROUS METALS

Gas Absorption and Oxidation. Gas Absorption and Oxidation, B. Woyski and John W. Boeck. Foundry, vol. 50, no. 14, July 15, 1922, pp. 571-573, 2 figs. Defects in non-ferrous metals caused by gas absorption often erroneously attributed to oxidation; defective metal brought back to normal by proper melting practice; oxides of low gravity remain in metal. Paper read before Am. Inst. Min. & Met. Engrs.

NUMBERS

Duodecimal System. Standardization of Numbers (Die Normung des Zahlenmasses), Alfred Sieber. Maschinenbau, vol. 1, no. 5, June 10, 1922, pp. 280-284, 4 figs. Disadvantages of decimal system and advantages of duodecimal system.

O

OIL

Briquetting. Solid Oil With Peat Vehicle, Wm. A. Hall. Petroleum Times, vol. 8, no. 184, July 15, 1922, p. 90. Brief description of method of producing solid oil with peat as vehicle.

Protection from Evaporation. Durable Foam Seal Stops Evaporation and Reduces Fire Risk, Paul Truesdell. Nat. Petroleum News, vol. 14, no. 28, July 12, 1922, pp. 43-44, 1 fig. Sealite, compound containing 50 per cent air, cornstarch, glycerine and gelatine and other ingredients, when poured over top of tank of oil, spreads over surface, forming floating seal which prevents evaporation and fire.

OIL ENGINES

Bolinda. Bolinda Oil Engines of New Type. Shipping, vol. 16, no. 1, July 1922, pp. 42-43, 1 fig. New fuel injection device fitted on top of ignition bulb from which fuel is sprayed downward toward piston thereby eliminating fresh-water and compressed-air injection for maintaining constant hot-bulb temperature.

Design. The Oil Engine of Today, Chas. E. Lucke. Power, vol. 56, no. 7, Aug. 15, 1922, pp. 241-243, 2 figs. Discussion of recent improvements in general design that have made oil engine thoroughly reliable, including fuel charging and cylinder cooling.

Heavy-Oil. Present State of Heavy-Oil Engines (État Actuel de la Question des Moteurs a Huile Lourde), Marcel Bochet. Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils de France, vol. 75, no. 1-3, Jan.-Mar. 1922, pp. 87-105, 15 figs. partly on supp. plates. Discusses marine engines used in various shipyards; describes semi-Diesel engine and its operation.

Marine. Types of Large Marine Oil Engines, David R. Hutchison. Inst. Mar. Engrs. Trans., vol. 34, Apr. 1922, pp. 1-30 and (discussion) 31-37, 21 figs. Novel features of Scott-Still engine as representing newest types. Operating cycles and fuel economy; cylinder charging and exhausting; combustion of fuel; cooling; framing; valve and maneuvering gear.

Operation. Oil Engine Hints, Bert Bare. Power Plant Eng., vol. 26, no. 14, July 15, 1922, pp. 704-707, 2 figs. Hot ignition; missing; hunting; failure to start; loss of compression; compression card.

OIL FUEL

Ships. Oil Fuel In Ships. Steamship, vol. 34, no. 397, July 1922, pp. 21-24, 6 figs. Many advantages of oil coal and review of some features of oil burning.

Vegetable. Using Vegetable Oils for Fuels (Utilisation des huiles végétales comme combustibles industriels), Maurice Leduc. Chaleur et Industrie, vol. 3, no. 25, May 1922, pp. 1277-1280. Their calorific power; French vegetable oils; unlimited production; use in oil-burning installations.

OFFICE MANAGEMENT

Staff Training. Scientific Organization of Work at the Factory (Contribution au problème de l'organisation scientifique du travail dans les ateliers), Gaston Vidal. Arts et Métiers, vol. 75, no. 20, May 1922, pp. 129-141, 12 figs. Activities of National Schools of Arts and Trades in training office workers.

OPTICAL INSTRUMENTS

Screw and Gear Inspection. Inspecting by Optical Projection. Machy. (N. Y.), vol. 28, no. 12, Aug. 1922, pp. 984-988, 6 figs. Description of methods, with particular data on screw and gear inspection.

P

PAINTS

Physical Properties. Some Physical Properties of Paints, P. H. Walker and J. G. Thompson. Ry. Rev., vol. 71, no. 3, July 15, 1922, pp. 76-81, 2 figs. Investigations by U. S. Bur. Standards presented at convention of Am. Soc. for Testing Matls.

Sulphate Pulp, Lined Digesters. Sulphate Pulp Made in Lined Digesters, P. C. Austin. Paper, vol. 30, no. 16, June 21, 1922, pp. 14 and 16. Prevention of leaks, improved yield and steam economy among advantages. Paper read before joint convention of Cost Assn. of Paper Industry and Am. Pulp & Paper Mill Superintendent's Assn.

PAPER MANUFACTURE

Starch, Use of. The Use of Starch in Paper Manufacture, W. A. Nivling. Paper Mill, vol. 46, no. 26, July 8, 1922, pp. 4-6 and 8, 11 figs. Consideration of various starches and their differences in sizing operation. Paper read at Superintendents' Convention.

PARACHUTES

Calthrop. A New Calthrop Parachute Development. Flight, vol. 14, no. 28, July 13, 1922, pp. 396-397, 4 figs. Parachute equipped with series of slots near periphery with flounces which deflect air escaping through them at desired downward angle.

PEAT

Boiler Firing. Experience With Peat Firing of Steam Boilers (Erfahrungen über die Verheizung von Torf im Dampfkesselbetriebe), Ph. Stauf. Zeit. des Bayerischen Revisions-Vereins, vol. 26, no. 13, July 15, 1922, pp. 103-106, 4 figs. Composition and calorific value of peat; suitability of furnaces for peat; comparative figures as to cost.

PIPE, CAST-IRON

Analysis and Selection. Getting Best Results with Cast Iron Pipe, F. A. McInnis. Fire & Water Eng., vol. 72, no. 5, Aug. 2, 1922, pp. 221-222. Practical suggestion as to selection of pipe including analyses as to sulphur content made in Boston and elsewhere.

PIPE LINES

Design. Pipe Lines (Rohrleitungen), M. Fränkl. Maschinenbau, vol. 1, no. 6, June 24, 1922, pp. 343-346, 5 figs. Essential points in pipe-line installations; most economic kind of pipe; most suitable design of a given installation.

PIPE, WOOD

Notes on. Some Observations Concerning Wood Pipe, J. W. Ledoux. Am. Water Works Assn. Jl., vol. 9, no. 4, July 1922, pp. 549-569. Cost design in particular; formula for strength; water hammer discharging capacity; comparison of wooden and cast-iron pipes.

PISTON RINGS

Manufacture. Development of Piston Rings (Das Wesen und die Ausbildung der Kolbenringe mit Rücksicht auf wirtschaftliche Fertigung und auf Dichtigkeit gegen Druck), Otto Graf. Maschinenbau, vol 1, no. 6, June 24, 1922, pp. 339-343, 11 figs. Old and new ways of production; deformation by hammering; testing of materials; dimensions of rings for ordinary and light-metal pistons, standardization.

POWER PLANTS

Austria. The Partenstein Power Plant (Das Kraftwerk Partenstein), Adolf Kvetensky. Elektrotechnik u. Maschinenbau, vol. 40, nos. 20 and 21, May 14 and 21, 1922, pp. 229-236 and 242-246, 13 figs., May 14: Describes construction of plant and its equipment and makes calculations as to its profitability. May 21: Describes machinery equipment including Francis spiral turbines, three-phase generators, transformers, switchboard arrangements, erection of poles for overhead lines.

Birmingham, Nechells Station. Electricity Supply in Birmingham. Electrician, vol. 88, no. 2301, June 23, 1922, pp. 744-750, 7 figs. Details of 105,000-kw. ultimate capacity station started before war and now reaching completion.

Development. Notes from Report of Prime Movers Committee of N.E.L.A. Power Plant Eng., vol. 26, no. 14, July 15, 1922, pp. 697-703, 9 figs. Résumé of development in power-plant engineering during past year.

Prairie du Sac, Wis. Increased Capacity at Prairie du Sac. Power Plant Eng., vol. 26, no. 14, July 15, 1922, pp. 687-693, 15 figs. Addition of four 60-cycle, 23000-v., generators which increase output by 12,000 kva. and auxiliary changes in connection therewith.

Steam Conditions. The Choice of Steam Conditions in Modern Power Stations, L. C. Kemp. Electrician, vol. 88, no. 2302, June 30, 1922, pp. 774-777, 4 figs. Investigation indicating that more careful selection of steam conditions should be encouraged.

POWER TRANSMISSION

Radiotelegraphic. The Problem of Radiotelegraphic Power Transmission (Étude sur le problème de la téléméeanique par T. S. F.), Maurice Guéritot. Onde Electrique, vol. 1, no. 3, Mar. 1922, pp. 141-151, 3 figs. Reviews work done in transmitting power by radio to perform certain work at a distance,

especially French investigations during war, and discusses difficulties of control at a distance.

PRODUCER GAS

Analysis and Composition. Producer Gas (Der Generatorgaskörper), E. Kraemer. Feuerungstechnik, vol. 10, nos. 17, 18 and 19, June 1, 15 and July 1, 1922, pp. 185–188, 199–203, and 211–214, 16 figs. June 1: Analysis and composition; gives table of limit values for CO_2, CO, H_2, and CH_4. June 15: Calculations and curves of planes of equal quantities of air, equal quantities of steam, equal temperatures, and equal efficiency. July 1: Discusses neutral plane dividing gas into two parts, one containing exothermic processes and other endothermic processes. Greatest methane content.

PULVERIZED COAL

Boiler Firing. Pulverized Coal Firing (Die Staubverbrennung), A. B. Helbig. Feuerungstechnik, vol. 10, no. 19, July 1, 1922, pp. 209–211, 2 figs. Describes various systems of feeding pulverized coal to combustion chamber.

Explosion Hazard. Pulverized Coal Is Dangerous on the Surface as Well as Underground; Precautions to be Taken in Handling It, L. D. Tracy. Coal Age, vol. 22, no. 5, Aug. 3, 1922, pp. 164–168, 5 figs. Precautions to prevent explosion, particularly with reference to driers and electrical devices; data on self-ignition. From paper read before Fire Chiefs' Club of Ohio.

Feeding. Principles of Feeding Pulverized Fuel, M. W. Arrowood. Combustion, vol. 7, no. 1, July 1922, pp. 31–34, 47, 6 figs. Consideration of proper method of injection to obtain best conditions at various points in furnace.

Household Furnaces. Burning of Powdered Coal in Household Furnaces, Thos. W. Atterbury. Engrs. & Eng., vol. 39, no. 6, June 1922, pp. 209–214, 1 fig. Reasons for adoption; present low efficiency of household furnaces; convenience of pulverized usage; smoke prevention; description of installation and costs.

Lead Smelter. Pulverized Coal at the Bunker Hill and Sullivan Smelter, Henry M. Payne. Eng. & Min. Jl.-Press, vol. 114, no. 4, July 22, 1922, pp. 149–151, 5 figs. Use of powdered fuel in Northwestern lead smelter proving to be more economical than oil; plant operates with minimum amount of attention; safety precautions taken.

R

RAILS

Bull-Head. Specification for Bull-Head Rails. Iron & Coal Trades Rev., vol. 105, no. 2836, July 7, 1922, p. 5. Specifications issued by British Eng. Standards Assn.

Wear. The Corrugation of Rails (Usure ondulatoire des Rails), M. E. Resal. Industrie des Tramways, Chemins de Fer et Transports Publics Automobiles, vol. 16, no. 181, Jan. 1922, pp. 10–17, 13 figs. Discusses question in connection with rolling of metal which may be responsible for the corrugation, and advises experiments to be made, especially to prove connection.

RAILWAY ELECTRIFICATION

France. Electrification in France, M. Sabouret, Elec. Ry. & Tramway Jl., vol. 46, nos. 1130 and 1136, May 12 and June 16, 1922, pp. 212–214 and 278–280, 5 figs. Report of chief engr. of Orleans Ry. Co. to Internat. Ry. Congress at Rome showing plans for 5000 miles to be electrified.

Main-Line Railroads. Electrification of Main Line Railroads, S. T. Dodd. Gen. Elec. Rev., vol. 25, no. 7, July 1922, pp. 439–440. Outstanding features of accomplished and contemplated installations.

Russia. Electrification Possibilities in Russia (Ruslands elektrificeringsmuligheter), E. Kraabel-Jörstad. Elektroteknisk Tidsskrift, vol. 35, no. 20, July 15, 1922, pp. 159–162. Plans for electrification at Moscow and Petrograd; water-power resources of Russia in Europe and Asia.

Trend of Development. The Electrification of Railways, F. Rowlinson. Beama, vol. 10, nos. 5 and 6, May and June 1922, pp. 349–357 and 437–444, 12 figs. Outstanding features of successful installation and facts to be considered in prospective ones.

RAILWAY OPERATION

Service of Supply. The Origin and Development of the Service of Supply, George G. Yeomans. Ry. Rev., vol. 70, nos. 23 and 24, vol. 71, no. 1, June 10, 17 and July 1, 1922, pp. 868–869, 923–927 and 12–15. Short history of most recent fundamental development in railway organization.

Train Control. Automatic Stopping of Trains and Repetition of Signals in the Cabs (Arrêt automatique des trains et Répétition des signaux sur les locomotives), J. Verdeyen. Annales de l'Association des Ingénieurs Sortis des Écoles Speciales de Gand, vol. 12, no. 1, 1922, pp. 16–32. Reviews literature on subject. Reply by C. Van de Velde, pp. 33–48, 1 fig.

British Approve Automatic Train Control. Ry. Age, vol. 73, no. 4, July 22, 1922, pp. 149–153, 2 figs. Ministry of Transport Committee recommends intermittent contact type; disapproves of speed control.

RAILWAY REPAIR SHOPS

Santa Fe Ry. Santa Fe Completes Modern Shops at Albuquerque. Ry. Age, vol. 73, no. 6, Aug. 5, 1922, pp. 237–242, 10 figs. Description of locomotive repair building.

RAILWAY SHOPS

Canadian Pacific at Angus. How Shop Output is Increased and Costs Reduced at Angus. Ry. Rev., vol. 70, no. 23, June 10, 1922, pp. 851–865, 19 figs. Organization and equipment and expression of value of effective shop scheduling system.

Car. Equipment and Operation of a Modern Steel Car Plant, Geo. A. Richardson. Ry. Rev., vol. 70, no. 24, June 17, 1922, pp. 913–918, 8 figs. Plant of Cambria Steel Co., Johnstown, Pa., which is integral part of steel manufacturing organization; capable of building 50 all-steel cars a day.

RAILWAY SIGNALING

Electric. Electric Control of Railway Switches and Signals (La commande électrique des grands postes d'aiguilles et signaux de chemins de fer), Lucien A.-H. Pahin. Révue Générale de l'Électricité, vol. 12, no. 1, July 8, 1922, pp. 23–31, 10 figs. Interior arrangement of electric signal cabins on French railways; describes in detail construction and operation of motor applied to each individual switch.

Locomotive Cab Signals. On the Question of Locomotive Cab Signals, Faustino Villa. Int. Ry. Assn. Bul., vol. 4, no. 5–6, May-June 1922, pp. 821–862, 17 figs. Classifications and functions; mechanical, electrical and electromechanical repeating apparatus.

Sweden. Safety and Signaling Installations on the Cristiania-Gjövik Line (Sikrings- og signalanlaeg ved Roa stasjon, Kristiania-Gjövikbanen), J. Lindboe. Teknisk Ukeblad, vol. 69, no. 26, June 30, 1922, pp. 246–250, 9 figs. Describes in detail signaling arrangements, electric power, wiring and connections, switching, electric motors, etc.

RAILWAY SWITCHES

Remote Operation. Remote Operation of Switches on the New Haven. Ry. Age, vol. 73, no. 6, Aug. 5, 1922, pp. 251–252, 6 figs. Satisfactory results are reported after 40 years experience with 28 low-voltage machines.

RAILWAY TERMINALS

Operation. Terminal Stations for Passengers, L. Maccallini. Int. Ry. Assn. Bul., vol. 4, no. 5–6, May-June 1922, pp. 753–761. Best arrangements to reduce number of movements of engines and empty cars.

St. Louis. Report on Improvement of Railroad Terminals in St. Louis. Ry. Rev., vol. 71, no. 4, July 22, 1922, pp. 99–113, 7 figs. Report on team track facilities.

RAILWAY TIES

Reinforced-Concrete. Note on Some Recent Types of Reinforced Concrete Sleepers, R. Desprets. Int. Ry. Assn. Bul., vol. 4, no. 7, July 1922, pp. 959–971, 6 figs. Investigation of Calot type tried by Paris-Orleans Ry. Co. and Vagneux type tried by Paris-Lyons-Mediterranean Ry. Co. Latter is less expensive.

RAILWAY TRACK

Effect of Rolling Stock on. Action and Reaction Between Rolling Stock and Track (Considérations générales sur les actions réciproques de la voie et du matériel roulant et sur le calcul des rails), R. Desprets. Annales des Travaux Publics de Belgique, vol. 13, no. 2, Apr. 1922, pp. 233–272, 6 figs. Analyzes forces and stresses, vertical, longitudinal and lateral action, and makes calculations of rails on this basis.

REAMERS

Standardization. Standardizing Shell Reamers and Arbors, H. S. Kartsher. Machy. (N. Y.), vol. 28, no. 11, July 1922, pp. 892–895, 7 figs. Standard dimensions governing fits, and gages used for inspection.

REFRACTORIES

Fireclay. Fireclay Refractories, C. E. Bales. Nat. Engr., vol. 26, no. 7, July 1922, pp. 300–303, 3 figs. Origin and occurrence of fireclay; mining and preparation for use; relation to boiler practice. Paper read before Kentucky No. 1, N.A.S.E.

Research. Report of the Refractory Materials Research Committee. Gas Jl., vol. 158, no. 3085, June 28, 1922, pp. 840–851 and (discussion) 851–852, 4 figs. Revision of British specification. Standardization of After-Contraction Test, by D. A. Jones. Thermal Conductivity of Refractory Materials at High Temperatures, by A. T. Green.

REFRIGERATING MACHINES

Turbo-Compressor. A New Refrigerating Machine. Ice & Refrigeration, vol. 63, no. 1, July 1922, pp. 43–45, 2 figs. Novel turbo-compressor using newly discovered low-pressure refrigerating fluid demonstrated before gathering of 300 engineers at plant of Carrier Engr. Corp., Newark, N. J., machine especially adapted for producing cold water required in cooling air for industrial purposes.

RELATIVITY

Application in Heat Industries. The New Mechanics and Their Application in Heat Industries (La Mécanique nouvelle et ses applications pratiques aux industries du feu), P. Drosne. Chaleur et Industrie, vol. 3, nos. 21, 22, 23, 24, 25 and 26, Jan., Feb., Mar., Apr., May and June, 1922, pp. 882–886, 971–975, 1070–1076, 1165–1169, 1270–1273 and 1368–1372, 6 figs. Application of theory of relativity to calculation of zones of combustion and transformation; kinetic and atomic theories; electrons and ionization; molecular isotropic law; occlusion of gases. Concludes that new mechanics give remarkably accurate picture of underground equilibrium of natural hydrocarbons.

RIVETING

Hammers for. Operations with Riveting Hammers. Machy. (Lond.), vol. 20, no. 511, July 13, 1922, pp. 453–455, 6 figs. Examples of cold-heading and rivet-setting operations performed on high-speed riveting hammers.

ROLLING MILLS

Reversing Passes. Layout and Arrangement of Reversing Passes in Rolling Mills (Unterwerke für Umkehrwalzenstrassen), H. Baclesse. Elektrotechnische Rundschau, vol. 39, no. 1, Jan. 31, 1922, pp. 1–5, 9 figs. Electric equipment and its advantageous location and arrangement.

Sheet Mills, Reconstruction. Reconstruction of Ayrton Sheet Mills, Middlesbrough. Iron & Coal Trades Rev., vol. 104, no. 2835, June 30, 1922, pp. 967–969, 8 figs. Description of installations including gas firing for all mill furnaces.

RUBBER

Lime as Accelerator. Prepared Lime in Rubber, H. L. Terry. Rubber Age, vol. 3, no. 5, July 1922, pp. 211–212. Preparation of lime for use as inorganic accelerator in rubber industry; qualities of and impurities in lime.

Manufacture. The Rubber Industry (L'Industrie du caoutchouc), F. Jacobs. Révue Industrielle, vol. 52, nos. 4, 5, 6, 7 and 8, Feb., Mar., Apr., May and June 1922, pp. 117–233, 165–166, 194–198, 220–222 and 256–262, 21 figs. Feb.: Preparation of mixtures; washing and drying of rubber; mixing and mixers; calendering; etc. Mar.: Discusses various methods and apparatus for vulcanizing rubber Apr.: Production of manufactured articles, such as belting, erasers, sponges, etc. May: Manufacture of rubber goods, such as gas tubes, tobacco pouches, rubber bands, etc. June: Manufacture of pneumatic tubes. Continuation of serial.

Microscopic Examination. The Microscope in the Rubber Industry, W. M. Ames. Rubber Age, vol. 3, no. 5, July 1922, pp. 213–214 and 217–218, 7 figs. Laboratory requirements and definite determination of structure and characteristics.

S

SCAFFOLDS

Suspended. Suspended Scaffolds for Building Construction. Contractors' & Engrs.' Monthly, vol. 4, no. 6, June 1922, pp. 45–46, 2 figs. Description of "Little Wonder" suspended scaffold, which is claimed to reduce possibilities of accidents.

SCREW THREADS

Tolerances. Screw Tolerances (Gewindetoleranzen), G. Berndt. Werkstatts Technik, vol. 16, no. 12, June 15, 1922, pp. 349–356. A compilation of material from all countries on tolerances for bolts, nuts, etc.

SEMI-DIESEL ENGINES

Construction and Application. The Semi-Diesel Engine, Its Construction and Application (Les moteurs semi-Diesel, état actual de leur construction et de leur utilisation), Adrien Schubert. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 134, no. 5, May 1922, pp. 418–505, 78 figs. Indicator diagrams; efficiency; fuel injection; water injection; ignition; starting; fuels, including vegetable oils; present types. Bibliography.

SEMI-STEEL

Properties and Use. Semi-Steel, J. Cameron. Metal Industry (Lond.), vol. 30, no. 26, June 30, 1922, pp. 623–629, 6 figs. Definition, field for use, tests and raw materials for production, heat treatment. Paper read before Insto. British Foundrymen. See also Foundry Trade Jl., vol. 25, no. 306, June 29, 1922, pp. 495–500, 6 figs.

SHELLAC

Origin, Utilization and Examination. Shellac Its Origin, Utilization and Examination (Der Schellack, seine Entstehung, Verarbeitung und Untersuchung), Hans Wolff. Chemiker-Zeitung, vol. 46, nos. 35 and 38, Mar. 23 and 30, 1922, pp. 265–266 and 291–293, 2 figs. Mar. 23: Production; types on market; bleaching and solubility. Mar. 30: Chemical composition, properties; uses.

SMOKE ABATEMENT

Paris. The Smoke Question in Industrial Centers (La question des fumées dans les agglomérations industrielles). Journal des Usines a Gaz, vol. 46, n. 11, June 5, 1922, pp. 161–167, 2 figs. Gives text of Paris police regulations to prevent smoke, and progress in their application.

SOLDERS

Aluminum. Tests of Aluminum Solders. Automotive Industries, vol. 47, no. 4, July 27, 1922, p. 168. Data on tests on soldered joints made at McCook Field.

Metallurgical Investigation. A Metallurgical Investigation of Solders, Wallace Dent Williams. Raw Material, vol. 5, no. 6, July 1922, pp. 216–223, 6 figs. Fusibility; scratch hardness; low melting point for white metals; silver solders; autogeneous soldering; borax substitutes.

SPRINGS

Helical. A Coiling and Heat Treating Plant for Helical Springs, William J. Merten. Am. Soc. for Steel Treating Trans., vol. 2, no. 11, Aug. 1922, pp. 977–983, 5 figs. Main features of plant for insuring maximum economy of labor and materials consistent with securing high-grade product.

The Cadman "Gato" Valve

The Cadman GATO Valve is standard equipment with the leading boiler manufacturers, oil refineries, and public utilities the world over, because of its unique features.

It is locked positively tight by a simple mechanical movement when closed, yet is easily opened or closed under all conditions by the slightest pressure on the quarter turn lever.

The provision of a ready means of adjustment ensures a life many times that of the ordinary plug valve. It is practically indestructible.

The GATO Valve possesses many advantages over any other of this type. These advantages are fully described in our new catalogue just off the press. A copy should be in the hands of every engineer and the coupon brings it.

Clip the Coupon

A.W.
Cadman
Manufacturing Co.
Pittsburgh
Pa.

Without charge or obligation please send me a copy of your new No. 7 Catalogue.

Name:..Position:........................

Company Name:..

Address:..

Leaf. Leaf Springs (Ressorts a Lames superposées), C. Reynal. Arts et Métiers, vol. 75, no. 21, June 1922, pp. 164–173, 9 figs. Symmetrical and unsymmetrical springs; length, thickness and flexibility of leaves, and their calculation; sensitiveness of springs

Manufacture. Single-Stroke Eye-Rolling Machine for Automobile Springs. Machy. (Lond.), vol. 20, no. 513, July 27, 1922, pp. 522–523, 5 figs. Description of machinery built in England.

STEAM ACCUMULATORS

Ruths. Steam Accumulators (Dampfspeicher), Johannes Ruths. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 21, 22 and 24, May 27, June 3 and 17, 1922, pp. 509 513, 537–542 and 597–605, 62 figs. May 27: Construction and application of Ruths accumulator; possibility of equalizing pressures with various boiler types; plants already built; use of these accumulators in new constructions or extensions of present plants. June 3: Cooling losses, water-level indicators; superheat accumulators. June 17: Existing installations of steam accumulators for equalizing variations in steam for boiling and heating, and for equalizing power and steam variations.

The First Ruths Steam Accumulator in Germany (Der erste Ruths-Dampfspeicher in Deutschland), Theodor Stein. Stahl u. Eisen, vol. 42, no. 24, June 15, 1922, pp. 924–933, 9 figs. Describes steam-accumulator installation in power plant of Lauchhammer Iron Works, fluctuations in load, construction details, and particulars of cost.

STEAM ENGINES

Automatic Control. Steam Engines With Automatically Controlled Steam Supply (Dampmaskiner med automatisk regulerbar dampudtagning), H. H. Mansa. Ingeniören, vol. 31, no. 30–31, May 27, 1922, pp. 189–194, 11 figs. Steam consumption and steam economics at factories using large amount of steam.

Flywheel, Degree of Irregularity. Graphical Determination of the Degree of Irregularity of an Engine (Calcul graphique du degré d'irrégularité d'une machine), G. Laville. Révue Générale de l'Électricité, vol. 12, no. 3, July 22, 1922, pp. 85–91, 10 figs. Method for determining moment of inertia of flywheel of machines as function of degree of irregularity.

Schmidt 60-Atmos. The Schmidt 60-Atmos. Steam Engine and the Use of High-Pressure Steam in Lignite Mines (Die Schmidtsche 60-Atmosphären-Dampfmaschine und die Anwendung höchstgespannten Dampfes auf Braunkohlenbergwerken), Otto H. Hartmann and Kurt Manning. Braunkohle, vol. 20, nos. 49, 50 and 51, Mar. 11, 18 and 25, 1922, pp. 769–776, 790–795 and 805–811, 30 figs. Mar. 11: Describes vertical tube boiler developed by Schmidt's High-Temperature Steam Co., in Kassel and gives results of experiments with maximum pressure boilers. Mar. 18: Consumption of heat of maximum-pressure reciprocating engines and turbines. Mar. 25: Advantages of maximum-pressure engines in plants utilizing waste steam.

STEAM METERS

Chemical Measurement. Measuring Steam by Chemical Means (Het meten van stoom langs chemischen weg), J. Rutten. Chemisch Weekblad, vol. 19, no. 21, May 27, 1922, pp. 229–232, 1 fig. Chemical method for measuring steam at factories where steam is largely used in various departments, which gives much more exact results than ordinary metering systems.

STEAM TURBINES

Construction. Flow of Steam and Construction of Large Steam Turbines (Strömungsvorgänge und Aufbau grosser Dampfturbinen), G. Zerkowitz. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 22 and 23, June 3 and 10, 1922, pp. 533–536 and 561–565, 15 figs. Expansion between blades; maximum performance of flow; incomplete expansion; influence of length of blades; means of reducing wear in parts; construction of steam turbines of large capacity.

Design. Modern Steam Turbines (Les turbines à vapeur modernes), Alb. Schlag. Révue Universelle des Mines, vol. 13, nos. 2, 3, 4 and 5, Apr. 15, May 1, 15 and June 1, 1922, pp. 95–100, 189–198, 265–272 and 351–358, 15 figs. Apr. 15: Actual state of steam-turbine industry; reaction and impulse types. May 1: Principal factors influencing construction of large turbines; security of operation; efficiency; dimensions; weight and cost, etc. May 15: Power and steam consumption. June 1: Maximum power of turbines at a given speed; accidents with large turbines; lubrication.

Disks, Calculation of. Contribution to the Exact Calculation of Steam Turbine Disks with Variable Thickness (Beitrag zur genauen Berechnung der Dampfturbinenscheibenräder mit veränderlicher Dicke), Alexander Fischer. Zeit. des Oesterr. Ingenieur- u Architekten Vereines, vol. 74, nos. 9–10 and 15–16, Mar. 3 and Apr. 14, 1922, pp. 46–49 and 71–73, 2 figs. Presents solution of the Stodola differential equation of radial displacement of rotating disks.

Hell Gate Station. Turbines at the Hell Gate Station. Power, vol. 56, no. 6, Aug. 8, 1922, pp. 194–199, 7 figs. Description of four main units which consist of two 40,000-kw. Westinghouse and two 35,000-kw. Gen. Elec. turbines.

Refrigerating Plants. Steam Turbine in the Refrigerating Plant, W. F. Schaphorst. Refrigeration, vol. 30, no 2, Apr 1922, pp 27–28 and 42–44. Sixteen advantages over other types of prime movers.

STEEL

Alloy. See ALLOY STEELS.

Ball. Ball Steel, Hilton G Freeland. Am. Soc. for Steel Treating Trans., vol. 2, no. 10, July 1922, pp. 898–911 and (discussion) 911–917, 5 figs. Ball manufacturer's problems arising from quality of steel received, and effect on final product.

Cementite Spheroidizing. Spheroidizing of Cementite in Steel, H. C. Ibsen. Forging & Heat Treating, vol. 8, no. 7, July 1922, pp. 300–303, 9 figs. Results of tests on 1 per cent carbon steel show that long-time anneal is not necessary to obtain spheroidized structure; such steel reveals increased ductility and shock-resisting value.

Chromium. See CHROMIUM STEEL.

Crystal Structure X-Ray Study. X-Ray Studies on the Crystal Structure of Steel, A. Westgren and G. Phragmen. Engineering, vol. 113, no. 2942, May 19, 1922, pp. 630–634, 12 figs. partly on supp. plate. Photograms of α-iron at 1,100 deg. cent. and δ-iron at 1,425 deg. cent.; crystal structure of iron modifications; influence of carbon or space lattice of iron in hardened steels; crystal shape of cementite. Paper read before Iron & Steel Inst.

Crystallization, Delayed. On Delayed Crystallisation in the Carbon Steels: The Formation of Pearlite, Troostite and Martensite, A. F. Hallimond. Engineering, vol. 113, no. 2946, June 16, 1922, pp. 767–769, 1 fig. Development of principles which explain delayed critical points and corresponding structure in terms of supersaturation theory. Paper read before Iron & Steel Inst.

Requirements and Properties. Requirements and Properties of Steels (Konstruktionsforderungen und Eigenschaften des Stahles), K. Wendt. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 24, 25 and 26, June 17, 24 and July 1, 1922, pp. 606–618, 642–648 and 670–674, 95 figs. Development of high-class steels; mechanical, chemical, physical and compound loads; behavior at high and low temperatures; heat treatment and alloying; formation of crystals; segregation and stresses; forging and rolling; course of fiber and steel; tensile strength; cross-sections.

Rock-Drill. Breakage and Heat Treatment of Rock Drill Steel. Eng. World, vol. 21, no. 1, July 1922, pp. 39–40. Progress report to members of Advisory Board to Bur. of Mines and Bur. of Standards.

Rustless. Investigation of Rustless Steels (Några undersökningar på rostfritt stål), Bengt Kjerrman. Jernkontorets Annaler, vol. 107, no. 4, 1922, pp. 133–149, 7 figs. Development of rust- and acid-resisting steels, their thermic-microscopic examination.

Tool. See TOOL STEEL.

STEEL, HEAT TREATMENT OF

Electric-Furnace. The Electric Furnace as it Affects Over-All Cost of Heat Treated Parts, C. L. Ipsen. Am. Soc. for Steel Treating Trans., vol. 2, no. 11, Aug. 1922, pp. 984–989, 9 figs. Points out advantages and economy of electric furnaces.

High-Speed Steel. The Toughness of High Speed Steels as Affected by Their Heat Treatment, Marcus A. Grossmann. Am. Soc. for Steel Treating Trans., vol. 2, no. 11, Aug. 1922, pp. 1001–1005, 5 figs. Results of measurements on high-speed steels of 18 per cent and 13 per cent tungsten type, hardened at temperatures ranging from 1700 deg. to 2250 deg. fahr.

STEEL WORKS

Power Systems. Power Systems and the Steel Industry, E. C. Stone. Iron & Steel Elec. Engrs. Assn., vol. 4, no. 6, June 1922, pp. 279–301 and (discussion) 302–320, 4 figs. Requirements for thoroughly reliable source of power supply, and consideration.

STOKERS

Underfeed, Low-Grade Fuel. The Underfeed Stoker Successfully Burns Low-Grade Fuel. Elec. Ry. Jl., vol. 60, no. 7, Aug. 12, 1922, pp. 221–225, 9 figs. High-ash, clinkering coal burned in specially designed underfeed stokers; operation features by flexibility, high efficiency, capacities up to 350 per cent.

SUPERHEATED STEAM

Power Plants. Superheated Steam a Factor in Power Plant Economy, R. A. Holme. Eng. World, vol. 21, no. 1, July 1922, pp. 35–38, 1 fig. Capacity and efficiency of equipment increased at moderate cost by installation of superheaters; savings in connection with all types of prime movers; advanced practice at Hell Gate.

Superheating. Superheating of Steam for the Purpose of Avoiding Condensation (Die Überhitzung des Dampfes zum Zwecke der Vermeidung von Kondensationen). Wärme u. Kälte-Technik, vol. 24, no. 12, June 15, 1922, pp. 139–141. Discusses superheating in detail; makes calculation of steam velocity in pipe lines.

T

TANKS

Calibration. A Rapid and Accurate Method for the Calculation of Storage Tanks, J W. McDavid. Chem. & Met. Eng., vol. 27, no 4, July 26, 1922, pp. 156–158, 1 fig. Description of apparatus for calibration of tanks.

TEXTILE INDUSTRY

Bleaching Without Boiling. New Process and Apparatus for Bleaching without Boiling. Color Trade Jl., vol. 11, no. 1, July 1922, p. 29, 2 figs. Method for bleaching of fine yarns and delicate fabrics by alternate use of pressure and vacuum.

Frame-Work Knitting Machinery. Frame Work Knitting Machinery, Robert Straube. Eng. Progress, vol. 3, no. 7, July 1922, pp. 141–147, 35 figs. Comparison of cloth weaving, frame-work knitting, and hand knitting; production of stitches on cotton knitting frame and formation of loops on circular frame; straight or flat frame and production of finished article on machines.

THERMIT WELDING

Process. Thermit Welding, J. H. Deppeler. Am. Welding Soc. Jl., vol. 1, no. 6, June 1922, pp. 33–36. Value of this method in all heavy operations.

TIME STUDY

Switzerland. Exact Determination of Working Time on the Basis of Time Observation (Die exakte Ermittlung von Arbeitszeiten auf Grund von Zeitbeobachtungen), A. Sonderegger. Schweizerische Bauzeitung, vol. 80, no. 1, July 1, 1922, pp. 5–8, 3 figs. Principles of time study and rate setting, especially those of Merrick; examples of calculations.

TOOL STEEL

Standardization. Tool Steel—Shall it be Standardized? Roy H. Davis. Raw Material, vol. 5, no. 6, July 1922, pp. 233–235. Arguments pro and con on substitution of analyses for tool-steel brands. Presented at Convention of Nat. Assn. of Purchasing Agents.

TOOLS

Press. Press Tool Operations in the Manufacture of Buckle Fittings, Albert Hind. Machy. (Lond.), vol. 20, no. 511, July 13, 1922, pp. 449–452, 4 figs. Details and operation of press tools for manufacture of metal brace or buckle fittings.

Straight-Form, Calculation. The Calculation of Straight-form Tools having Top Rake. Machy. (Lond.), vol. 20, no. 510, July 6, 1922, pp. 416–418, 4 figs. Method of using data given in Machinery's Handbook for figuring top rake on tools which are to cut tough and hard materials.

TRACTORS

Belt Speeds. Considerations Affecting Belt Speeds, A. B. Welty. Agricultural Eng., vol. 3, no. 7, July 1922, pp. 115–116. Data with view to determine ideal belt speed for any particular type and size of tractor.

Reactions to Hitches. Tractor and Plow Reactions to Various Hitches, O. B. Zimmerman and T. G. Sewall. Soc. Automotive Engrs. Jl., vol. 11, no. 1, July 1922, pp. 107–115 and (discussion) 115–116, 17 figs. Reactions explained with special reference to slope and cross furrows; stability analyzed.

TURBO-COMPRESSORS

High-Speed Airplane. Turbo-Compressors for High-Speed Aviation, A. Rateau. Engineering, vol. 114, nos. 2951 and 2952, July 21 and 28, 1922, pp. 91–94 and 123–125, 9 figs. Discussion of design; specific pressures and weights of air under normal atmospheric conditions. Paper read before Instn. Mech. Engrs.

V

VISCOSITY

Determination. Viscosity Determination by Means of Orifices and Tubes, W. N. Bond. Physical Soc. of Lond. Proc., vol. 34, Part 4, June 15, 1922, pp. 139–144, 1 fig. Investigation of corrections applicable to determination of viscosity due to abnormal flow at ends of tubes. Expressions for end-corrections.

Determination for CO_2, N_2O, CO and N_2. Viscous Properties of CO_2, N_2O, CO and N_2, C. J. Smith. Physical Soc. of Lond. Proc., vol. 34, Part 4, June 15, 1922, pp. 155–165, 2 figs. Direct comparisons by observing time required by mercury pellet across equal volumes of gas through capillary tube. Mean area of collision deduced from Chapman's formula.

W

WATER POWER

Resources Index Inventory System. Water Resources Index Inventory Filing System. Can. Engr., vol. 42, no. 27, July 4, 1922, pp. 667–671, 3 figs. Method developed by Dominion Water Power branch for recording, collating and analyzing water resources data; coöperative investigations with provincial organizations; both graphical and written records.

WATERWAYS

St. Lawrence River. Possibilities of St. Lawrence Seaway, Wm. L. Saunders. Can. Engr., vol. 43, no. 2, July 11, 1922, pp. 128–130. Comparisons with other waterways; project economically sound; lower rates for water-borne freight power feature; would serve large population. From address before joint mtg. of A.I.E.E. and A.S.M.E.

WELDING

Pure Iron for. Manufacture and Use of Commercially Pure Iron in Gas and Electric Welding, C. A. McCune. Am. Welding Soc. Jl., vol. 1, no. 6, June 1922, pp. 8–23, 10 figs. Five characteristics of wires for successful welding.

[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; THERMIT WELDING.]

MECHANICAL ENGINEERING

Volume 44 November, 1922 No. 11

Ten Years' Progress in Management[1]

Management Stands as a Great Body of Knowledge and Practice to Facilitate the Operation of Industry —It is the Agency by which Community, State and Nation Shall Endure.

By L. P. ALFORD,[2] NEW YORK, N. Y.

TEN YEARS have passed since the Committee report on The Present State of the Art of Industrial Management was presented to The American Society of Mechanical Engineers. The request is now made for a review of the progress of management during the intervening decade. Unfortunately for the purpose of such a study, eight of these ten years were abnormal, many of the management changes and innovations introduced were of a temporary nature or were mere expedients, and it is difficult to separate them from other and more permanent developments.

The only satisfactory way to treat the review is to base it upon the report of 1912, which was well received and in large measure approved. This course has therefore been adopted.

At the outset we should recall and pay generous tribute to three of our late great leaders who aided in preparing that report and took part in its discussion: Frederick W. Taylor, the pioneer management; Henry L. Gantt, who humanized the movement; James M. Dodge, the earnest, constructive supporter. During our ten-year period these men of vision and power completed their life work.

To obtain information on the worth-while changes which have taken place, letters were written to management and industrial engineers, to executives of plants in various lines of industry, and to educators familiar with industrial developments. Many interviews were held with men having industrial and managerial responsibilities. The response to these requests has been most generous. The author is deeply indebted for the information received and expresses his sincere gratitude to all who have given aid.

The report of 1912 declared the new element in management to be: "The mental attitude that consciously applies the transference of skill to all the activities of industry." It also quoted[3] and endorsed three regulative principles:

a The systematic use of experience
b The economic control of effort
c The promotion of personal effectiveness.

New interpretations and expanded meanings have been given to these principles, but they have in nowise been weakened or susseded. One correspondent writes: "Note, for example, the nearly universal acceptance of the principles. . . ."

In answer to the question, "What steps have been made in the progress of management since 1912?" a wide range of opinion was expressed as shown by the following sixteen quotations from correspondents' letters. The first gives a particularly well-balanced judgment of the situation.

> It seems to me that management has very definitely progressed in the last ten years along certain main lines.
>
> In the first place, good management is more insistent today on knowledge as a basis of judgment, rather than the old judgment based on personal observation. Management is more and more demanding costs, a knowledge of inventories, monthly profit and loss statements, statistics, and records of all kinds as pictures of events on which to base judgment.
>
> In the second place, management is now undergoing a definite metamorphosis in the matter of industrial relations, and managers are waking up to the fact, as a practical element in their business, that they owe more to their employees than mere wages, and that whistle blow and hustle are not all there is to factory operation.
>
> It is this belief and the spirit developing, rather than the volume of the action up to date, which is a matter of very definite progress in the past ten years of management.

Ten opinions, three to the effect that management has retrogressed or made little or limited progress, and seven stating the belief that progress has been made and mentioning certain details of improvement, are grouped to present a contrasting though in the main favorable picture.

> Management (the directing group) has retrogressed in its acceptance of the principles of management, while labor has materially progressed toward a broader acceptance of these principles.

> I believe that very little progress has been made in the adoption of scientific-management principles in industries outside of metal working with a few notable exceptions.

> The main advance, and that lamentably slow, has been in putting into practice knowledge already available previous to 1912.

> During the past ten years, we have passed through the period of first glamour, then the reaction of a loss of confidence, and have finally evolved into the general recognition of the legitimate place of a new branch of engineering art and science—management engineering.

> The important steps in progress in management during the past ten years have been from unintelligent rule-of-thumb management, through scientific management to intelligent management. The latter has advanced steadily during the decade.

> The greatest progressive step has been toward standardization of appliances and methods.

> The most definite progress made during the past ten years is the universal acceptance of the merits of specialized production and standardization of design. These two steps have opened the way to a third simplification of method.

> The reaction from destruction and waste incident to warfare and reconstruction has been toward the elimination of waste in industry as a management function. Waste in all forms has been more closely observed than hitherto, especially during the past two years. The effort to do away with waste has led to the fixing of budgets and the determination of cost standards.

> Important steps in the progress of management since 1912 are:
>
> *a* Greater use of facts in the establishment of the standards by which business is conducted,
>
> *b* Broader recognition of the principle that industry exists for service to humanity,
>
> *c* Greater appreciation of the importance of regularization or control in the successful conduct of the industries,
>
> *d* Wider understanding of the economic value and importance of the management engineer in the operation of business.

> There has been a great increase in the use of specifications not only to govern purchased materials but also to attain uniformity of process, quality and cost, and thus to insure reliability of product. Many plants now have well-equipped laboratories staffed by scientific men and some regularly employ consulting scientists. In the larger corporations research laboratories are not uncommon. Few of these departments are over ten years old and they evidence a rapidly growing appreciation of pure science as a tool of management.
>
> The need of early and reliable figures as a mechanism of management has caused many companies to prepare monthly a complete statement of their business and earnings. A constantly increasing number of companies are publishing annually a detailed statement of their financial condition and many are publishing such statements quarterly. This voluntary publicity indicates a sincerity and frankness rare in management of an earlier decade.

---

[1] Brief reviews of recent developments in the United Kingdom and Germany which were also presented during Management Week, immediately follow the present paper.

[2] Editor *Management Engineering*. Mem. Am. Soc. M.E.

[3] *American Machinist*, vol 36, p. 857, The Principles of Management, by Church and Alford.

Presented during Management Week, Oct. 16–21, 1922. To be read by title at the Annual Meeting, New York, December 4 to 7, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Abridged by the omission of 11 appendices. Copies of the complete paper may be obtained gratis on application. All papers are subject to revision.

The final quotations in regard to progress, five in number, discriminate between management form and substance. Progress is indicated in both of these aspects.

> The biggest and most lasting accomplishment in the inculcation of management principles is that, like religious teaching whose significance has been forgotten during years of prosperity, they again in the years of depression following the war developed a new significance in the minds of the thoughtful. A principle is not established in the actual social inheritance of the race—as a step forward—until man has applied it to himself and seen whether its application makes him a better man in his social relations. So management principles are being used as yardsticks to measure individual industrial development. This means that these principles are becoming a subconscious part of the mental equipment of industry, and not only is this real progress, it is fundamental.

> The development and use of the Gantt chart is the most important step of progress, because it calls attention to the movement of facts, to the necessity of basing decisions on facts rather than on opinions, and because it helps managers to foresee future happenings.
>
> A second important step is the change in the method of installation from the old type which organized from the top down to the new type which builds from the bottom up.
>
> A third important step is the development of the theory that the cost of an article includes only those expenses actually incurred in the production of the article, and that the expenses of maintaining one machine in idleness cannot be charged into the cost of the output of another machine. Along with this theory came the development of a method of arriving at costs of idleness and work.

> Probably the greatest progress consists in a better understanding of the problems of management with a particular acceptance of the facts to which Taylor called attention, that management is an art which may be practiced advantageously through the application of certain principles and the scientific method I do not think, as yet, that the great majority of men at the head of industries have anything like an adequate understanding of scientific management, nor that they are able to distinguish between form and substance in this respect. They have, however, apparently emerged from the attitude of opposition and mistrust of so-called scientific management, but are satisfied with a superficial application of the principles of management.

> The important steps of progress made in management since 1912, I would say, are as follows. The order in which they are named is not significant:
>
> *a* A greater appreciation of the human factor in industry.
>
> *b* The growing recognition that employees should have a voice in the management as relating to those questions that directly affect tham.
>
> *c* The recognition of the strategic position of shop foremen and the necessity of more carefully selecting and training them.
>
> *d* The increased recognition of the value of fundamental principles.
>
> *e* The recognition of, and in a large degree the adoption of, standard systems of cost accounting from the point of view of timeliness, as a barometer rather than history, as an instrument of production rather than a matter of finance.
>
> *f* A great development in mechanical equipment, combined with improved plant layout and building plants to fit manufacturing process.
>
> *g* A marked advance in sales policies.
>
> *h* A marked advance in substituting the trained, competent engineer for the old "cut-and-try" type of executive.

> Using figures, which after all are most impressive, but basing those figures purely on my impressions, I would say that since 1912 industry has progressed in management by some 30 to 40 per cent in the appreciation of the fact that there is a management problem aside from the old concept, which was that the owner had simply to censor the things that happened within his jurisdiction. I should say that there had been a 20 to 25 per cent endeavor to install the mechanisms of management, considering in this figure the generally known stores systems, operation studies, wage-incentive plans, etc. In some cases, as for instance in stores control, the percentage might run a great deal higher, but I am refraining from increasing my estimate for it is my belief that these mechanisms that we have installed are, for the most part, of a makeshift character, and that in industry as a whole and considering only the larger companies, I doubt if more than five or six per cent are possessed of mechanisms at all acceptable in the final scheme of what management should do and possess.
>
> As to the real concept existing today of what management is, and what conditions must be considered, influenced and coördinated to bring about the situation which should exist I doubt if more than one-fifth or one-fourth of one per cent of the companies in this country possess a knowledge or even appreciation of what is real management.

Combining and weighing these carefully prepared statements and adding to them certain well-recognized facts, there emerges a group of factors of varying importance which mark the progress of management during the past decade. These naturally arrange into three groups, of which the first concerns changes in mental attitude.

a The ancient controversy as to whether management is a science or an art has subsided, with increased recognition of the scientific basis of management.

b The attitude of opposition and mistrust toward management and the passionate antagonism to the installation of management methods have in general disappeared.

c Among those responsible for the carrying on of industry there has grown an appreciation of the existence of problems of management. (The appointment of Herbert Hoover as Secretary of Commerce and General Dawes as Director of the Budget reflect an appreciation by the Government of the need for management in our national affairs.)

d Acceptance of the principles of management has broadened among engineers, executives in industry, and educators.

The second group of factors of progress concerns the application of management methods.

e The engineering or scientific method has extended in industrial cost accounting. Among the developments are uniform cost-accounting systems (Appendix No. 1 to the complete paper lists 64 manufacturers' associations which have adopted such systems), the theory and method of determining and applying standard costs, the methods of determining idleness losses, the forecasting of sales leading to long-term production schedules, and the budgeting of future expenditures.

f Appreciation of the possibilities and advantages of standardization, simplification, and elimination of waste has spread rapidly during the past two years.

g The demand for knowledge, facts, as a basis for judgment has grown insistent in all good management. This has led, among other developments, to a widespread use of specifications and graphics as a means of recording and communicating management knowledge. (The first modern book on graphics in the English language was published as recently as 1910. The Gantt-type control chart has been developed into its present form since 1917.)

h Management methods have been applied or installed in practically every manufacturing industry, in distributing concerns and in institutions. (The report of 1912 listed 52 industries in which some form of management had been installed. A similar list prepared in 1922 would group all the branches of American industry.)

The third and final group of these factors concerns especially significant developments, which after being stated are subject to explanation and comment.)

i Management activities have broadened far beyond the installation of those mechanisms which are usually associated with the Taylor System, and which were emphasized in the report of 1912. (Appendix No. 2 to the complete paper lists 77 items of management work arranged under four headings: General, Labor, Material, Equipment.)

j Some eight or ten of the leading American engineering schools have established courses in management since 1912.

k Appreciation of the importance of the human factor in industry and attempts at its study from a fact basis have been the most striking management development.

l Management engineers have declared that the service motive must prevail in industry and that all questions concerning human relationships must be considered in a spirit devoid of arbitrariness or autocratic feeling.

Management Mechanisms

To secure information as to the use of management mechanisms the question was asked, "What (if any) mechanisms of management do you consider as generally accepted (*a*) in principle, (*b*) in practice?" From correspondents' replies the following twelve quotations have been selected.

> I do not believe that any of the mechanisms of management are generally accepted in principle or in practice.

> I know also that even where some of these things (mechanisms of management) have been established and we hear about them and might conclude that the firm using one or more of them is quite advanced, it often is not at all so. The feature described is only an unrelated "stunt," not supported

by a complete coördinated system of administration and usually begins to go to pieces not long after it is installed.

There is at the present time a retrograde movement in regard to the building up of stores and making operation studies However, as I see it, this is merely a temporary depression in the curve, and I believe that the general tendency of this curve is upward with a very slow ascending grade.

Incentive wage-payment plans have had a temporary setback due to labor conditions caused by the war and to the reluctance of managers in general to consider such plans in any other light but of profit to the company. I do not think that the main service which the incentive plan can give—namely, that of stabilizing relations between employers and employees—has been given sufficient attention by the management.

I believe that such mechanisms as balance of stores, routing, operation, studies, incentive wage plans, personnel work, etc., are generally accepted in principle, but that efforts to install them frequently (perhaps most of the time) miscarry, and either accomplish little or no good. This is often due to a failure to see to it that details connected with the mechanisms are fully understood and looked after.

In a general way, the mechanisms of management are widely accepted now in principle and much less widely in practice.

Undoubtedly, good storeskeeping is becoming very generally accepted. We know that unless we keep accurate records of the materials used we cannot get the most satisfactory results I think storeskeeping is accepted both in principle and practice as well as the intelligent study of operations.

I believe that balance of stores is accepted in principle and in practice, that is, in so far as a written record of quantities in stores is kept in the office rather than in a storesroom, and that a minimum or order point is predetermined and an order placed when it is reached. It is generally accepted in principle, though not in fact, that an incentive wage-payment plan is desirable and effective. It is accepted in principle that facts are shown on charts better than in tables of figures.

In principle, undoubtedly, all of the main mechanisms of management have been thoroughly established.

In a great measure all of the mechanisms of management as developed by Taylor and his immediate associates have been generally accepted in principle. But while they are being widely applied, my impression is that in great majority of the cases the application is half-baked in character and the results, while they may be satisfactory to the companies concerned, are far from being so satisfactory as they should be, either to the management or to the employees. My experience indicates that in most such cases an application such as Taylor would have approved will almost invariably result in increased production ranging from 30 to 100 per cent or more, depending on the nature of the business.

The following management mechanisms have been accepted in varying degrees:

Stores Control. In principle and practice very generally.

Operation Standardization. (*a*) In technical aspects, generally in principle, fairly so in practice. (*b*) In personal aspects, fairly accepted in principle, to a limited extent in practice. [By (*a*) I mean speeds, feeds, equipment, tools, etc.; by (*b*) motion and time studies of human elements.]

Wage-Payment Incentives. Generally in principle and in practice so far as direct labor is concerned. But little application has been made to indirect labor.

Cost Accounting. Generally accepted both in principle and practice.

Selection and Training of Employees. Fairly well accepted as to principle, but little in practice.

Purchasing Control. Generally as to both principle and practice.

Scheduling and Planning. Fairly well accepted in principle. Limited in practice in some industries, well established in others.

I find mechanisms being accepted one by one without a full realization of the part they are to play in the scheme as a whole. That is to say, I will find a company suddenly appreciative of the value of operation studies. It will thereupon proceed to organize to make operation studies, and for the time being in its new enthusiasm it pursues what threatens to become a hobby rather than a part of its business. This pursuit at times leads into the installation of other mechanisms. It begins to recognize, from the operation studies, that a balance of stores is essential, and that a wage incentive is desirable. I find, however, that this progress is accidental rather than planned.

Mechanisms of management such as are discussed in the 1912 Report are generally accepted in principle, but poorly carried out in practice in the majority of establishments. On the other hand, few, representing the best organizations, have developed these things to a degree which serve as valuable guides.

Planning and control are used more and more extensively in plan operation. The tendency of the majority, however, is to try to gain the benefits of more intensive control through partial makeshifts which record past accomplishments instead of actually planning the work. The importance of control, in fact, in increasing production through elimination of idle time, men, and machinery, is not yet recognized except in a few markedly successful establishments. The developments along these lines are being undertaken frequently through inexperienced, low-grade men, who adopt mechanisms as such, instead of developing existing methods on fundamental principles.

Balance of stores is accepted almost universally in principle and widely used in practice. Accountants have been quick to recognize its advantages, and have made it an essential part of their accounting mechanism. On the other hand, two of the most vital features for assisting in the control of production, the column of "stores apportioned" and the entering of "minimum" quantities of each item permissible, are apt to be omitted.

The development of time study and job analysis, while widespread, has been unsatisfactory; piece rates are more and more universal, but their determination is still largely on a basis of past performance, aided by time studies which simply record these performances in more detail instead of analyzing the operations and determining the methods and units which will give most satisfactory results. There is still lack of appreciation of the fact that the chief aims of time study and job analysis must be:

a To resolve the operations into such units that they can be recombined to provide for all variables;

b To take advantage of this unit study to eliminate unnecessary operations, substitute improved methods, and remove defects in equipment and in control.

c To enable the workman to earn more money often with less effort; and,

d To indicate means for improvement in quality and practicable methods for making the improved quality routine.

To these statements of the acceptance of management mechanisms it is possible to add a few quantitative facts. It will be recalled that the field reports of six industries, given in the Report of the Committee on the Elimination of Waste in Industry of the Federated American Engineering Societies, were based on an extensive questionnaire. The replies in four of these industries—metal trades, boot and shoe manufacturing, men's ready-to-wear clothing manufacturing, and printing—have been studied to show the use of mechanisms of management. The facts brought forth are presented in six tables included in the complete paper, of which the accompanying Table 1 is a summary. The questions from whose replies the facts were drawn are given in Appendix No. 3 to the complete paper.

TABLE 1 SUMMARY FOR 51 PLANTS IN 4 INDUSTRIES

Mechanisms of Management	Boot & Shoe, 8 plants			Men's R. M. Clothing, 9 plants			Printing, 6 plants			Metal Trades, 28 plants			Totals, 51 plants		
	None	Inadequate	Good	None	Inadequate	Good	None	Inadequate	Good	None	Inadequate	Good	None	Inadequate	Good
1 Selection and Placement	0	6	2	0	4	5	0	5	1	[1]0_0	6_4	10_8	0	25	26
2 Incentive Wage Plan	0	0	8	4	2	3	1	1	4	2_1	6_3	8_8	8	12	31
3 Planning Centralized	4	0	4	4	2	3	3	2	1	3_1	8_2	5_9	15	14	22
(*a*) Routing, order of work	4	1	3	4	2	3	5	0	1	5_2	6_2	5_8	20	11	20
(*b*) Scheduling, machine assignments	3	3	2	3	2	4	3	2	1	4_1	5_3	7_8	14	15	22
4 Time Study	5	2	1	3	3	3	5	0	1	6_2	2_1	8_9	21	8	22
5 Cost Control	1	3	4	2	5	2	3	2	1	4_2	3_6	9_4 1	12	19	20
6 Idle-Time Analysis:															
(*a*) Men	7	1	0	6	3	0	5	0	1	13_8	0_0	3_4	39	4	8
(*b*) Machines	7	1	0	8	1	0	3	0	3	9_6	1_0	6_6	33	3	15
7 Purchase Control	1	4	3	3	1	5	3	2	1	3_1	4_1	9_{10}	11	12	28
8 Balance of Stores	1	1	6	3	1	5	4	1	1	2_1	4_1	10_{10}	11	8	32

[1] The two figures shown separately in the metal-trades columns represent totals for the 16 plants (upper figure) covered by the regular questionnaire, and the plants (lower figure) which filled out only a condensed questionnaire.

Turning to Table 1 and arranging the eight mechanisms in the order of the number of plants in which they are installed *in some form*, we have:

1 Selection and Placement
2 Incentive Wage Plan
3 Balance of Stores
4 Purchase Control
5 Cost Control
6 Planning (routing, scheduling)
7 Time Study
8 Idle-Time Analysis.

Rearranging in the order of the number of plants where the installation is *good*, we have:

1 Balance of Stores
2 Incentive Wage Plan
3 Purchase Control
4 Selection and Placement
5 Planning (routing, scheduling)
6 Time Study
7 Cost Control
8 Idle-Time Analysis.

The weight of opinion and fact brings the conclusion that certain mechanisms of management have made decided headway in acceptance both in principle and practice, and form an assay of four industries the importance of application yields two groups:

a Balance of Stores
Incentive Wage Plan
Purchase Control
Selection and Placement

b Cost Control
Idle-Time Analysis
Planning
Time Study.

In the installation of such mechanisms a significant change is becoming evident. In early days of management the mechan-

isms concerned the physical means of production. They were originated by the executives and were ordered into the shop.

At a later date, as emphasized in the report of 1912, the value of methods which concerned the worker was appreciated. Training was the first to have any widespread trial. But the attitude was still the developing or forcing of a mechanism from the top downward.

Within the decade under review, another attitude has been adopted in a few instances. It seeks to make the foremen and even the workers consciously parties to the development of the plan before they are put into effect. It endeavors to arouse interest, to inspire to achievement, to release creative energy. Its effect is to install methods and mechanisms from the bottom upward with celerity and improvement in personnel relations.

Management Education of Engineering Grade

Where there was probably but a single college course in management in 1912, there are now eight, in these institutions:

Columbia University
Massachusetts Institute of Technology
New York University
Pennsylvania State College
Purdue University
University of Kansas
University of Pittsburgh
Yale University—Sheffield Scientific School.

The subjects in these courses are given in a fourth appendix to the complete paper. In addition to this form of instruction, management subjects have been introduced in mechanical-engineering courses. Examples are the pioneer work at Cornell University—Sibley College, and at the Worcester Polytechnic Institute.

The growing importance of this branch of engineering education is shown by the number of men enrolled. An appendix to the complete paper (No. 5) gives the enrollment of all students in colleges of engineering in the United States for the school year 1921–1922. The total is 53,414. The number in management courses is 1123, identified as—

Administration Engineering	725
Industrial Engineering	389
Industrial Management	9
Total	1123

The 277 students in "Commercial Engineering" courses have not been included, although they undoubtedly received some instruction in management subjects.

While these management courses in the beginning were based on mechanical engineering their character seems to be changing, so that it can now be said that they are based on engineering broadly, with emphasis on fundamental subjects. There is a tendency to lessen or limit qualitative instruction in details of production. Without doubt, the character of the instruction is improving as teachers gain a wider and sounder experience in the application of management principles.

The significance of this new branch of engineering education is not its extent as measured in numbers of students, but in the fact that at least eight leading institutions have added it to their regular and older courses.

It is unfortunate that no common name has been adopted for these courses; at least four are in use.

The Human Factor in Industry

The report of 1912 presented the human factor in industry with particular emphasis on the responsibility of managers and executive to train their workers and the same thought was prominent in the discussion. According to the comment of the Committee in its closure, one of the striking characteristics which had already gripped attention was "the presence throughout the discussion of a human spirit in keeping with the best trend of thought toward social justice," and "the development that has taken place within the last few years leading to a new appreciation of the needs and rights of employees."

Henry P. Kendall in his discussion of the report[1] outlined the operation of an employment department which he had initiated. The employment man interviewed applicants, selected workers by tests, placed them in positions for which they were fitted, required medical examinations, kept records of each employee, kept in touch with the foremen in regard to the deportment, skill and earning power of the employees, had charge of discipline and discharge, and gave advice, suggestions, and sympathy to the workers throughout the organization.

These disclosures in outline foreshadowed a great wave of industrial relations work which swept through American industry after the outbreak of war. The movement received its impetus from the demand for workers in a time of extreme shortage, and was influenced by emotionalism and social theory. With the return of a labor surplus in 1921 the unsound features have in the main disappeared, leaving but vestiges of the methods and devices which were initiated in such profusion.

The present situation as regards personnel work is appreciation that personnel problems exist, recognition that their solution is a responsibility of management, and a growing realization that job analysis, selection, placement, and training can be put on a scientific basis.

Associated in thought, though not necessarily a part of any employment or industrial relations plan, is the rise of works councils in American industry. Several hundred have been established during the past decade. In August, 1919, there were 225, in February, 1922, approximately, 725.[1] Their development has been in response to a desire on the part of the workers for a means of expressing their beliefs and wishes in regard to matters arising in employment, and on the part of the management for a means of communicating with their employees and gaining and holding their confidence and good will. The movement but emphasizes the fact that the development of the relationships of employer and employed is a responsibility of management.

The Service Motive

Management engineers as a group have declared that the service motive must prevail in industry, that everything planned and done must be directed to securing the worthy result of producing useful goods with a minimum expenditure of time, material, and human effort. One of the clearest statements was written by Henry L. Gantt a few weeks before his death.[2]

> We have proved in many places that the doctrine of service which has been preached in the churches as religion is not only good economics and eminently practical, but because of the increased production of goods obtained by it, promises to lead us safely through the maze of confusion into which we seem to be headed, and to give us that industrial democracy which alone can afford a basis for industrial peace.

This disinterested purpose has been accepted as an ideal for the entire engineering profession, by becoming the challenging thought in the preamble to the constitution of the Federated American Engineering Societies.

To the factors dealing with the steps in the progress of management which have been discussed, should be added a consideration of the extension and growth of management societies which has taken place during the past ten years.

The earliest was the Society for the Promotion of Scientific Management, founded informally in 1910 and organized in 1912. In 1916 the name was changed to the Taylor Society, and in 1918 it was reorganized. Appendix No. 6 to the complete paper gives details of the growth of this society.

The first national organization to deal with personnel matters beginning with the training of workers was the National Association of Corporation Schools, founded in 1913. By 1917 its work had broadened to include all of the activities classified as human relations. In 1920 the name was changed to the National Association of Corporation Training. In May, 1922, it was merged into the National Personnel Association. See Appendices Nos. 7 and 11 to the complete paper outlining the different steps in the development of this society.

In May, 1917, in response to a war demand, The Society of Industrial Engineers was founded. In 1919, it was functionalized and has carried on the activities of a professional engineering so-

---

[1] Trans. Am.Soc M E., vol. 31, p. 1208.

[1] See Reports of the National Industrial Conference Board.

[2] Organizing for Work, p. 101.

ciety. See Appendix No. 8 to the complete paper. This Appendix describes the formation of the society.

A second personnel society was organized during the war, May, 1918, under the name of the National Association of Employment Managers. On March 1, 1920, the name was changed to The Industrial Relations Association of America. May of that year registered the peak of the movement, the Chicago National Convention being attended by 5000 persons. The change in business conditions affected it adversely and in December, 1921, the Board of Directors voted to disband the organization. Early in 1922 it was merged into the National Personnel Association. See Appendices Nos. 9 and 11 to the complete paper for details of the growth of this association.

Although The American Society of Mechanical Engineers provided the forum for the presentation of the earliest papers on management, no part of that society was particularly devoted to management matters until the formation of Professional Divisions in 1920. In July of that year, the Management Division was organized. It soon led all of the other Professional Divisions in membership and has held that position ever since. Appendix No. 10 to the complete paper defines management and sets forth the purposes of this division.

There are, therefore, four societies concerned with management—three in its engineering to technical aspects, and one restricted to personnel matters. The combined membership, not discarding duplications known to exist, is 4041.

Management Division A.S.M.E.	1,740
Society of Industrial Engineers	1,032
The Taylor Society	769
National Personnel Association[1]	500
Total	4,041

This membership is growing rapidly; more than one-half has been gained during the past two years for that period spans the founding and growth of the management division of The American Society of Mechanical Engineers.

Within the last two years joint activities have been originated among these and other societies with the promise of benefits to all who are concerned with management. Included are: Development of a management terminology; development of a classification for management literature; standardization of management graphics; and development of methods for the measurement of management.

Management Results

The report of 1912 stated that the results of good management had been: "A reduced cost of product, greater promptness in delivery with the ability to set and meet dates of shipment; a greater output per worker per day with increased wages; and an improvement in the contentment of the workers." There was no evidence at that time that goods had been reduced in price to the consumer.

To a degree this evidence has now been supplied. There are examples where good management has held down prices during a period of inflation and reduced prices as soon as business conditions changed. These acts benefited the consumer. Therefore the management movement can be said to have earned its economic justification.

Management as developed through a generation of effort stands today as a great body of knowledge and practice, to facilitate the operation of industry and the conduct of business. Through organization it determines policies, plans basically over long periods of time and fixes impersonal relationships; through preparation it plans in detail how, when, and by whom work is to be done; through direction it initiates and maintains the processes of production and distribution.

Here, then, is a tremendous, hitherto unknown engineering tool. What is it for? The answer is a spur to every engineer and industrial executive:

Industry and business as developed in modern civilization must continue else infinite misery will overtake the human race. Management is the agency by which community, state, and nation shall endure.

---

[1] The National Personnel Association also has 129 company members.

DEVELOPMENT OF MANAGEMENT IN THE UNITED KINGDOM

By JAMES F. WHITEFORD,[1] LONDON, ENGLAND

IN GENERAL, it may be stated that management practices in the United Kingdom are following very closely the same sequence of developments that has been instituted in American industries. The application is a few years late, but the best portion of the practices in American industries are being fairly generally accepted.

Standardization. The most important development in this country during the past ten years has been a general acceptance of the principle of standardization. One instance will serve as an illustration. Ten years ago one prominent automobile manufacturer supplied his customers with 26 different designs of cars. Today his main advertisement consists of, "This is the only design we make." A manufacturer of food products who had over 3000 lines in his price list ten years ago, now manages to supply the needs of his customers with 215, which includes several packings of the same article.

Specialization. Concentration has become very evident in respect of personnel as well as in the nature of the product, and more and more the individuals of each organization devote their whole attention to certain definite functions the scope of which is more and more limited. Employment of personnel, planning of work, centralized control through statistics, and greater attention to welfare of the employees are the noticeable features in present-day industrial works in this country. This is merely repeating the experience again in American industries.

Employee Representation. Very great advances have been made in British industries in providing opportunity for the employees to participate in the management of the industries. This is particularly true in respect of matters pertaining to working conditions, discipline, and methods of wage payment. In some factories the Whitley Council idea has been adopted in part, the council representing the actual participation of fully 10 per cent of the total employees engaged, but the form of participation varies in each factory.

In general, the Whitley Council as originally promulgated has not been accepted. The ultimate objective was the complete control of each industry by employers and employed, the whole country to be organized under the control of one council. The general and district councils were designed to provide joint management of the industry, deciding all questions of policy and other matters pertaining to the general welfare of the business, which plan was, in my opinion, unsound in principle, since it made no provision to include the buying public. The partial participation in the management has, however, been effected through this medium although one large labor union, the Amalgamated Society of Engineers, refused from the start to sanction the idea or support the movement in any form. The general results obtained are, however, sufficient to warrant the statement that employees' representation is in general use for dealing with matters pertaining to discipline and conditions of employment. It is doubtful if there will be any great extension of duties.

Costs and Statistics. Extensive development has become evident in British industries in respect of improvements in methods of costing, and in providing works statistics for the guidance of the management. In costing work the British manufacturers have not gone into the extensive detail which characterized the installation in American industries, but have contented themselves with providing for the main principles in this branch of factory accounting.

Buildings and Equipment. The new factory buildings are ample evidence of the fact that provision of suitable working conditions and ample supply of light and effective ventilation are accepted as being very necessary in all factories, and provide a distinct contrast with the older buildings in this respect. Up-to-date machinery is also evidence, all of which indicates a new phase in the management of industries in this country.

Welfare. Canteens, playing fields, various forms of recreation, and other matters of similar purport are now receiving a great

---

[1] Industrial Engineer. Mem. Am.Soc.M.E.

deal of attention in all branches of British industries. These are now regarded as very necessary supplements to the ordinary factory buildings and equipment. In many factories rest periods are in use, and in certain of these provision is also made for providing liquid refreshments during those periods. On the whole, there is every evidence that the industrial executives have realized the necessity for providing for the general improvement in the welfare, in working conditions, of their employees.

Wage Payment. Many forms of wage systems are in use, but straight piece work still predominates. Government regulations provide that all employees on differential wage systems shall be provided with data enabling them readily to calculate their earnings. This is probably one of the main reasons why piece work continues to be used extensively. The trades unions in the engineering, printing, and allied trades refuse to accept any form of differential wage plan.

Time Study. The employment of the stop watch in the development of wage-payment standards is being adopted gradually. Its use is still considerably behind American practice, but it is now being generally recognized that basic data are necessary for planning work as well as for wage-payment purposes.

THE DEVELOPMENT OF SCIENTIFIC INDUSTRIAL ORGANIZATION IN GERMANY[1]

BY G. SCHLESINGER,[2] CHARLOTTENBURG, GERMANY

SCIENTIFIC organization in Germany has developed only within the last twenty years. Before that time practical and far-sighted men had sought to adapt the old workshop organization to the rapidly growing industrial works; the engineer devoting his attention to plant and equipment; and the manager occupying himself with questions of bookkeeping and shop accounting. But it was all done without coördination and without system.

Then it came about that the heads of the sales and technical departments of a leading firm of machine-tool builders (Ludwig Loewe & Co., Inc., Berlin) decided to coöperate, with the result that an organization was developed in this establishment that was far superior to that of any other industrial works. Later the head manager of the firm made what was for those times an extraordinary decision: he consented, in the interests of industrial progress in his country, to publish an account of the organization which had been built up in the course of six years. This publication made a deep impression on the industrial and scientific world.

Factory organizations can plan their layout and equipment, their working program, and their cost accounting. In this paper it is proposed to deal principally with cost accounting.

The plan of the accounting system employed by the Loewe Company is briefly as follows:

The factory costs as shown by the "general accounting department" were distributed over the different working departments through the medium of a "shop-record department." The combination of these two departments formed an account which in the general accounting department was called the "shop-record account" and in the shop-record department, the "central account." The distribution was very carefully conducted. A check-up would determine whether everything had been properly distributed. As regarded the shops, the quota would be determined by charging them pro rata to the wages of the workmen. The shops and branches had differentiated (proportionate) charges of the wages.

In a workshop manufacturing only standard parts, partly with very simple and cheap, partly with very complicated and expansive machines, separate costs (known as "place costs") were determined for the various working centers.

At the same time Sperlich published a work in which he recommended that the ordinary simple, flat addition for overhead be replaced by one to be determined separately for each production unit.

Soon after this, the Danish authority West and W. H. Bach of Germany adapted American improvements to German conditions, and later certain large industrial concerns engaged American experts to reorganize their plants in order to introduce American organization methods; but this did not go far beyond the experimental stage.

The only important publication at this time which deserves special mention and which is in a way a connecting link between the old empirical and the new scientific periods, is the work of H. Peiser, business manager of the Berlin-Anhalt Machine Works, Berlin-Dessau, published in 1919, in which a much closer connection is developed between the shop and general accounting department than obtained with Ludwig Loewe & Co.

PROGRESS THROUGH THEORETICAL INVESTIGATION

When one takes into consideration the scientific trend of the German mind, it is not surprising that real progress has been made in this field through theoretical investigation. This progress is due to the work of Dr. Johann Fried. Schär, formerly professor at the Academy of Commerce of Berlin, and founder of modern commercial science.

Schär's idea of the future of factory accuntancy was made very clear to the initiated in his standard work, Bookkeeping and Balance, which has now reached its fifth edition.

In this work he deals, not with planning or management, but with capital, with which the very bases of factory organization are created. "Costs" are not calculated, but the factory capital or assets, the circulation of which is closely followed throughout the work. With a proper accounting system it should be possible to have the assets constantly under control through the monthly intermediate balance *without* inventory.

Schmalenbach, a pupil of Schär's, corrected a fault in the latter's system which made itself particularly apparent in the post-war period. It is this same fault which Gantt scores in his book Organizing for Work, and which he claims exists in some of the most progressive American industrial plants. Schmalenbach in his theory of "*dynamic balance*" recommends the separation of the cost accounting from Schär's capital accounting, which is objective and static. Gantt proposes to consider only those factors in a cost-accounting system which are directly concerned with production. Both are opposed to a distribution of the costs, with which the bookkeeping is burdened. Both wish to obtain the net costs of products constructively. The author does not know whether Gantt ever solved this problem. There is nothing to that effect in the above-mentioned book. At any rate he has read or heard nothing of the carrying out of the theories of Schär and Schmalenbach; but has found them applied in the practical work of Ernst Just and Elizabeth Vöhl, with whom he coöperated during four years and whose work will now be described in detail.

THE WORK OF JUST AND VOHL

The progress of these two is based on philosophical principles and practical experiments, which latter were conducted in about 600 small industrial plants in twelve different branches of industry. The result was the Hansa accounting system with its four successive stages. With this completed they consulted Schär, who gave them the benefit of his wide knowledge of accounting and organization problems. His theoretical conclusions agreed with the practical results they had obtained and helped greatly in the explanation of these complicated problems.

Then followed twelve years of practical work in large and medium size factories representing all branches of industry. The author has been specially privileged in being made acquainted with the results of this work and he is convinced that industrial plants could be operated with far greater success if they would adopt this system of organization.

Just starts with a search for objective measures which will serve as a substitute for the "experience and intuition" characterizing present-day methods. The aim of this scientific research is to find the vital law of a manufacturing plant through analysis of its problems and to build it up anew.

In Just's practical mind the scientific requirements of Schär took shape in the following problem: How can what goes on in a factory—the expenditure of capital and the creation of new capital—be actually and ideally presented simultaneously? The problem is therefore this: that every movement of the industrial capital

---

[1] Abridged.

[2] Professor of Engineering, Technische Hochschule. Mem. Am.Soc.M.E.

in its circulation from stationary capital (assets) to journal assets (production costs, overhead) to production assets (products) and back again to stationary capital (stock assets, customers' orders, bank deposits) be once actually and once ideally presented.

Just and Vöhl found the solution of this problem through combining the ideas of Ludwig Loewe, Schär and Schmalenbach, and arranging them into three separate accounts:

1 One for stationary capital = calculation of assets account
2 One for journal assets = shop account
3 One for production assets = products account.

These three accounts are kept according to the principles of double-entry bookkeeping, and are therefore self-controlling.

However, these three accounts are kept separately only during the period of business activity. On closing day—intermediate balance, annual balance—they are combined and become part of the assets account. As they bear a fixed relation to one another and are combined on closing day, they therefore control one another.

Through the clear and systematic arrangement of the component parts of this accounting system, especially the production costs, only one accounting formula is required which, in contrast to former systems (Loewe, Peiser, American) does not charge everything to wages, which is distribution backward, but *builds up* from the bottom and makes its possible to recognize the influence of the separate factors, which was the aim of Gantt.

The author wishes now to discuss briefly the attitude of German industry to the scientific and practical development described.

The work of Just and Vöhl, which has not hitherto been made public and consequently cannot have been discussed, must necessarily be excepted. Unfortunately it must be admitted that leading engineering societies and industrial associations have not only disregarded the treatises of Schär and, to a certain extent, those of Schmalenbach, but have instituted a sort of counter movement with the argument that the work of Schär and his pupils does not meet with undivided approval. At the request of one representative engineering society, The Committee for Economic Production (AwF), a special committee was appointed consisting of twenty members, including engineers, merchants, industrial leaders, economists, scientific and practical experts, for the purpose of seeking out the best of the literature on hand, supplementing and improving it on the basis of their own experiences, drawing conclusions from the whole result, and publishing these as a "standard," somewhat on the order of the standard sheets on allowances, screw threads, pulleys, etc., published by the German Industrial Standards Committee.

This compilation was published in two editions in the years 1920 and 1921, under the title, Basic Scheme of Net Cost Finding, and was sent to all German industries.

It must be admitted that this "basic scheme" represents in no respect an improvement on those of Loewe, Peiser, or the American authorities. This result was to be expected when such difficult problems—probably the most difficult that technical and scientific industrial research have to deal with—are settled by majority conclusions.

GERMAN INDUSTRIAL ATTITUDE

While "practical" America is making every effort to build up a *scientific* system of industrial management, "scientific" Germany is thus returning to purely *practical* experience for guidance in the organization of industrial plants. But not all have taken part in this retrogression, and the author can at the same time report that the same head manager, Waldschmidt, of the Ludw. Loewe factory, who eighteen years ago permitted the epoch-making description of his work to be published, recently requested the practical research workers, Just and Vöhl, to discuss the basic principles of their work for the benefit of German industry at the Research Society for Scientific Management over which he presides. After two introductory addresses which were presented in April, 1922, Just and Vöhl, at the request of the above-mentioned society, prepared seven theses, in which they present their views of the factory-accounting methods now in vogue. Five distinguished professors of engineering and commercial science (Schär, Schmalenbach, Schilling, Schlesinger, and Wallichs) will take the opposite side in a debate to be held before the board of directors of the society on September 14 of this year, and it is hoped that this discussion will serve to bring about a radical change in works organization in Germany.

The theses are as follows:

SEVEN THESES FOR DISCUSSION

I—It is *wrong* to place shop accounting in charge of the separate departments in such a way that a sales-accounting system is conducted under the sales manager, a shop-accounting system under the shop manager, etc. It is *right* to establish a uniform system of shop-accounting with a position within the administration corresponding to the following scheme:

a Management
b Work
  1 Outside work
  2 Inside work
c Auditing

The auditing should therefore be independent of the work, and both should supply the management with means with which to control the work.

II—It is *wrong* to attempt to bring about the necessary unity in accounting by forcing it into *one* accounting system (mingling assets, operating and sales accounts indiscriminately together). It is *right* to build up a unit system of accounting consisting of three divisions, which can be balanced separately during work. These divisions are:

1 Calculation of the stationary capital: *Calculation of assets.*
2 Calculation of capital used in factory operation: *Operating Capital.*
3 Calculation of capital gained from products: *Production assets.* On periodical closing days they must be combined.

III—It is *wrong* to build up an accounting system partly on a systematic and partly on an unsystematic basis as is usually the case. For instance:

1 Calculation of stationary capital systematically, according to principle of double-entry bookkeeping
2 Shop calculation unsystematically, as single-entry
3 Production calculation also as single-entry.

It is *right* to conduct the whole accounting system according to the principles of double-entry bookkeeping.

IV—It is *wrong* to determine the relation between (*a*) capital and production accounting and (*b*) capital and stock accounting in such a way that one must specifically explain the other. It is *right* to establish the inter relation of the three accounts similar to that between seller and purchaser as follows:

1 Determination of overhead: Seller or contractor is capital accounting, purchaser is shop accounting
2 Calculation of material and labor: Contractor is capital accounting, purchaser is production accounting
3 Calculation of shop costs: Contractor is shop accounting, purchaser is production accounting
4 Calculation of finished products: Contractor is production accounting, purchaser is capital accounting
5 Closing calculation (annual balance or monthly intermediate balance): Contractors are shop and production accounting, purchaser is capital accounting.

V—It is *wrong* to organize the accounting system in such a way that it computes (1) too late, (2) too seldom and (3) only with the aid of an inventory of (*a*) the assets and (*b*) the results. It is *right* to conduct the accounting in such a way that this information is obtained (1) during production of work, (2) once a month, and (3) automatically.

VI—It is *wrong* to determine the net cost value of products by means of calculation (by auditing). It is *right* to determine the net costs by means of accounts (so-called record-keeping) conducted on the principles of double-entry bookkeeping and which keep pace with production progress.

VII—It is *wrong* for different concerns in the same branch of industry to have separate systems of accounting, so that comparisons with regard to the elements of net costs cannot be made between them, and consequently agreements with workers, government authorities and trade competitors cannot be made on a known basis. It is *right* that every industrial association should require its members to adopt a uniform system of accounting to the end that intelligent comparison may be made.

The author, however, is witness to the fact that these theses present only conclusions from the practical work that these two have successfully carried out in the most widely different branches of industrial work. Besides their fundamental ideas, they have also developed working rules, methods and means for putting these ideas into practice.

In conclusion, the author would say that it gives him great pleasure to be able to acquaint the American industrial world with the results of scientific and practical industrial organization in Germany. He is convinced that after a long period of lagging behind, his countrymen have now caught up with Americans in scientific management. However, the deeper foundation that they possess and the greater economy of operating their system (they can carry out the work of accounting in factories according to their method with half the personnel that is required with the usual American system), will perhaps prompt American industry to take note of their organization, science and practice, as German industry once gladly and gratefully accepted advice and information from American sources.

The Commercial Economy of High Pressure and High Superheat in the Central Station

By GEO. A. ORROK,[1] NEW YORK, N. Y.

IN THIS AGE of progress when the designers of central stations of all types and kinds are vying with each other in the use of higher pressures and temperatures as well as multiplying the complication of the steam generator, prime mover, and auxiliaries, it is expedient to go back to the beginnings of the central station and by a review of the line of development get a broad perspective of the field of power generation which will enable us to apply, to the newer developments, those basic principles of commercial economy and efficiency necessary to a proper solution of the problem.

The earlier use of steam when its expansive force had not been discovered, is best shown by the Newcomen pumping installations, in which the steam was used at atmospheric pressure. Watt discovered the expansive force of steam and so improved the boiler, engine, and steam piping that 15 lb. gage could be used economically. From his time until about 1900 rising pressure kept pace with improvements in materials and in the design and construction of steam generators and piping, with occasional excursions into the realms of higher pressure and temperature. Practice at this date (1900) may best be illustrated by the work of the Wildwood engine. Since 1900 improvements in steam generators, piping, and prime movers have been made with increasing rapidity, and many modern plants are running on 250 lb. and 200 deg. of superheat, using standard piping and valves with the newer designs of boilers, superheaters, and turbines. Table 1 shows the pressures and economies theoretically possible and attained in a central station, with all the results reduced to British thermal units in the coal per kilowatt-hour of useful work.

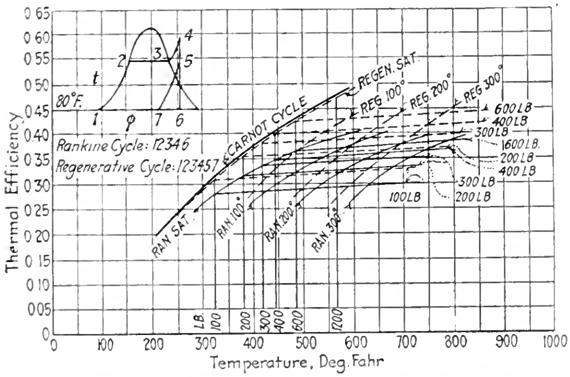


FIG. 1 THEORETICAL THERMAL EFFICIENCY OF THE CARNOT CYCLE, THE RANKINE CYCLE, AND A REGENERATIVE CYCLE, USING BOTH SATURATED AND SUPERHEAT VALUES FOR RANGES UP TO 1200 LB. AND SUPERHEATS OF 750 DEG. AND ABOVE

TABLE 1 STEAM PRESSURES AND ECONOMIES THEORETICALLY POSSIBLE AND ACTUALLY ATTAINED IN CENTRAL STATIONS

Year	Engine	Pressure, lb. per sq. in.	Temperature, deg. fahr.	Thermal efficiency, Carnot cycle, per cent	Actual B.t.u. per kw-hr.	Actual overall thermal efficiency, per cent
1770	Newcomen	15	212	2.7	416,000	0.82
1810	Watt ..	30	300	9.17	61,000	5 6
1900	Wildwood	215	400	20.8	19,200	17 75
1922	Modern	265	650	35 00	18,000	19.00

Our engineers are now using better and more uniform materials than ever before. Our metallurgical and manufacturing methods have been greatly improved. Copper, wrought iron, and cast iron have been discarded for boiler purposes. Steel and even alloy steel are in common use and their uniformity leaves little to be desired. Certain of the non-ferrous alloys are in common use and play their part in aiding the common security which characterizes modern installations. Copper boilers and 212 deg. maximum temperature gave place to wrought-iron boilers and 30 to 40 lb. pressure with a maximum temperature of 300 deg. The use of steel as a boiler material raised the pressure to 200 lb. and the temperature to 400 deg., while our modern steels allow pressures up to 400 lb. with a maximum temperature of 750 deg. In certain distillation plants temperatures as high as 1100 deg. have been obtained, but the life of the material is short.

Now it is well known that steel when heated to comparatively low temperatures, say, 900 or 1000 deg., loses its strength and becomes unfit to sustain loads, and the heat strains from even moderate heating of 300 or 400 deg. may cause certain deformations of a highly unsatisfactory character. Cast-steel valves have deformed at 750 deg. to such an extent as to render them useless, and the "growth" of ordinary cast iron at temperatures above 450 deg. is known to be destructive; but notwithstanding this the later constructions at 250–300 lb. pressure and 700 deg. maximum temperature are commercial. The first cost is not excessive, repairs are moderate, and the life of the installation is all that can be desired.

COMMERCIAL LIMITS OF PRESSURE AND SUPERHEAT IN THE CENTRAL STATION

What, then, are the commercial limits of pressure and superheat in the central station? In Fig. 1 we have calculated and plotted the theoretical thermal efficiency of the Carnot cycle, the Rankine cycle, and a regenerative cycle, using both saturated and superheat values for ranges up to 1200 lb. and superheats of 750 deg. and above. It will be seen that the chosen regenerative cycle for saturation follows very closely the efficiency of the Carnot cycle, while the Rankine cycle falls below the Carnot cycle increasingly with rise of pressures. The superheat lines for both cycles are nearly parallel and maintain this characteristic over a wide range. The gain from regeneration increases with pressure and is constant for equal superheat. For any final temperature the gain from pressure increments decreases, but the gain from regeneration increases with pressure increments. Thus at 750 deg. final temperature the Rankine efficiency increases from 33.5 per cent to 40.5 per cent with pressure rise from 200 to 1200 lb., while the regenerative efficiency increases from 37 per cent to 48.5 per cent with the same pressure increase.

Fig. 1, dealing with theoretical efficiencies only, does not show the station losses which aggregate around 45 per cent. Grouping the losses, we may say that the generator efficiency is 97 per cent, turbine efficiency 78 per cent, boiler efficiency 80 per cent, leaving for auxiliaries, piping, and radiation 91 per cent, all of which multiplied together give 55 per cent efficiency.

TABLE 2 SAVINGS EFFECTED THROUGH INCREASE IN STEAM PRESSURE

Case	Cycle	Pressure, lb	Max. temp. deg. fahr.	Theoretical efficiency, per cent	Station efficiency, per cent	Actual efficiency, per cent	B.t.u. per kw-hr.
1	Rankine	200	750	33 5	55	18 4	18,500
2	Rankine ..	1200	750	40 5	55	22.3	15,300
	Saving			21			3,200
3	Regenerative.	200	750	37	55	20.35	16,800
4	Regenerative	1200	750	48.5	55	26.7	12,800
	Saving.. ..			33.3			4,000

Table 2 shows how these figures work out for the above suppositions. The saving by regeneration when using 200 lb. pressure (Case 1 – Case 3) is 1700 B.t.u., and when using 1200 lb. pressure (Case 2 – Case 4) is 2500 B.t.u. Considering the trend of the curves in Fig. 1, on this page, comparatively little is gained by further superheating, but there has been no attempt to go above 800 deg. and the flattening out is much more marked as the temperature increases.

---

[1] Consulting Engineer, 17 Battery Place. Mem. Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 4 to 7, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Copies of the paper may be obtained gratis on application. All papers are subject to revision.

Water has its critical temperature at 704 deg. and the critical pressure is about 3200 lb. Pressures up to this limit may therefore be considered, and since oil-still temperatures up to 1100 deg. have been used, we may consider superheat temperatures up to that point. We know that the first allotropic change in steel occurs at about 1300 deg. and 1100 deg. is well below this point. Here, however, we must look into the physical properties of the steels used in power-plant construction.

When steel is heated the first sign of change—a dull red just visible in the dark—appears at about 750 deg. Visibility in daylight begins at about 850 to 900 deg. and a full dark red is attained at about 1100 deg. The full cherry red is attained at the first allotropic change of 1300 deg. Good boiler steels increase in tensile strength up to about 600 to 700 deg. and lose much in ductility, but above 800 deg. the tensile strength rapidly falls off and the ductility largely increases. Cast steels of proper carbon content and suitable for fittings, valves, and turbine construction show the same properties within rather narrow limits. Pipe steels have nearly the same characteristics, but the temperature at which the tensile strength starts to fall is around 550 to 600 deg. This lack of ductility or increase of brittleness at the maximum temperature of use must be compensated for by a larger factor of safety (i.e., increased thickness and weight with higher cost) and a more careful selection of material. But with increased thickness it must not be forgotten that the safe stresses must be correspondingly lowered. The variation of strength of materials with temperature is covered in an appendix to the complete paper.

Variation of Strength of Materials with Temperature

This subject may be considered from five points of view, depending on the conditions under which the materials are to be used.

(a) *Boiler Material.* Here we know that the maximum temperature cannot exceed 704 deg., the critical temperature of water, and that the fire side of the tube or drum can only be a few degrees hotter. If 1200 to 1800 lb. per sq. in. be the chosen pressure, the water temperature is 625 deg. at maximum and the fire side will not exceed 725 deg. normally. This temperature is well within the maximum-strength zone, and only care is needed to secure sufficient ductility.

(b) *Superheater Material.* The maximum temperature of the inner surface of the tubes may be a little higher than the maximum superheat. The outer temperature depends on the position in the boiler. Radiant-heat superheaters are now commercial where the pressure parts are protected with a heat-absorbing and conducting covering of cast iron. The fire surfaces may be 1400 deg. to 1600 deg. while the inner-wall temperature is as low as 700 deg., but 1100 deg. is comparably easy of attainment. Bare-tube superheaters would have a maximum outside temperature of around 1200 deg., but the life at this temperature is unknown. The maximum safe point may be taken as 800 deg. superheat temperature and 950 deg. outside temperature.

Neither the tube manufacturers nor superheater manufacturers are afraid of these conditions, and I believe they are prepared to guarantee their product under such conditions.

(c) *Piping Material.* Under this category the condition is markedly different. The steam side of the pipe is below the maximum temperature of the steam. The outer surface is much lower and the thickness of the material can be increased to compensate for the lower elastic limit of the material. The ductility is improving with temperature increase. Pipe joints are the only serious trouble, and the modified Van Stone joint with the pipe edges welded for tightness is the apparent solution. Experience with this joint has been satisfactory.

(d) *Valves and Fittings.* Valves and fittings must necessarily be made of castings, and the low-carbon, open-hearth steel used, while falling off in strength sooner than the worked material used in boiler and piping, has still a respectable elastic limit at 1100 deg. As in the last category, the inside-wall temperature is lower than the steam temperature, with still lower temperatures at the outer wall. But the shape of the casting is all-important. Globe valves of the double-beat or Wanick type can be made with practically no flat surfaces and with two axes of symmetry. Internal pressures do not seriously deform this design, but external strains may cause minor troubles. Throttle valves and marine stop valves are usually of this type and can be kept tight at 750 deg. It is probable that a temperature of 1100 deg. could be safely undertaken with these valves if special precautions were used in the design of the seat, disk, and stem. Flexible-disk, double-beat valves are used in Europe at temperatures in excess of 750 deg.

Gate valves have only one axis of symmetry and flat surfaces of considerable size. Here seat and disk troubles are encountered at temperatures above 700 deg., and it may be some time before the manufacturers can guarantee a tight job at the higher temperatures. This type of valve is peculiarly sensitive to outside strains tending to deform the seats and disk.

(e) *Turbine High-Pressure Ends.* Pressures can make little difference here as the high-pressure parts are comparatively small and without doubt the pressure will be reduced 50 per cent in the first nozzle. There need be no high-pressure stuffing box, so that the highest pressure to be packed against will be about half the maximum. Temperature strains will be the only thing that need be considered, and the expansion will reduce the superheat in the first-stage nozzle to a workable value, which is 750–850 deg. It is to be noted that steam-chest or nozzle-box troubles have been the only prominent troubles where 400 lb. and 750 deg. superheat have been tried out, and it thus appears that a proper design will obviate most of the trouble. Cast or forged steel must be the material used.

In general, the turbine designers say that 1200–1500 lb. pressure has no terrors for them and can be used when desired. They can supply the apparatus. Temperatures are more troublesome and no one apparently cares to go much above 700–750 deg. at the present time. Superheater and valve materials at present seem to be the deciding factor in the use of high pressures and temperatures, and there is apparently very little which careful design and the selection of proper materials will not overcome.

Only a portion of the central-station installation is affected by high pressures and temperatures, especially where electric auxiliaries are used. The boiler and piping system and prime mover cover the entire list, and in the usual central station this has represented about 40 per cent of the entire installation cost. Latterly, with the larger station the percentage is around 30, and may be taken at 25 per cent for the newer and larger stations of which Hell Gate and Calumet are types. If the station cost be taken at $100.00 per kw. as an average figure this portion of the installation has cost $25.00, and at 15 per cent the fixed charges are $3.75 per year or on 5000 hours' use 0.07 cent per kw-hr. What, then, will be the extra cost of this apparatus when designed for higher pressures and temperatures? Standard boilers today can be bought up to 275 lb. pressure; 300 lb. necessitates thicker plates and tubes, and prices advance accordingly. 400-lb. boilers have been purchased recently and 500-lb. boilers have been built. Flash boilers of the Serpollet and De Laval types using pressures in excess of 1200 lb. and coil boilers of the Herreshoff type using equally high pressures have been built as experiments or in toy sizes as for automobile work or for high-speed launches. Schmidt's water-tube boiler working at 900 lb. has been run 14,000 hours with marked success. Boilers for 400 lb. pressure have been offered at about 50 per cent increase in price and 1200-lb. boilers have been figured at a 100 per cent increase in price.

Turbine designers are at work on designs arranged to utilize higher pressures, but higher temperatures seem more troublesome to them. I have no estimate, but we can safely apply the same percentage increases of price to the turbine that obtain with the boiler. Steam piping decreases in size with increasing pressure, so much so that it is doubtful if a 1200-lb. steam line would cost more than a 200-lb. line of the same capacity. The volume of high-pressure steam at 1100 deg. maximum temperature is quite uncertain, but the chances are that our figures are not more than 10 per cent from the truth.

Summary

We may then summarize as follows:

a Pressures up to 1200–1500 lb. at least are commercial and may be attained without serious difficulty.

b Temperatures for the present are commercial up to 700–750 deg., which should not be exceeded until our materials for valves and superheaters are improved. More extended experience is nec-

essary before the range of 800 deg. and over is attempted in a commercial installation.

c With the completion of the Steam Table Research it will be possible to calculate accurately just where the possible limits of economy in pressure and temperatures may be located. At the present time the uncertainty of all values above 200 lb. pressure and 4000 deg. fahr. temperature render most of our calculations of only academic value.

d There still appears to be more economy in a closer study of operation and construction losses—resulting in improving the efficiency of central stations installed in accordance with the present accepted canons of design—than in the attempt to widely increase the temperature range of our heat cycles. While we may save 400 B.t.u. per kw-hr. by using a regenerative cycle and increasing pressure and temperature, it should be possible to save nearly as much by a reduction to the lowest limits of the heat losses which we know exist in our present installations.

TABLE 3 SAVINGS IN COAL

Pressure lb. per. sq. in.	Super-heat temp., deg. fahr.	Carnot effy.	Reg. effy.	Rank. effy.	Reg. × 0.55	Rank. × 0.55	Reg. B.t.u.	Rank. B.t.u.	Saving over R. 200 lb. 700°, B.t.u. per kw-hr. Reg. C.	Rank. C.	Saving in lb. coal per kw-hr. (13800 B.t.u) Reg. C.	Rank. C.
200	700	53.5	37	33.4	20.3	18.35	16820	18620	1800	—	0 13	—
400	700	53.5	41.2	36.3	22.6	19.95	15100	17120	3520	1500	0.255	0.109
600	700	53 5	43.5	38	23.9	20.9	14300	16350	4320	2270	0.313	0.1645
1200	700	53.5	47.5	40	26.1	22	13100	15500	5520	3120	0.40	0.226
200	1000	63	38	35	20 9	19.25	16350	17750	2270	870	0 165	0.065
400	1000	63	42.8	37.6	23.5	20.7	14500	16500	4120	2120	0.299	0.1535
600	1000	63	45	39.5	24.7	21.7	13820	15720	4800	2900	0.348	0.21
1200	1000	63	49	41.5	26.9	22.8	12700	14970	5920	3650	0.43	0.257

Savings of Regenerative Cycle

In Table 3 we have given for 700 and 1000 deg. maximum temperature and for four pressures the theoretical efficiency of the three cycles used, the practical efficiency of the Rankine and regenerative cycles, and the savings per kilowatt-hour for all conditions over the Rankine cycle at 200 lb. and 700 deg. maximum temperature in B.t.u. and lb. of coal of 13,800 B.t.u. content.

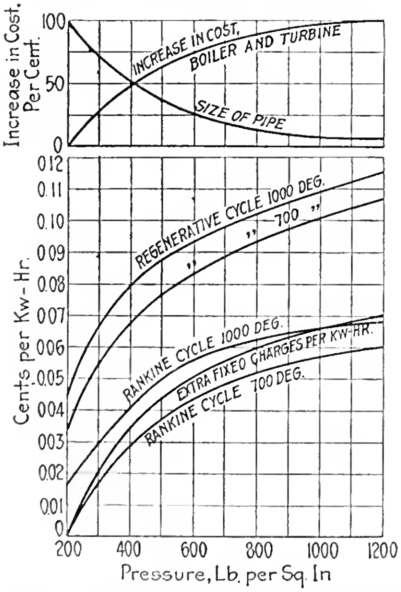


Fig. 2 Savings in Cents per Kilowatt-Hour for All Conditions Over the Rankine Cycle at 200 lb. and 700 Deg. Maximum Temperature, Based on $6.00 Coal

In Fig. 2 these savings are plotted in cents per kilowatt-hour on the basis of $6.00 coal, together with the extra-fixed-charges curve. At the top of the figure are two curves showing the percentage increase in cost of boiler and turbine and the decrease in size of pipe required for a given quantity of steam. It will be seen that the extra fixed charges are always greater than the coal saving for the Rankine cycle (ordinary operation) at 700 deg. maximum temperature, and that the additional gain for the 1000 deg. maximum temperature barely exceeds the additional fixed charges. We cannot then expect much from increasing pressures and the ordinary methods of using steam. Increasing temperatures help to some extent, but not enough to be attractive, since the saving is nearly all used up by the additional fixed charges.

With the regenerative cycle the results are much better and useful savings are indicated, increasing considerably with pressure and slightly with temperature. It is evident that some such regenerative cycle must be used, but the rewards from increasing temperature are not commensurate with the costs. Many regenerative cycles are possible, but the one used shows nearly the maximum economy. Such cycles need many heat interchangers and a number of separate feed pumps for the close approach to theoretical figures. Indeed, Thurston and Stanwood[1] in 1899 pointed out that with an infinity of heaters and pumps the Carnot efficiency might be equaled. So far, however, four or five stages have been the ultimate practical application, and not more than three have stood the commercial test. It would appear that considerably better design must be put in the apparatus if many steps are proposed, and also that more consideration must be given to the operating difficulties.

Acknowledgment

Much of the work in connection with the preparation of this paper has been done by W. S. Morrison and M. A. Guigou, members of the Society. An appendix dealing with the properties of metals at high temperatures and which accompanies the complete paper is the work of Mr. Morrison; most of the calculations have been done by Mr. Guigou and the drawings made by Mr. H. H. Worth, Junior Member Am.Soc.M.E. Credit should also be given to a number of my friends and associates who have criticised the paper during its preparation.

When the plant of the Buffalo General Electric was put into operation in 1916 and 1917, it represented the high-water mark in steam pressures and temperatures in large power-plant practice in this country. This plant attracted international attention, and although at that time it was predicted by some authorities that five hundred or six hundred pounds pressure was a probability of the near future, there are still many large plants that seem to favor pressures of about three hundred pounds and a total temperature of around six hundred degrees. There are a few exceptions, but in the main the operator has not taken kindly to pressures and temperatures much above these, as it has been found one thing to design and construct a plant for high steam pressures and temperatures and an entirely different thing to operate the plant and make it give reliable service. However, many of the earlier operating difficulties have been overcome and, after what might be considered a pause at steam pressures of about three hundred pounds, the tendency is again to go to higher pressures. A notable example of this is the new plant of the Public Service Company of Northern Illinois, at Waukegan. These boilers, which will operate at four hundred pounds pressure, are of a new design especially adapted to high pressures in large units. Although this is the first time that pressures in excess of three hundred fifty pounds have been employed in large plants in this country, marine-type boilers have been built for six hundred pounds but they have been small-sized units. The new boiler is a somewhat radical departure from the standard designs that have been employed in large sizes for stationary work up to three hundred fifty pounds.

An increase in Rankine cycle efficiency is obtained with an increase in pressure up to about eighteen hundred pounds, after which it begins to fall off. However, this increase in efficiency is not in direct proportion to the increase in pressure. With steam at a constant temperature of seven hundred degrees there is a gain of about three and one-half per cent between one hundred fifty and three hundred fifty pounds. From this point the curve begins to flatten out, and the gain between three hundred fifty and six hundred pounds is only two per cent, with an additional gain of two per cent by carrying the pressure up to one thousand pounds.—*Power*, Sept. 12, 1922, p. 424.

---

[1] Trans. Am.Soc.M.E., vol. 21, pp. 192 and227.

The Preservation of Decaying Wood Roofs

General Theory of Wood Decay—Methods Employed in Preserving Wood Roofs Economic Considerations in Prolonging the Useful Life of Repaired Roofs

By WENDELL S. BROWN,[1] PROVIDENCE, R. I.

RAPID development in industry, like the accelerated progress of civilization, is often and perhaps inevitably accompanied by certain afflictions and disorders. And in the last quarter century one of the disturbing conditions which has arisen and which is demanding increasing attention in certain sections of the industrial world has been the serious decay of wood roofs.

Now a roof is a cover of a building, according to one dictionary definition. But unfortunately, since the advent, in buildings of home-made weather, either in the form of artificially high or naturally high relative humidities—due to some necessary process—a roof must have other attributes than covering only, if it is to act as a real shelter. For, under certain conditions instead of constituting a protection, the reverse is true, and the roof becomes a positive source of trouble. This happens when the formation of condensation (commonly called sweating) on the ceiling is so rapid as to cause dripping into the room below, with consequent annoyance to the occupants and often serious damage to machinery, building, and materials in process.

Happily, it is a comparatively simple matter, by adopting suitable insulation, to prevent the formation of condensation on, and dripping from, the under surface of the roof, for any usual condition encountered. That is, theory and laboratory tests, authenticated by actual installations, have provided accurate methods for rationally designing many different types of roofs to meet varying requirements as to relative humidity and temperature carried in the room below.[2]

But with respect to wood roofs, prevention of visible condensation is only part of the story, for the reason that cracks between the plank afford a more or less direct channel by which warm, moist air from the room below reaches the roofing paper, which latter is practically at the temperature of the outside air. If this temperature is below the dewpoint of the said contacting room air, precipitation of moisture or condensation results; which means nothing more nor less than that the first ply of roofing paper and the top of the wood roof itself are saturated with water during the greater part of the heating season in temperate or colder climates. Laboratory tests and the experience of those who have removed old mill roofs bear this out.

In fact, this rot-inducing feature is the outstanding bugbear and cause of excessive mortality in wood roofs of those manufacturing buildings—such as textile mills, finishing plants, paper mills and food factories—which utilize or by nature house high relative humidities. The damage is enormous—greater than generally realized—amounting to hundreds of thousands of dollars annually in building material alone, besides occasioning often more serious losses in production and general derangement. Many such unenviable records exhibit useful roof lives as short as three years, with a possible average of ten years and a maximum of twenty-five years, depending upon the severity of atmospheric conditions within and without the building, and the species and quality of lumber used.

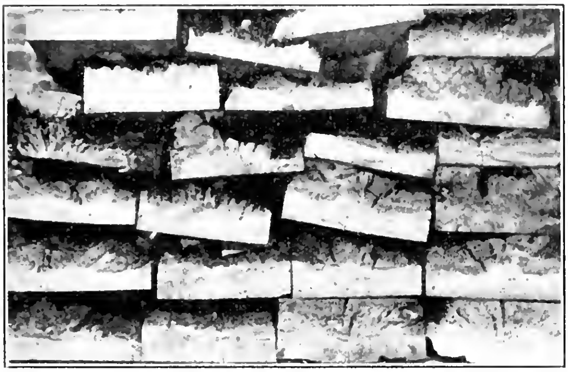
Notwithstanding the subject under consideration is the preservation of old wood roofs, it would be remiss not to admit that some of them are not worth saving. The correct determination of whether or not a roof is worth saving lies in a full consideration of the problem from a purely utilitarian viewpoint, and the paper aims to indicate general principles by which this often debatable question may be settled, and also to describe one method by which the desired result has apparently been attained.

General Theory of Wood Decay

The almost exclusive cause of decay in wood is the destroying action of certain fungi, of which there are several varieties. These, however, in order to accomplish their destructive work, must have a favorable environment, which, in addition to suitable media in the form of wood fiber from which their food supply may be obtained, consists of the proper amount of moisture, temperature and air supply. There are two general classifications of such fungi:

1. The "dry rot" group, thriving in a comparatively narrow range of cool to moderate temperatures and not requiring great amounts of moisture;
2. The "damp rot" or "mill roof" group, thriving over wider and generally warmer temperature ranges, but requiring relatively large amounts of moisture for their normal development.

As indicated in the name, we are concerned particularly with the second group, which requires either air at practically 100 per cent relative humidity or a free supply of water in its liquid state. Incidentally, since air is necessary for fungus growth, the presence of water to such an extent as to prevent admission of air to the wood cells is fatal.



(*Photo by F. J. Hoxie*)

Fig. 1 Showing Typical Decay in Roof Plank Starting at Top Surface

Wood roofs over buildings housing ordinary temperatures and humidities lack only one requirement to make them excellent media for infection and decay from the second group. This one deficiency is moisture, which, in the case of those special roofs under consideration, is supplied by condensation.

There are perhaps half a dozen kinds of fungi most commonly found attacking mill roofs, and the limits of temperature and moisture most favorable to their development vary somewhat with the species. Many investigators, both here and abroad, have devoted considerable study to the classification of fungus diseases, and the conditions affecting their germination, dissemination, and subsequent development and viability. For instance it has been found that the temperature at which most of the mill-roof fungi grow and spread lies between the approximate limits of 35 deg. fahr. and 110 deg. fahr., the optimum limits for development being considerably narrower than the above—approximately 75 deg. fahr. to 100 deg. fahr. Alternate wetting and drying is destructive to the spores cast off by certain fungi; and some varieties develop best in darkness, while others require diffused light, but not direct sunlight.

Ordinarily, decay in roof plank starts at the top surface (see Fig. 1), especially if the first ply of paper is dry sheathing not mopped

---

[1] Engineer, F. P. Sheldon & Son. Mem. Am.Soc.M.E.

[2] See original paper on this subject by F. P. Sheldon & Son, Engineers and Architects, Providence, R. I., entitled Experiments to Determine the Relative Effectiveness of Various Types of Roofs in Preventing the Formation of Condensation upon their Under Surface, read before the National Association of Cotton Manufacturers, 102nd Annual Meeting, Boston, Mass., April 25, 1917.

Presented at the Springfield Regional Meeting of The American Society of Mechanical Engineers, Springfield, Mass., September 25–27, 1922. Slightly abridged.

down. Sometimes, however, infection seems to get a foothold first just above the tongue and groove or spline and progresses more rapidly within the central portion of the plank lying between the two extremes of moisture.

In sawtooth buildings, valley plank usually decay first, this being generally traceable to one or more of the following contributory causes:

a Since sawtooth lighting areas ordinarily face approximately north, the valleys are considerably shaded by adjacent sawteeth, which latter intercept the warming effect of the direct solar rays when the sun is at low altitude during the heating season.

b Often heating coils are located solely under the glass or at some distance up the wooden back of the sawtooth, leaving the valley portion chilled, and subject, therefore, to excessive condensation.

c There is a tendency for moisture or condensation to drain toward the low point of the roof.

An indication of the comparative extent to which rotting has progressed in various portions of a roof may often be had from the brown extractive matter deposited in rusty streaks on rafters and plank. Decay is usually greatest in plank and beams at bearings because, due to the additional insulating properties of the supporting members, the locus of condensation[1] dips as indicated in Fig. 2. Tops of roof rafters and girders rot first—usually for the same reason; and other conditions being equal, decay is more active in the vicinity of ventilators, cold conductor pipes, etc.

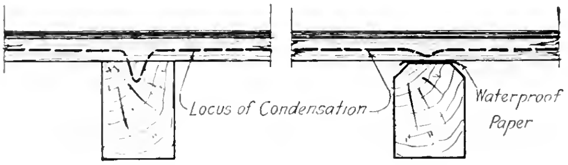


Fig. 2 Fig. 3

Fig. 2 Showing How Locus of Condensation Dips Over a Beam or Rafter

Fig. 3 Showing How Locus of Condensation May be Raised by Chamfering Corners of Beam or Rafter

But the quality of lumber as well as species or variety is also a vital factor in its longevity, and variations in the former often tend to upset too close generalizations concerning the placement of decay. For instance, three years ago two bays of roof plank and one roof rafter in a Rhode Island weave shed were replaced with entirely new but unsuitable material having a high percentage of sap wood. The plank is already more than one-half rotten and is in a worse condition than the remainder of the roof which is thirteen years old.

Methods Employed in Preserving Wood Roofs

Taking up the question of treatment, there seems to be no practicable means of preventing exposure to infection, or of eliminating rot-inducing conditions, as far as temperature alone is concerned.

For new wood roofs antiseptic treatment is possible, and several processes, such as creosoting and kyanizing, may be adopted for the preservation of plank. One creosoting concern has recently introduced a priming paint and claims that it is not penetrable by creosote, thus making possible the application of white ceiling paint directly without sheathing. Girders and beams may be made of steel, but if untreated timber is used the upper edges of beams may be chamfered and covered with a layer of waterproof paper, as shown in Fig. 3. Chamfering tends to raise the locus of condensation, and the paper still further assists in keeping the top of the beams dry.

In the case of existing roofs the treatment must of necessity be ameliorative rather than preventive or curative; and it should be clearly understood that the term "preservation" is meant to indicate merely the economic postponement of ultimate roof renewal and not the attainment of permanency. Briefly, the treatment consists in removing from the fungus its water supply by preventing condensation so far as is practicable. And condensation is decreased by insulating the outer roof surface, the extent of inhibition depending upon the amount of insulation.

There are certain inherent limitations to this treatment which prevent the full attainment either of water-supply removal or of sterilization. First, it is impracticable on account of excessive initial expense to lay enough insulation to wholly prevent condensation within the roof plank even in moderately cold winter weather. Second, certain fungi are suspected of having a faculty—once they are well developed—of manufacturing water to a limited extent through a decomposition of the wood structure itself, provided said decay is deep seated and protected from too rapid evaporation. That is, water in its liquid state is not absolutely necessary for their maintenance. The important characteristic of this treatment is therefore a retarding action accomplished by making the environment as unfavorable as practicable.

Top insulation has the effect of moving the plane or locus of condensation for any given set of atmospheric conditions nearer the outer surface of the plank than before, and in mild weather of eliminating it entirely. In other words, the rate of condensation is reduced, as is also its duration, resulting in checking inroads of disease already established, and also in lessening the susceptibility of timber to further infection.

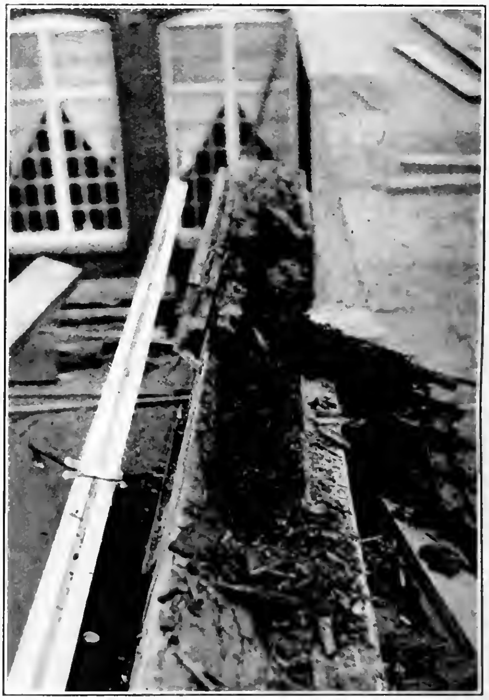


Fig. 4 Typical Decay in Yellow-Pine Girders

Insulation should be in sufficient amount to entirely prevent condensation on the under side of the roof in most severe weather, and if wood, should itself be antiseptically treated. Creosoted yellow-pine boarding nailed to furring strips has been found to be an economical type of insulation. Cheap, open-grained lumber, preferably sap wood, should be used, since it readily absorbs the necessary amount of wood preservative. By laying it over furring strips, additional and especially effective and inexpensive insulation in the form of an air space is obtained. This type of insulation also adds materially to the strength of the roof plank; in fact, it may be made thick enough to support the old plank if the latter have become seriously weakened, and the importance of not interrupting production is paramount. The old plank, where dangerously decayed, would then be spiked to the new plank from below.

---

[1] "Locus of Condensation" may be defined as a plane whose temperature equals the dewpoint temperature of the contacting room air. Below this plane no condensation takes place; above it, condensation occurs with increasing activity as the top surface of the roof is approached.

In order to prevent entrance into the new insulating air space of warm, humid air from the room below (and therefore condensation which would otherwise occur within the upper insulating deck and would drip upon the lower untreated plank), it is necessary to have a waterproof membrane between the old roof and the new insulation. The old roofing paper may be left intact and used for this purpose, if practical. On one large weave shed the new insulation was laid directly on the tar-and-gravel roof without removal of gravel, except what could be easily brushed off. If considerable structural renewal becomes necessary, however, it will generally be found advisable to remove the roofing paper entirely, and after necessary replacements have been made, to lay down a two-ply roof over the same before applying the insulation.

An economic consideration of the question invariably shows that the additional insulation saves enough heat to help very materially in meeting fixed charges on the initial cost of installation. This is illustrated later. Furthermore, dripping from the ceiling, which may have been experienced previously, will be stopped.

Sometimes it is advisable to rearrange the heating system so as to obtain a more uniform distribution. In sawtooth buildings a portion of the heating surface should be placed under the plank and a portion under the glass, the object being to obtain a balance (that is, as little circulation of air as possible directly under the sawteeth) and thus maintain a uniform and somewhat higher temperature here, without, however, increasing the room temperature on the working plane. The effect is to decrease still further the rate of condensation within the old roof and the number of days of its occurrence during the year.

The most recent installation with which the author is familiar was completed a month ago under the direction of F. P. Sheldon & Son, Engineers and Architects, with which firm he is connected. The building is a sawtooth weave shed have a projected roof area of 116,000 sq. ft.

The weave shed is now twenty-three years old, and during the past ten years considerable portions of the roof have been replaced. For humidity, during approximately the first twenty years, it depended upon the admission of moist basement air through belt holes in the floor at each individual loom, the basement being traversed by a canal and containing more or less standing water. Recently, mechanical humidifiers were installed with the intention of maintaining a more constant relative humidity (approximately 75 per cent) than was before possible. The humidifier installation probably has accelerated roof decay somewhat, but, on the other hand, the basement may now be properly ventilated, and the present ravages of decay in floor plank, beams, and columns prevented, or at least materially retarded.

Fig. 5 General View of Contractors' Plant

Sixty per cent of the roof plank was so rotted as to need renewal. Two per cent of the 6-in. by 12-in. yellow-pine rafters, and 25 per cent of the 11-in. by 14-in. yellow-pine girders were replaced for the same reason. The good condition of the rafters is worth noting and is doubtless due in part to their narrowness, which tends to prevent any marked dip in the locus of condensation—see Fig. 3.

The technique in this particular instance was briefly as follows: The insulation consisted of $^7/_8$-in. square-edged, creosoted yellow-pine boarding nailed on $^7/_8$-in. creosoted furring pieces, resulting in a $^7/_8$-in. air space between the old roof and the new boards. The lumber was treated on the job by the hot-dip process, being unloaded direct from the cars to a storage pile within 40 ft. of the creosoting tank, which latter was of steel, 20 ft. long, 7 ft. wide and 5 ft. deep, and had ample capacity for 3000 ft. B. M. of lumber used daily. Boards were stuck with 6-ft. pieces every six boards and were divided into two sections for a given charge, each section fastened with a cable sling. An A-frame derrick (Fig. 6) made of two 50-ft. telegraph poles was used for lifting the sections into the tank. It also served in removing batches from the tank and hoisting them to the weave-shed roof. Heavy timbers were used to ballast the lumber being treated, and these were taken to and from the tank on a carriage moving on rollers, and were lifted from it by the derrick. A batch, after being lifted out of the hot creosote, was held over the tank and allowed to drain for three or four minutes. It was then hoisted to the roof, after which practically no more dripping occurred; the partial vacuum set up by the air and steam in wood cells, cooling, contracting, and, therefore, sucking in the excess surface oil.

Fig. 6 View of Derrick and Creosoting Tank

The creosote oil used on the job was furnished in a tank car placed on a siding some 300 ft. from and considerably above the creosoting tank, thus allowing a gravity flow in the pipe line connecting the two. Make-up oil was added each time a batch was removed, except that toward the end of the creosoting process, after all the oil had been placed in the tank, the amount of lumber per batch had to be gradually reduced. During treatment the oil was held at a temperature of about 230 deg. fahr. by means of high-pressure-steam coils having a total heating surface of 270 sq. ft., placed in the bottom of the tank.

The use of wet or unseasoned wood was apparently not detrimental, except for the fact that a longer treatment was necessary in order to insure thorough penetration by first boiling out the entrained water.

The creosote oil used was a modification of Grade 1, American Railway Association Specification, having a specific gravity at 59 deg. fahr. of at least 1.08, and giving, when distilled, no distillate below 392 deg. fahr., not more than 1 per cent below 410 deg. fahr., and not more than 10 per cent below 455 deg. fahr.

The penetration was quite thorough, the amount of oil used averaging 9.4 lb. per cu. ft. for a 20-hour treatment. The creosote cost \$0.29 per gal. delivered, which, reduced to a board-measure basis, added \$0.022 to the unit lumber cost of \$0.03, and made a total of \$0.06 per board foot for treated boards—labor and overhead for treatment included, but not laying. The labor of laying on roof amounted to about \$0.02 per ft. B. M.

Where plank were rotted at bearings, but fairly sound elsewhere, new bearing strips were spiked to each side of the rafter for necessary support.

Not more than one sawtooth for half its length was opened up at any one time, with consequent interruption to only that machinery under this particular section. This usually amounted to less than eighty looms for a period not over nine or ten hours.

Economic Considerations in Prolonging the Useful Life of Repaired Roofs

Consideration of the problem from the standpoint of economics shows, for this particular building, if the given insulation prolongs the useful roof life no more than *five* years, that it was warranted and preferable to an entirely new durable roof. Each additional year of life is therefore a net gain, as is also the very real and important (but in this case uncapitalized) saving due to substantially postponing the period in which greater interruption to manufacturing, incident with entirely new roof construction, would occur. The solution was based on the following approximate assumptions made after the necessary study of existing conditions:

1 Regardless of building decay, the felt-and-slag roof, on account of its age and condition, would have required replacement within one year at an estimated cost of $17,000.

2 If decayed members in need of immediate renewal were to be merely replaced by new, without the insulation feature, it was estimated that equal replacements would again be necessary within fifteen years.

Problem: Determine the minimum number of years by which the given insulation must prolong the useful life of the repaired roof in order to prove a financially sound investment, and preferable at this time to an entirely new durable roof.

a The cost of the project was approximately as follows:

Insulation, i.e., creosoted plank in place, including extra two-ply waterproof membrane	$18,000
Felt- and -slag roofing	17,000
Necessary renewals of plank, rafters, and girders, removal of old roofing, painting, etc.	28,000
Total	$63,000

b The minimum cost of an entirely new and durable treated wood roof on yellow-pine rafters and steel girders, including painting, complete erection, etc., was estimated at $110,000.

Working out several trial examples, it is found that the said insulation in order to be justified should add at least *five years* to the useful roof life. Sample computations follow.

(1) The approximate 20-year cost of the repaired roof *with insulation* (that is, the cost over its augmented useful life of 15 + 5 = 20 years) may be calculated as follows:

Initial cost (wholly depreciated)	$63,000	
Yearly interest at 6% = $3,780 having a value in 20 years if compounded annually at 6 per cent of	139,000	
		$202,000
150 tons of coal saved annually at $7 per ton = $1050, having a value in 20 years if compounded annually at 6 per cent of		39,000
Total 20-year cost		$163,000

It is worthy of note that the insulation saves annually in coal 1,050/18,000 or 6 per cent gross of its cost and vitally affects the computations by reducing the number of years by which the said insulation must lengthen the roof life in order to be justified.

(2) The approximate comparative 20-year cost of repaired roof *without insulation* is obtained as follows:

Cost of repairs good for 15 years and then wholly depreciated, $17,000 for roofing plus $28,000 for replacements [see (*a*) above]	$45,000
Yearly interest at 6 per cent = $2700, having a value in 20 years if compounded annually at 6 per cent of	99,000
Cost of equal repairs 15 years hence (probably reduced to $30,000), depreciation at 5/15	10,000
Yearly interest at 6 per cent = $1800, having a value in 5 years if compounded annually at 6 per cent of	10,000
No coal saved	......
Total 20-year cost	$164,000

(3) The approximate comparative 20-year cost of a new and durable roof having an assumed life of forty years is obtained as follows:

Initial cost, $110,000, depreciation at 20/40	$55,000	
Yearly interest at 6 per cent = $6600, having a value in 20 years if compounded annually at 6 per cent of	242,000	
		$297,000
100 tons of coal saved annually at $7 per ton = $700, having a value in 20 years if compounded annually at 6 per cent of		26,000
Total 20-year cost		$271,000

Conclusion

While it is realized that the foregoing assumptions concerning future prices are conjectural, there is apparently ample margin in the result to show the described treatment to be, in this case, an economical procedure. This factor is especially emphasized when the avoidance of serious interruption to production, which would have attended entirely new construction, is considered; as well as the fact that dripping from the ceiling, which occurred previously during severe winter weather, is prevented.

Several other decayed wood roofs have been similarly insulated within the past three or four years with apparently beneficial results, so that this treatment has passed beyond the purely theoretical or experimental stage.

It is easy for an engineer to recommend sweepingly entire roof renewal with more permanent material, such as concrete, treated plank, redwood, etc., as the only real satisfactory solution of a given problem, but the correct answer is ordinarily determined only after careful analysis and evaluating and balancing every factor pertaining to each individual case. Each situation has its own especial features which should be critically examined; and to an executive considering ultimate costs, the question of maintaining production is often of greater weight than building economics pure and simple.

The tremendous damage caused by "damp rot," which is progressing insidiously in many industrial plants today, should be brought to light and more fully realized. In some brick buildings with wood roofs disintegration has occurred amounting in three years to one-quarter the value of the structure; other buildings entirely of wood have been practically a total loss above the foundations in the same time. Even less rapid depreciation instanced in the nearer normal example given has more than a merely local effect. Besides handicapping the manufactory itself, and being reflected in the cost of goods to consumers, such losses must ultimately have an appreciable effect upon international trade, and are intolerable if this nation is to enter into forward-looking competition in world markets. Plainly, damp rot constitutes one affliction of which our modern industry must purge itself if the United States is to play its rightful part with increasing service as a great vital and industrial nation.

A wood preservative new in this country but used in Europe and particularly in Belgium for a number of years is aczol, which is composed of ammonia, copper, zinc and phenol. All of these component parts have been used to a greater or less extent in wood preserving work, but the novelty of this compound lies in the fact that the inventor has succeeded in producing it in soluble form. It is entirely soluble during impregnation and precipitates while the wood is being permitted to dry in the air. The drying causes the evaporation of the ammonia, which simply acts as a carrier of the other ingredients. The phenolic salts of copper and zinc become firmly imbedded in the wood fiber—in fact the sap and ligneous material is soluble in the solution and this liquid is replaced by the precipitated salts.

The impregnation of wood with creosote is accomplished by placing the wood in a large airtight vat. The air is then pumped out to as high a vacuum as possible and the heated creosote is put in under pressure. With aczol the process can be conducted without the use of vacuum and without heating the solution. Wood impregnated with aczol is much stronger than that done with creosote, due, probably, to the cementing action of the salt in and around the wood fiber. It is clean, dry, odorless, and fire-resisting, and can be tooled and worked exactly as untreated wood.

The material is manufactured in rather concentrated form and is diluted—six parts of the product to ninety-four parts of water—in the field.

Records of the use of wood impregnated with aczol have been kept in Belgium for the past decade. Coal-mine operators testify that "aczolated" timber has remained in its original sound condition for eight years. It has also been used successfully on wood paving and in railroad ties, where the rotting is extremely rapid, especially in some climates. It is predicted by a number of competent men that the use of aczol will rapidly displace that of creosote because of its greater durability and greater ease of handling.—*Chemical and Metallurgical Engineering*, Sept. 6, 1922, p. 509.

Spherical Gears

By CHARLES H. LOGUE,[1] SYRACUSE, N. Y.

The basis for a study of all gears whose pitch surfaces are in rolling contact is found in the study of the bevel gear. By acquiring this point of view, not only are the elementary features of bevel-gear design brought out and applied to spur gears, but also the real connection between the two types is shown. This is essential to a complete understanding of either. The author has specially endeavored to point out the necessity for a difference in the design of the teeth heretofore not considered, and to present the entire matter in the simplest possible manner.

The tooth action of all gears whose pitch surfaces roll upon each other is developed upon the surface of a sphere, within which these pitch surfaces are enclosed. A study upon this basis is essential to a complete understanding of the action of both spur and bevel gears.

To illustrate, let us begin with a pair of miter gears whose pitch radii are 1 in., and which will operate at a shaft angle of 90 deg.; the apex distance (spherical radius) being 1.4142 in. Now consider a series of spherical enlargements, maintaining the same pitch radii for the gears. It will be noticed, as this enlargement progresses, that the angle of the axes is gradually reduced and that the gears very soon assume the appearance of spur gears, the pitch cones gradually merging into cylinders, which are attained when the radius of the enclosing sphere, or the apex distance, reaches infinity. Practically, we may thus develop cylindrical pitch surfaces within the range of a good-sized drawing board. See Fig. 1.

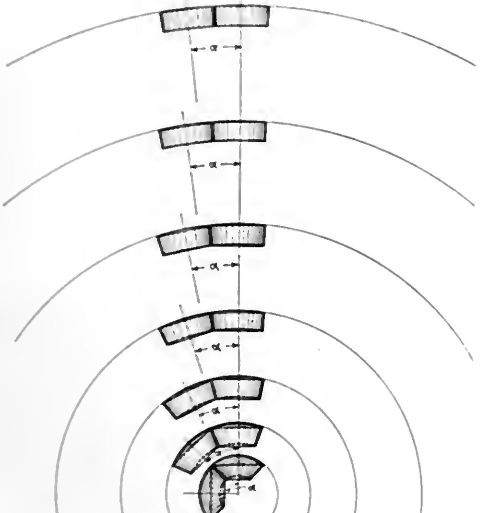


Fig. 1 The Evolution of the Spur Gear
(Angle $a=0$ when radius of sphere is infinite.)

Another way in which this fundamental may be illustrated is by considering the gradual enlargement of the radius of the crown gear, or our molding element. The pitch radius of the crown gear is the radius of the sphere, and its pitch surface is enclosed by one-half of the complete sphere. This pitch surface is a plane through the great circle, known as the "crown surface." Fig. 2 shows the nature of the engagement for a continuously enlarged crown gear with a pinion, the spherical radius being increased successively from *a* to *b* and from *b* to *c*. When the radius of the sphere is increased from *a* to *b* the angle of axes is reduced from A_1 to A_2, and then to A_3 by the increase to *c*. It is apparent, when an infinite spherical radius is considered, that the angle of axes *A* will be 90 deg. The angle of axes being 90 deg. and the ratio of reduction infinity, spur and bevel gears are identical.

Fig. 3 shows conical pitch surfaces within the sphere. The center of this sphere must be the common intersection of these conical surfaces, or the intersection of their axes. The angle of axes may be altered as desired, when new pitch cones will automatically form as shown in Fig. 4. By again considering a sphere whose radius is infinity, it will be apparent that an angular adjustment of the axis, as illustrated by Fig. 4, corresponds to a change in the distance between centers for spur gears. For spur gears the pitch diameters of both gear and pinion automatically form through a point which is the intersection of the line of action and the line of centers. Consider, for spur gears, that this occurs upon the surface of a sphere whose radius is infinity and apply this same development upon the surface of a sphere whose radius is the apex distance for bevel gears such as shown by Fig. 4. A drawing board for the development of tooth action should be a wooden sphere whose radius is the apex distance. For a pair of bevel gears of 49/11 ratio and 5 diametral pitch, operating at 90 deg., this "drawing board" would have a radius of 5.022 in. For the same gears operating at a zero shaft angle, the regulation drawing board is properly employed, on which we may also lay out a pair of gears whose angle of axes is 90 deg. when the ratio of reduction is infinity, or any pair of gears whose pitch surfaces are enclosed by a sphere whose radius is infinity. It will be noted that for any pair of gears enclosed by a measurable sphere, all tooth parts are properly expressed by angles, the only lineal dimension being the radius of the sphere.

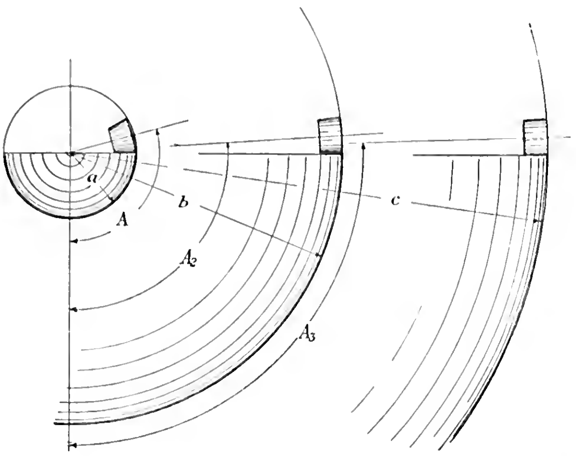


Fig. 2 Nature of Engagement for a Continuously Enlarged Crown Gear with a Pinion

Line Formation

All modern gear-cutting machines are based upon the molding process, by which, in theory, the teeth of the gear or pinion in process are molded or formed by the conjugating action of the teeth of a crown gear, or for spur gears, we may say, by the teeth of a rack. At present we will deal only with the development of the formation lines upon the pitch surfaces. This resolves itself into a study of these lines upon the pitch surface of the molding element, the transmitting of these lines to the pitch surfaces of the gear and pinion being entirely automatic. A defective line upon the pitch surface of the gear simply means defective crown-gear development.

---

[1] Consulting Engineer.

For presentation at the Annual Meeting, December 4 to 7, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

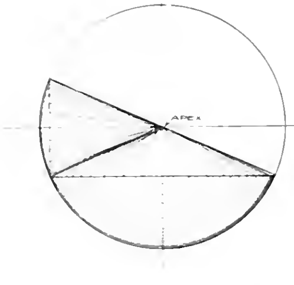


Fig. 3 True Pitch Cones

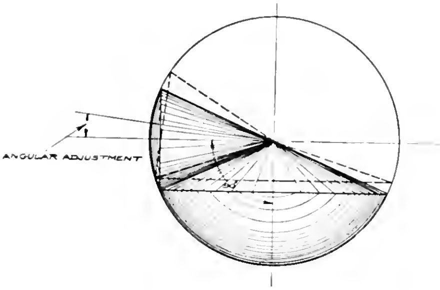


Fig. 4 Correct Separation of Pitch Cones

(Illustrating the increase in pitch cones due to an angular adjustment of axes. This corresponds to an increase in center distance for spur gears, and has a corresponding effect upon obliquity of action.)

Formation lines are developed upon the crown surface (pitch surface) of the crown gear. The outer circumference is spaced off to conform to the required pitch, and from each of these points upon the circumference we develop lines which approach the center or pole of the crown gear by means of an equiangular or logarithmic spiral of the desired angle. If a zero spiral, which will mold a straight-tooth gear, is required, we have only to draw radial lines from each point upon the circumference to the pole of the crown gear. Or if a spiral of, say, 30 deg. is required, the development line must be drawn so that any tangent forms a constant angle of 30 deg. with the radii vectores. That is, this line leaves a point upon the circumference of the crown gear at an angle of 30 deg. with a radial line drawn from that point, and continues obliquely toward the pole, forming a continuous line whose tangent with any radial line which may be drawn through it forms an angle of 30 deg., or any other desired angle of spiral. See Fig. 5. This same line being described from each point upon the circumference, the line formation of the crown gear is complete.

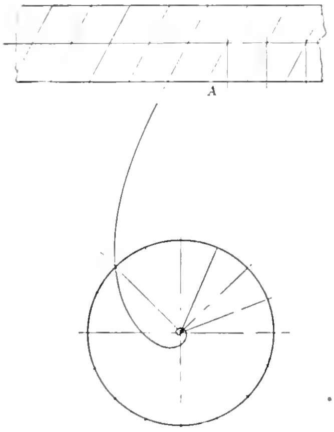


Fig. 5 Development of Formation Lines on Pitch Surface of the Crown Gear

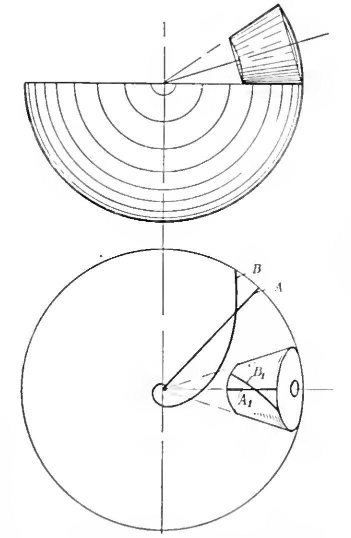


Fig. 6 Developed Lines on Crown Surface of Crown Gear

If we now consider the extension of the spherical radius to infinity we see that the pitch is laid off along a rack length, and this extension of the logarithmic spiral reaches the pitch surface of the rack as a straight oblique line at an angle from the vertical corresponding to the angle of spiral. See *A*, Fig. 5. In this extension, however, we refer to this angle as the "angle of helix." The spiral upon the conical pitch surface of the gear to be molded is the helix upon a cylindrical pitch surface. When the radius of the crown gear is infinite, radial lines become parallel lines, so that for straight teeth the developed lines upon the rack are simply drawn perpendicular to the lineal edge of the rack. Fig. 6 shows two developed lines on the crown surface. *A* is that of a zero spiral angle (straight tooth) and *B* a spiral development of about 35 deg. These lines are "printed" upon the pitch surface of the gear, as A_1 and B_1, by rolling the pitch surface of the gear over the pitch surface (crown surface) of the crown gear. The ratio of this rotation is as the sine of the pitch angle of the gear.

The Logarithmic Spiral

By reason of the growing interest in the logarithmic spiral and its application to spiral crown-surface development, also its interesting relation to the involute, it is thought that a treatment dealing with the spiral bevel gear should include a short description of the spiral. A graphical development is shown in Fig. 7. The radius vector is the distance from the pole to any point on the spiral. The radii vectores increase in geometric progression for a constant angle of advance. This angle (k) may be assumed and the ratio of progression P found as follows:

$$P = \frac{1}{2.7182818^{\frac{k \cot S}{57.293}}} \quad \ldots\ldots\ldots\ldots\ldots [1]$$

in case the spiral development is negative, toward the pole, or from the radius vector r_1; and

$$P = 2.7182818^{\frac{k \cot S}{57.239}} \quad \ldots\ldots\ldots\ldots [2]$$

in case the spiral development is positive, away from the pole, or, say, from radius vector r_{12}. S = angle of spiral.

We have $r_2 = r_1P$
$r_3 = r_2P$ or r_1P^2
$r_4 = r_3P$ or r_1P^3, etc.

When the spiral is developed toward its pole the value (negative) of the ratio P will be less than 1, and for a development away from its pole (positive) the ratio P will be greater than 1. The constant 2.7182818 is the Napierian base. The radius vector is the side opposite. The instantaneous radius of the spiral at any radius vector is the hypotenuse of a right triangle, as shown in Fig. 7 by heavy lines. This same triangular relation continues at all points on the spiral. Assuming a spiral

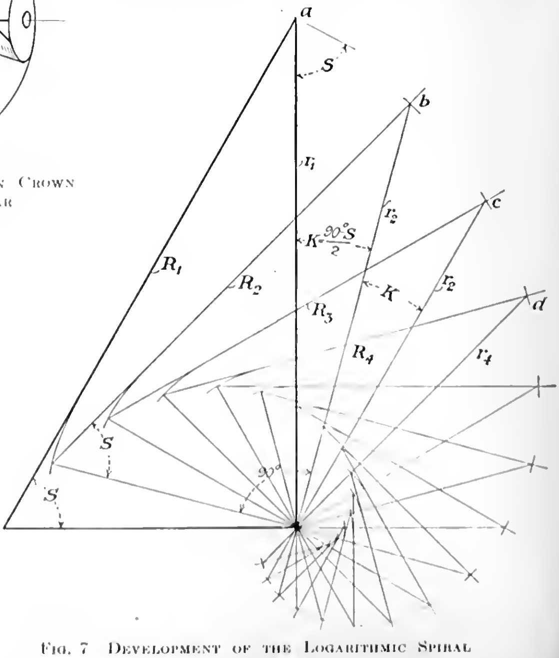


Fig. 7 Development of the Logarithmic Spiral

angle of 30 deg. and an angle k of 5 deg., the geometric ratio (P) for the spiral development by points, away from the pole, is found to be 1.163. Beginning with an initial radius vector, as r_{12}, of 1 in., the positive radii vectores increase in the following order:

r_{12} = 1.000 in. r_8 = 1.830 in. r_4 = 3.347 in.
r_{11} = 1.163 in. r_7 = 2.128 in. r_3 = 3.892 in.
r_{10} = 1.353 in. r_6 = 2.474 in. r_2 = 4.527 in.
r_9 = 1.574 in. r_5 = 2.878 in. r_1 = 5.265 in.

The geometric ratio for successive negative radii vectores toward the pole is 1/1.163 = 0.8598; thus r_2 = 0.8598 × r_1, or 0.8598 × 5.265 = 4.527; and r_3 = 0.8598 × r_2, or 0.8598 × 6.527 = 3.892, etc.

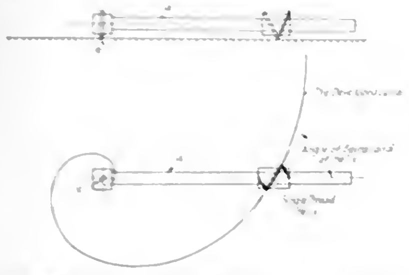


Fig. 8 Device for Describing a Logarithmic Spiral on a Crown Surface

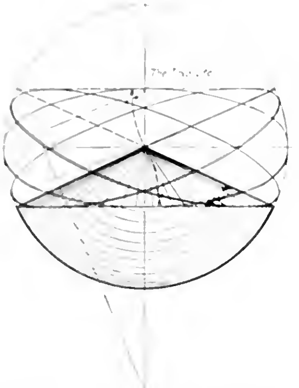


Fig. 11 Developing the Involute from the Base Surface of the Crown Gear by Means of a Disk

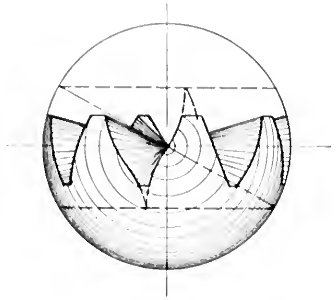


Fig. 14 The Involute Crown Gear (Grant)

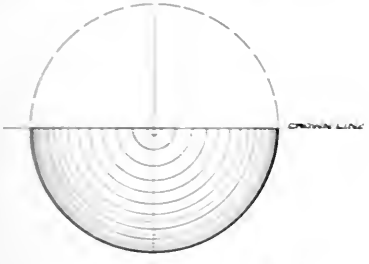


Fig. 9 Crown-Gear Pitch Surface

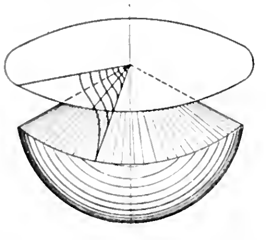


Fig. 12 Involute Described by Several Points on Disk of Fig. 11

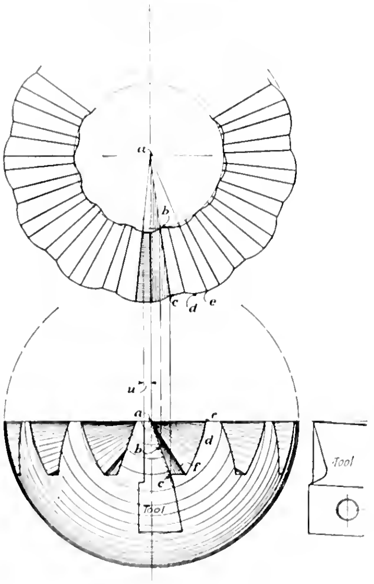


Fig. 15 Generator Tool Replacing One Side of the Molding Tooth

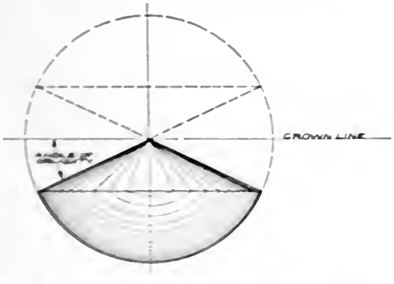


Fig. 10 Base Surface of the Involute Crown Gear

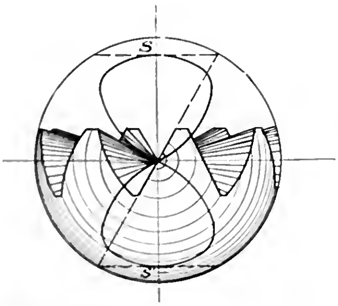


Fig. 13 The Octoid Crown Gear (Grant)

By making the angle $k = (90° - S)/2$, the spiral may be graphically developed by a series of points. Draw the first triangle to radius vector a as shown. Then draw potential radii vectores b, c, d, etc., at progressive angles k. Also draw base lines at right angles to these radii vectores. Now, with the pole as a center, strike an arc tangent to the hypotenuse R_1 of the first triangle, intersecting the base line of the radius vector b. From this intersection draw the second instantaneous radius (R_2) at an angle from the base line equaling the angle of spiral. This line will cut the potential radius vector r_2 at b, locating the second point on the spiral. Continue this development as far toward the pole as possible or as desired.

$$\text{Instantaneous radius of spiral } R \text{ (hyp. of triangle)} = \frac{r}{\sin S} \quad \ldots [3]$$

$$\text{Developed length of spiral} = \frac{r_1 - r_2}{\cos S}, \frac{r_1 - r_3}{\cos S}, \text{ etc.} \ldots\ldots [4]$$

that is, the developed length of the spiral is found by dividing the difference in the length of any two radii vectores by the cosine of the angle of spiral, which is the same as the length of a helical development across the face of a rack, the difference in the length of the radii vectores being the length of the rack face.

A logarithmic spiral may be described upon a crown surface by means of a fixture such as that shown in Fig. 8. A single helical thread raised upon a cylinder whose angle with the axis is the desired angle of spiral, will describe this spiral when rolled around with the center of the crown surface as a pole. Less than one complete turn of the helix is required. The spiral may be extended as desired by sliding the cylinder along its axis a and continuing the development. This helix may be developed on the cylinder by means of the action of an oblique line upon the pitch surface of a rack. This oblique line is the result of an extreme extension of the spiral. (See last paragraph under Line Formation.)

Infinity Radius

An infinity radius cannot be reached in practice, if it can be conceived at all. What is really meant by an infinity radius is a radius of such a length that no curvature can be detected within the length of the arc employed. This idea of an infinity radius will therefore vary with the means employed for describing the

length of the arc used and the skill of the draftsman. For a pair of 1 diametral pitch gears, the pinion radius being 6 in. and the ratio of reduction 25:1, we may ordinarily ignore the pitch radius of the gear in a graphical development of the tooth action and draw in the gear as a rack, as the pitch radius of the gear is 120 in. or 10 ft. Of course, a more careful or a more skilful draftsman might actually use a 10-ft. radius for developing the pitch circle of the gear within the action, but even the most careful or the most skilful man will finally reach a point where he will ignore the curvature and use a straight edge. Our measure of infinity is relative only, so that we may safely define rolling pitch surfaces within our conception as bounded by a sphere. This definition will be of material assistance in the study of the development of the teeth in the molding element, that is, in the crown gear, as it will show that the entire length of this crown tooth from its pole or apex to our conception of "infinity" has but one development.

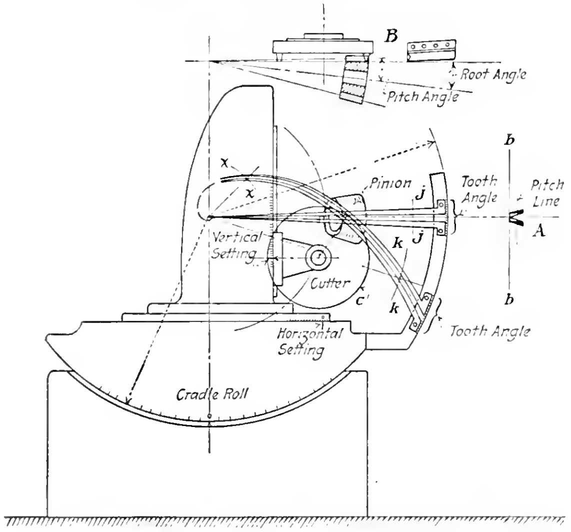


Fig. 16 The Gleason Cradle-Roll Generator as Applied to the Production of Straight-Tooth and Spiral Bevel Gears

The Crown Gear

Fig. 9 shows the pitch surface of the crown gear. The base surface is developed by a cutting line from the pole that is inclined from the crown line to the desired angle of obliquity as shown in Fig. 10. The involute profile is developed by means of a flat disk whose radius is that of the sphere. A series of points upon this disk will describe the involute the entire distance from the pole to the outer radius of the sphere (see Fig. 11). This development at the outer point of the disk, it should be noted, is upon the *surface* of the sphere, and it must be continued at all points. This disk is operated exactly as though rolled around between two base cones, the upper base surface or cone in Fig. 11 being indicated by dotted lines. Fig. 12 shows the involute described by several points upon the disk and illustrates the surface development of the crown-gear teeth.

Referring again to Fig. 11, let us assume that this drawing was produced by photographing a similar layout in which the spherical radius was, say, 10 ft. The total height of the involute, as measured on Fig. 11, is but a small portion of the same height on the original drawing. This height upon the original drawing would show, for all practical purposes, a perfectly flat profile; therefore, as far as this particular height of development is concerned, the radius of this sphere (10 ft.) is infinity. No matter what extreme spherical radius we may consider, an involute developed thereon will be that of Fig. 11 in case the scale of our conception is reduced accordingly. It is apparent that the accuracy of the involute tooth is limited only by our conception of infinity. Even then we are always brought back to Fig. 11 if the full involute development is considered. Fortunately this is never required.

The Octoid Crown-Gear Tooth

It is obviously impossible to generate a bevel gear with the involute form of tooth. (See Fig. 11.) The involute-generating tool would present a peculiar double-curved profile difficult to form, as will be apparent; also it would be necessary for this profile to change as the tool approached the apex; therefore the involute "molding" crown tooth cannot be duplicated in practice. The "octoid" tooth owes its existence to the fact that its crown-gear tooth is the only practical generating or molding tool: the profile being flat, no change takes place or is required as it approaches the apex during its cutting action. We have taken our conception of an infinite radius development of the involute and have arbitrarily applied this conception to measurable radii, as ordinarily employed in bevel-gear practice. This means that the larger the bevel gears engaging at a given angle or the smaller the angle of axes for given diameters, the nearer the action of the teeth approaches that of the involute. Also it is apparent that as we approach the small ends of the teeth, a further departure from the involute is made in any one pair of gears. Thus we may say that the nature of the action of the teeth in any pair of bevel gears is constantly changed at each point along the face length. Figs. 13 and 14, from Grant's Treatise, show the involute and the octoid crown gear. It will be noted that the flat "octoid" crown-gear tooth results in an "hour-glass" or "figure-eight" line of action, from which this form of tooth derives its name.

Generating the Teeth

In practice the teeth of the molding crown gear are replaced by cutting tools, which are of course necessary for non-plastic materials. Fig. 15 shows the planing tool which replaces one side of a tooth in the conventional crown gear. The length of face that may be cut is limited by the width of the point of this tool, or by *u*. Point *a* on this planing tool must be so located that its cutting plane represents both the side of a crown-gear tooth and the line of the bottom of the tooth space. To generate the opposite tooth space, a similar tool must be placed to represent the opposite side of the same crown-gear tooth. The point of this second tool must be located at *e*, its cutting edge representing the side *d* and the bottom or root line *f* of the crown-gear tooth. Both point *a* and point *e* must travel toward the apex *a′*.

Fig. 16 shows an outline of the Gleason cradle-roll generator as applied to the production of both straight-tooth and spiral bevel gears. The "molding teeth" for both types are here represented by tapered triangular wedges as shown at *A*, the angles of the sides of these wedges being formed to the angle of obliquity. The apex of these "wedges" is the apex or pole of the crown gear. Each pair of wedges are adjustable for tooth size by means of "tooth angle" settings, and their tops lie in a plane parallel with the cradle roll or on the crown line. In action the cradle rolls around the apex of the "crown gear" and the pinion or gear in operation rotates upon its axis, the action between the two being that of the pitch surface of a bevel pinion with the pitch surface of a crown gear as illustrated by Fig. 2. It will be noted that, as in Fig. 15, the tops instead of the pitch line of the crown-gear teeth are upon the crown surface and intersect the pole parallel with the cradle roll. This modification does not in practice seem to affect the accuracy of the gears, although the tops of the teeth in the molding gear (points of tools) should intersect the pole at an angle with the crown surface equal to the dedendum angle of the gear in process. The Bilgram generator does not contain this error, however. Any acting section of these molding teeth is taken with the pole as a center, as sections *j-j* and *k-k*. Proportional thickness is as the radial distance, as *x-x* to *k-k*, etc.

In practice the *straight* molding wedges are replaced by planing tools as shown at *B*, Fig. 16, and an approximation of the spiral wedge is secured by mounting a circular cutter, as *c*, so that its radius approximates the instantaneous radius of the spiral at the average apex distance of the gear in operation, as is shown. This cutter is rolled around the apex of the generator exactly as the spiral wedge and may be made, by various vertical adjustments, to represent a tooth in the molding crown gear; this, however, cannot be a true spiral but is an approximation thereto by means of a circular arc of a fixed radius. As shown in Fig. 16, vertical and horizontal settings are employed to locate properly the cutter

at its best average position, and these settings are also employed to allow the circular cutter to represent each side of a crown-gear tooth. Since the tops of the teeth in this cutter are set to the crown line, the axis of the gear in operation is set to its root instead of its pitch angle. The ratio of roll, however, is based upon pitch-surface contact. This pitch-surface contact does not actually occur unless we consider the pitch angle of the crown gears as being less than 90 deg. (see Fig. 17). The practical error, however, is slight.

Fig. 17 shows the engagement of two crown gears as embodied in the action of the machine in question. For spiral bevel gears a pair of such crown gears are necessary, as a right-hand spiral crown gear is required to mold a left-hand spiral pinion and a left-hand crown gear to mold a right-hand spiral gear. A study of the entire matter is therefore reduced to a study of these two crown gears. If they will not properly engage, we cannot expect a satisfactory product. The generator is the crown gear; that is, the action of the generating tools must be studied as if they were the teeth of the crown gear which, in theory, "molds" the teeth in the production gears.

Contact Lines

The important point to bear in mind when designing or when generating any "twisted tooth" gear, either spiral bevel or helical spur, is that their action and formation is exactly that of straight-tooth bevel or spur gears at any instantaneous section. The essential difference between twisted and straight-tooth gears is that in the former the instantaneous line of action across the face of the tooth is diagonal—at an angle with the pitch surface approximating the angle of the spiral or helix, while in the latter the action is along radial lines for bevel gears and along parallel lines for spur gears. Thus with straight-tooth gears the contact occurs instantaneously across the entire length of face, while for twisted-tooth gears it is distributed over different points of the line of action and across to adjoining teeth.

In case the axial distance between any two adjoining teeth (axial pitch) is less than the face width, we have, theoretically, a "pitch-point lock;" there being continuous contact at the "pitch point" or at the intersection of the line of action with line of centers, which is also the common point of tangency of the two pitch circles. This pitch-point lock should assure uniform velocities, but this is defeated mainly through errors in spacing. A pitch-point lock, as specified, is not essential to the quiet operation of any pair of gears: there is no sharp dividing line between successful and unsuccessful gears upon this basis. Any angle of spiral or of helix will help, and this assistance increases with the angle through a fairly uniform field. In turbo-reduction gears the axial pitch is often as low as one-twentieth of the face width, and the number of teeth in instantaneous contact across the pitch point is very often in excess of the number of teeth in the pinion. For such a condition we may say that an actual pitch-point lock is "approached," at least, but it is never attained in practice.

The total length of contact in twisted-tooth gears is exactly the same as for straight-tooth gears when based upon the number of teeth in contact upon the acting (virtual) section and the length of face: the number of contacts points times the length of bearing at each point is always equal to the number of teeth in contact upon the acting section times the length of the face.

Conventional Practice

In practice we often lose sight of the spherical nature of bevel gears. Fig. 18 shows the conventional development of the bevel gear by dotted lines. The back angles are machined flat and the back face or seat must of course be flat, but the spherical principle may be adhered to by adding any desired amounts, as b or b_1, to the "back cone distances" a and a_1, obtaining distances c and c_1 and employing these dimensions as a basis for all cutting and inspection operations. Both the generator and the testing machine must be set up in strict accordance with these dimensions. See Figs. 19 and 20.

It is apparent from a study of Fig. 18, also by reference to Figs. 3 and 4, that when bevel gears are designed to operate at any particular shaft angle (usually 90 deg.), operating clearance (backlash) must be cut in the teeth. In case the teeth are cut full size—that is, if the combined circular thickness of gear and pinion teeth is made equal to the circular pitch—the angle of axes must be increased in order to secure operating clearance, which is absolutely essential to the successful operation. It will be noted that operating clearance is an angular measurement; therefore, when gears are designed to operate at a shaft angle of 90 deg., the amount of backlash secured may be measured by operating these same gears without backlash and noting the angle of engagement, which must then be less than 90 degs. (see Figs. 21 and 22). Fig. 21 shows the gears held as they are to operate, with operating clearance between the teeth. Fig. 22 shows the effect of eliminating this clearance by dropping the pinion into snug engagement with the gear. In this figure the pinion has been dropped around the apex or shaft intersection, which is the center of the sphere. It will be noted that the back face of the pinion now leans away from the gear at an angle which is the same as the change in angle of axes. An oversize pinion would lean in, increasing the angle of axes. This angle might be termed "pinion inclination." A pair of pointers (Fig. 23) will show that for straight-tooth bevels the radial lines of the teeth intersect the crown line at some one point, and a measurement by pinion inclination will at once show whether or not this point of intersection is the apex or pole of the crown gear.

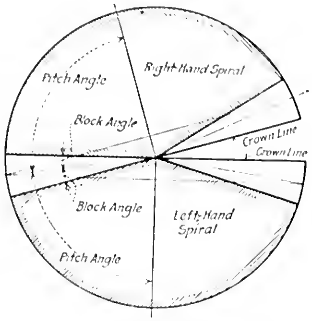


Fig. 17 Engagement of the Molding Crown Gears

When a pair of spur gears are moved into engagement, the tops of the teeth are first brought parallel with each other, and as the centers are farther reduced the engagement will occur at the extreme face of the tooth profiles and across their entire length. The backlash is gradually reduced as the gears are moved toward each other, with a continued deepening of their engagement until the desired amount of backlash is secured. This is their correct operating position and if the resulting distance between centers is not as required, the thickness and perhaps the depth of the teeth must be corrected accordingly. To parallel this procedure in the assembly of bevel gears, they must be rolled around each other with the intersection of their axes (center of sphere) as a center. Thus, to bring the faces parallel as the gears enter contact, the angle of axes must be increased an amount equaling the sum of their addenda angles, as shown in Fig. 24. Fig. 25 illustrates the result of an attempt at axial adjustment which is ordinarily thought to amount to the same thing as a parallel movement for spur gears. The axial position of bevel gears must be assumed as fixed: we are given no leeway in this respect except, of course, to determine the possibilities of assembly range when the gears are mounted in service.

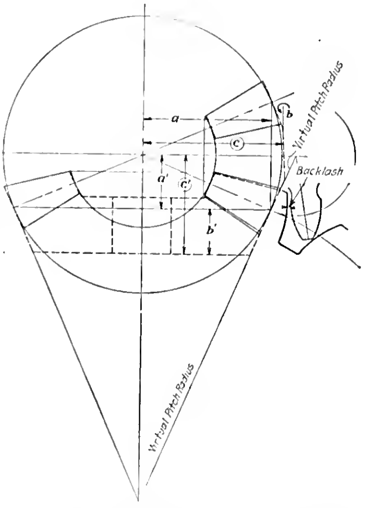


Fig. 18 Theoretical Construction of Bevel Gear, with Conventional Layout Shown in Dotted Lines

Effect of the Spherical Radius upon the Design and Assembly of Gears

Referring again to Fig. 1, it will be noted that as the radius of the sphere enclosing the pitch surfaces is increased, the change in the pitch across the length of the gear face is reduced; that is, the change in the pitch within the face length is more rapid with the smaller radii. When the radius of the sphere is infinite, there is no change in the pitch engagement; that is, the pitch is the same across the entire length of face. It follows that when a large sphere encloses the pitch surfaces, the change in the pitch relation is correspondingly slight. Thus, spur gears can be assembled as desired; any "error" in their axial location cannot affect their operating quality; also the pitch diameters and the obliquity of action adjust themselves to whatever center distance may be employed.

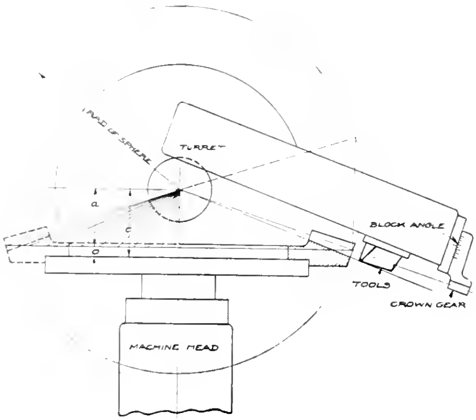


Fig. 19 Back Cone Distance on Gear-Tooth Generator

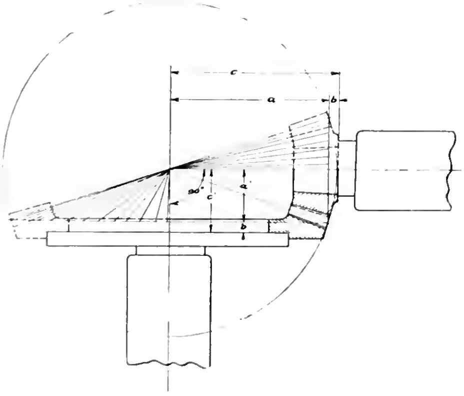


Fig. 20 Fixed Position of Testing-Machine Heads

Changes in the center distance of spur gears correspond to an angular change in the axes of bevel gears, so that an angular error in the shafts upon which bevel gears are mounted simply changes the amount of operating clearance, and aside from this cannot be called an error. Bevel gears are therefore essentially different from spur gears in that a correct axial location must be secured for the former, while it is of no importance in the assembly of the latter type. Spur gears need only be correctly cut and assembled on parallel shafts. Bevel gears must be so designed and cut that a *range* of axial adjustment (which does not affect spur gears) is allowable in their assembly. In fact, this allowable range of adjustment is taken as a measure of operating quality. It is impossible always to assemble bevel gears with their pitch cones intersecting exactly, or to maintain such an exact condition in service; therefore in the design of the teeth we must provide for the engagement of unequal pitches. A pair of bevel gears which will operate as desired in but one exact position, as specified, have little or no commercial value, while an equally accurate pair of spur gears would fulfill all requirements.

Tooth Design

Gear and pinion addenda, also proportional tooth thickness, as recommended by the Bilgram Machine Works represent excellent practice for 14½-deg. or 15-deg. straight-tooth bevel gears. We might well apply the same principle to 20-deg. gears or, for that matter, to those of any obliquity desired. For 20-deg. gears, however, the addenda may be made equal for both gear and pinion with good results, the addendum in each case being 1/pitch. The design of spiral bevel-gear teeth is too unsettled at this writing for any recommendation to be made and cannot well be included within the scope of this paper. Attention, however, should be called to the connection between spiral bevel and helical spur gears. In addition to this we also have the herringbone-gear practice to draw upon for points in the design of the spiral bevel gear.

A proper determination of the number of teeth in the gear and pinion is of first importance. The basis for this is the pitch diameters, obliquity, and angle of spiral. The working depth is properly a function of the pitch so that suitable profiles may be obtained, and this working depth is properly proportioned between the gear and pinion addenda on a basis of the ratio of reduction and the angle of obliquity. The difference between the gear and pinion addenda is the greatest for the lowest obliquity used (say, at 14½ deg.), and as the obliquity is raised the difference between the gear and pinion addenda is less pronounced. Thus the employment of equal addenda for 14½ deg. is prohibitive for the ratios, while for an obliquity of 22½ deg. it is good practice and may ordinarily be recommended for an obliquity of 20 deg. in case the pinion tooth is not too weak.

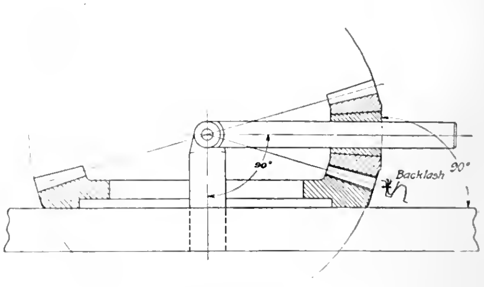


Fig. 21 Operating Position of Bevel Gears with Backlash between Teeth

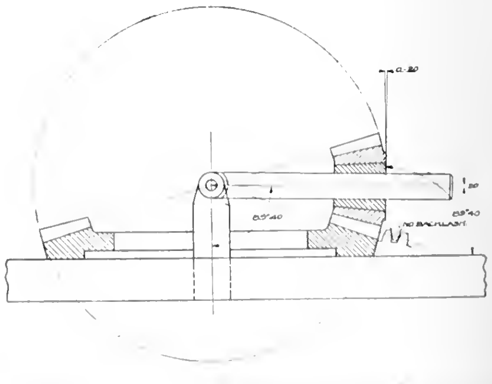


Fig. 22 Pinion Inclination to Eliminate Backlash Shown in Fig. 21

The usual bevel-gear reduction for automobile drives is around

5.1, varying from 3:1 to 6:1. In spur gears this would correspond to ratios between 9:1 and 36:1, the usual ratio being 25:1. For such ratios the angle of approach may be made equal to the angle of obliquity; that is, the slide at the beginning of the arc of approach may be 100 per cent without excessive wear. For obliquities of 22½ deg. or less, no sign of excessive wear has been found upon the approach with an angle of approach which equaled the obliquity; that is, with bevel-gear ratios in excess of 3½:1. On the other hand, it is recommended that the angle of recess be limited to 22½ deg. for all obliquities. Practically the same percentage of roll is found for each ratio, independent of the angle of obliquity, so that it is possible to reduce the number of teeth as the angle of obliquity is increased with no change in the relation of slide to rolling action. It might be suggested here that the allowable percentage of sliding contact on approach and on the recess be proportioned on a basis of the ratio of reduction, as it is apparent that no fixed rate can properly cover all ratios, or that the amount allowed on approaching action must be restricted to that which properly limits the amount of slide on the recess, at least for the usual automobile bevel-gear reduction.

It is thought that the mean percentage of sliding contact is a poor gage by which to measure wearing quality. The point to be watched is the maximum instantaneous percentage of slide. It has been noted that an angle of recess just a little to great has caused failure; also, when the maximum instantaneous points are within proper limits, that little or no improvement in wearing quality is found by a further reduction. With the maximum instantaneous points of contact within proper limits, it is thought that comparative wearing quality is properly gaged by the sine of the angle of obliquity, taking the torque from the base radius and as the sine of twice the angle of obliquity for given pitch diameters: the sine times the cosine being the sine of twice the angle, divided by 2. Thus, 14½-deg. gears may be compared with 20-deg. gears as the sine of 29 deg. to the sine of 40 deg.; that is, 0.6428/0.4848 = 1.33, or 33 per cent in favor of the 20-deg. gears, the pitch diameters being the same for each obliquity.

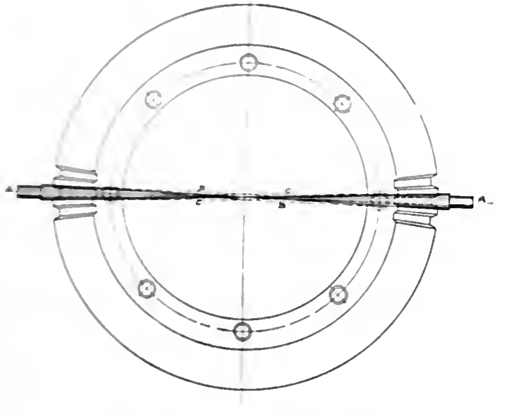


Fig. 23 Proper Use of Pointers

[*A*, Tools properly set toward apex. *B*, Tools improperly set (Drop both tools if bearing is crossed). *C*, Tools improperly set (Raise both tools if bearing is crossed).]

Mean Tooth Pressure

In designing the housings for bevel gears it is important that correct thrust loads be determined, especially when we are dealing with the spiral bevel gear. It is not the intention here to enter into these axial-thrust calculations, but simply to point out means by which the mean tooth pressure, as affecting the thrust loads, may be obtained. Ordinarily we are given a distance on the pitch surface of the bevel pinion one-third the face length from the large end of the tooth as the point from which this pressure may be calculated, but this is thought to be in error.

Suppose, for example, that the *average* pitch radius of the pinion is 1 in. and the pitch angle is such that the pitch radius at the small end of the pinion is 0.5 in. and at the large end is 1.5 in. The motor torque is, say, 4000 in-lb., therefore the pressure as figured at the small end of the tooth of the bevel pinion would be 8000 lb.; but the pressure at the large end of the tooth would be 2667 lb., not 2000 lb., as might be our first estimate. This pressure (2000 lb.) is attained at a pitch radius of 2 in. From this it is evident that the point of mean pressure must be located somewhat toward the small end rather than toward the large end of the tooth.

Pressure on the teeth varies, of course, inversely as the pitch radii, but the pitch radii do not change with the proportionate distance from the average along the pitch surface. Plotted values for pitch radii and proportional tooth pressure will develop a hyperbolic curve, not a straight line. We have:

$$M = \frac{c}{d - e} \log_e \frac{d}{e} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5]$$

in which M = mean tooth pressure
c = motor torque in inch-pounds
d = maximum pitch radius
e = minimum pitch radius
r = mean pitch radius.

To locate the mean pitch radius, we have:

$$r = \frac{c}{M} \quad \ldots\ldots \quad [6]$$

As an example, let c = 1000 lb., d = 1.5, and e = 0.5. Then d/e = 1.5/0.5 = 3.0, for which $\log_e$ = 1.0986. Whence—

$$M = \frac{1000}{1.5 - 0.5} \times 1.0986 = 1000 \times 1.0986 = 1098.6 \text{ lb.}$$

and—

$$r = \frac{c}{M} = \frac{1000}{1098.6} = 0.9102 \text{ in.}$$

The average radius is 1 in. Ordinarily it would appear sufficiently accurate to consider the *average* as the mean pitch radius and figure thrust loads accordingly.

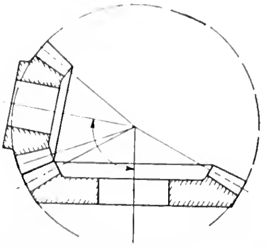


Fig. 24 Bringing the Faces Parallel as the Gears Enter Contact

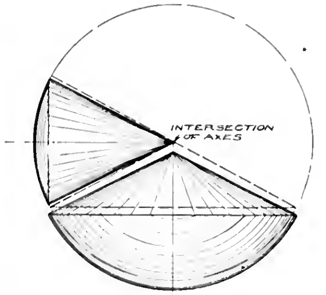


Fig. 25 Effect of Axial Adjustment of the Pitch Cones of a Pair of Bevel Gears

(Dotted lines illustrate automatic rearrangement of pitch cones in case gear is moved away from pinion along its axis in an attempt to increase the backlash; that is, to obtain operating clearance not allowed in cutting the teeth. The real apex point is the intersection of the gear and pinion axes. The figure shows the lines of action crossed due to the movement of the gear outside the sphere.)

A Discrepancy in Calculated Tooth Thickness

Allowing for the chordal thickness of a bevel-gear tooth upon the virtual pitch radius along which the back face of the teeth are machined, also allowing for the chord of the sphere enclosing the pitch surfaces proper, there is still a discrepancy between the calculated and the required thickness of the teeth. A pair of bevel gears will not assemble as in their fixed operating position (see Figs. 19 and 20) until the teeth are cut somewhat smaller than the figures given. Undoubtedly the calculations are in error: the profile of the teeth upon the sphere is evidently not properly understood, as the discrepancy varies with the radius of the sphere. For a radius of 3 in. (5 pitch) it is necessary to reduce the size of either gear or pinion approximately 0.015 in., while for a spherical radius of 5.5 in. the usual amount necessary is 0.010 in. This is offered as an interesting point which has up to the present time defied solution, although the explanation is probably simple enough, as are all fundamentals of gear design.

Suggestions as to Standardization of Machine Tools

By FRED H. COLVIN[1] and K. H. CONDIT,[2] NEW YORK, N. Y.

THERE are two outstanding phases of the problem of standardization of machine tools, one as it affects the builder and the other its effect on the user of the machines. The former can be left to the builders themselves, as it affects the cost of manufacture and the amount of capital invested. The latter, the effect of standardization on the user, is of direct interest to all.

One of the first considerations in making or advocating any change from existing practice is whether the benefits to be derived are worth the cost. This holds good with the proposals for standardization of machine tools, and this question of cost very frequently makes what we are pleased to call standardization really a matter of elimination. We usually eliminate unnecessary sizes and make those which we retain the standard, rather than adopt an entirely new standard which is the result of careful investigation, calculation, and experiment. And while this may not be the ideal procedure, it is the practical solution in most cases. Devising a new standard too often means simply adding another variety rather than eliminating many which are now in use.

The Advantage of Uniformity

Those who deprecate this unscientific method of standardization should remember that one of the greatest advantages of standardization, perhaps the greatest, lies in uniformity rather than in perfection as to the standard adopted. Taking the gear shift of an automobile as an example, the question of superiority in any particular shift sinks into insignificance in comparison with the advantages of having any one of the gear shifts adopted as standard on all cars. The typewriter keyboard is another excellent example of this.

Standardization of machine tools from the standpoint of the user can be confined to two specific points, work-holding and tool-holding devices. The former affect principally the spindle noses of lathes and the T-slots of planers, milling machines, boring machines, drilling machines, and the like. Tool-holding devices affect the spindle noses of milling machines and drilling machines, turret holes, tool posts, grinding-wheel spindles, etc. And while these look innocent enough on the surface, it does not take long to find that it involves the old controversy as to tapers, which is enough to start a heated argument in any shop.

Interchangeability and Accuracy

Every mechanic who has handled precision work knows that it is not practicable to interchange lathe chucks on very accurate work with the idea that the chuck will run dead true on more than one machine. On the great majority of work, however, the ability to change chucks from one lathe to another, without the bother of making adapters (which usually add considerably to the overhang) would be of great service in many shops. In the same way fixtures should be interchangeable from one machine to another by the use of standard T-slots in the tables and probably a standard distance of the first slot from the edge of the table.

The inability to use given turret tools in more than one machine imposes an unnecessary expense on the shop overhead and also directly affects future sales of the machines in question. The builder whose machine has odd sizes of turret holes, for example, will have a hard time securing an order from a shop equipped with machines having a different size, even though one be as logical as the other. And while an order once secured might tend to force a continued use of this machine, it is apt to prevent an order at least as often as to secure one.

T-Slots

The standardization of T-slots is probably the easiest place to make a beginning, and here again it will undoubtedly result in the elimination of perhaps half the sizes, retaining only those which are necessary. A canvass of the total number of each size of T-slot cutters sold should make it easy to select the sizes most in use.

But even T-slots have several points to be considered: the width of slot opening, the width and depth of the T for the bolt head, and the depth of metal over the slot to resist pulling out a piece of the table. Uniformity as to this latter feature is, however, less important than the width, as that is what affects the use of tongs for locating milling fixtures and the like. The distance of the outside T-slots from the edge of table is also important.

It may be well to emphasize right here that no matter what is being standardized, it must be remembered that a definite tolerance must be given in each case. And in considering tolerances, let us bear in mind that the modern tendency is toward a unilateral tolerance—a plus tolerance on the slot or hole and a minus tolerance on the part which fits into it. Let us get away from the "plus *or* minus" tolerance on the same piece.

Standardizing T-slots also involves the standardizing of the T-bolts which are to be used in them. Carl Barth has given this careful attention and his recommendations have been taken up by H. Cadwallader, Jr., of Philadelphia, who now manufactures T-bolts to the Barth standards.

Another point to be considered in standardizing work and tool-holding devices is to have the same size on as many machines as may be practicable. It may often be convenient to use the same chuck on a 14-in. and a 24-in. lathe. This is probably too big a range to be adequately covered by the same spindle nose, but it is quite possible that the same size of nose might be used on two or three sizes of machines. Some builders already use the same feed box on different sizes of machines, which is a very sane and sensible practice.

There is considerable talk of standardizing machine capacities, such as the swing of a lathe. But while it would be more convenient all around to know just what was meant by a 14-in. lathe, this is really a problem of the salesman and the buyer. If the seller prefers to cut prices by selling a 17-in. lathe under the name of a 14-in. lathe, it hardly affects the user so long as the work-holding or tool-holding devices on the lathe are standardized.

The milling-machine builders have perhaps done more in this line than builders of any other machine tools. A No. 1 machine now has approximately the same capacity in nearly all makes. The use of numbers, however, has little to commend it, whether it be milling machines or wire gages, and it is believed that main dimensions as to capacity would be more satisfactory to users.

Standardization Does Not Hamper Progress

One of the stock objections to standardization is that it prevents progress and the development of new ideas and designs. If, however, we consider that the Society of Automotive Engineers has done more in the way of standardization than any one else and then note the development in the automobile industry, this objection is easily answered. Is it likely that automobiles or other machinery would be more highly developed if each builder used a special-sized nut with a special thread? Standardization of such parts as nuts, piston pins, and other parts simply means that the designer calculates his requirements, such as to the kind of loads and stresses, and selects the standard part which meets his needs instead of designing an entirely new nut or pin of a slightly different size. It must also be remembered that standards are not as fixed as the pyramids, but can be changed whenever occasion really demands.

While all our efforts at standardization at this time should be devoted to such details of machine tools as affect the user, such as work- and tool-holding devices as has been pointed out, it is quite probable that the machine-tool builders themselves may find further standardization desirable. Research may show that bearings of certain dimensions are best for given spindle loads and speeds. Designers would then determine the load to which the spindle of a new machine would be subjected, and after considering all the conditions, would select the proper bearing from a list of standards.

---

[1] Editor *American Machinist*. Mem. Am.Soc.M.E.

[2] Editor *American Machinist*. Assoc-Mem. Am.Soc.M.E.

Presented at the Springfield Regional Meeting of The American Society of Mechanical Engineers, Springfield, Mass., September 25–27, 1922.

This would simplify manufacture and greatly reduce the number of tools and gages to be carried in stock, as well as the stock of bearings themselves. This phase of the matter, however, does not concern the user of the machine, and he will do well to confine his efforts at securing standardization to such features as concern him directly.

The Problem of Securing the Adoption of Standards

In addition to the engineering and economic aspects of machine-tool standardization, there is the adoption phase—for all practical purposes this is a selling problem. The best engineers of the United States, or of the world for that matter, may gather in solemn conference and decide that certain standards shall be established, but they have no power to do anything more. If the manufacturer concludes that his present practice is sufficiently satisfactory and is not convinced of the need for innovation, there is little that the standardizers can do.

Very often the problem is essentially a "selling" problem and one for which the average engineer is temperamentally unsuited. Diplomacy, tact, persuasiveness—the stock in trade of the salesman—are needed at this stage of the game. Even they would be futile if no means were at hand for gathering together the men who must make sacrifices if a standard is to be adopted, for lacking such means the task of reaching each man individually and reconciling his views with those of all the others, would be herculean.

The machinery for handling the engineering and industrial problems connected with this phase of standardization already exists in the American Engineering Standards Committee, and the rules of procedure of this committee are designed to bring about the early adoption of approved American Standards. To this end all Sectional Committees are required to include in their personnel representatives of *all* organizations which are in any way interested in the manufacture or use of the standard under consideration. Since these organizations are officially represented on the committee which prepares the standard, it is obvious that the members of these organizations are committed to the adoption of the standard to the extent that any individual or firm is committed by the actions of an organization to which he or it belongs. Just how well this arrangement is going to work out when it comes to universal adoption of a standard it is too soon to say, but at least the plan shows promise.

It may be that the Division of Simplified Practice of the Department of Commerce recently organized by Secretary Hoover will have a part to play in securing the general adoption of the standards for small tools and machine-tool elements which are to be developed by the Sectional Committee sponsored jointly by the National Machine Tool Builders' Association and The American Society of Mechanical Engineers. This, of course, will be determined as the work of the Committee progresses.

So far the Division has done its best work in fields of industry not closely connected with engineering. It is coöperating, however, to the fullest extent with the American Engineering Standards Committee in furthering the establishment and introduction of standards.

Standardization is a tremendous job and it may prove to be one beyond the capacity of any standards body yet organized. But it is a job that must be done and some means will have to be found. For the present, existing agencies should be given the fullest possible support by every one interested, manufacturer or user. Whatever is accomplished will benefit every one and is well worth any sacrifices that may have to be made.

Standardization of Small Tools

How the First Cost of Small Tools Can Be Greatly Lowered, without Sacrificing Their Efficiency, by the Adoption of Standards That Will Permit Their Manufacture on a Quantity Basis

By CARL J. OXFORD,[1] DETROIT, MICH.

Machine tools and small tools are so closely related to each other and interdependent that their respective developments logically should go hand in hand. In the past we have had instances of close coöperation between machine-tool builders and small-tool manufacturers. The results have invariably been noteworthy, and beneficial both to the coöperating firms, and to the tool-using industries in general.

Powerful and rapidly operating machine tools may be designed and built, but their success is largely nullified if they require cutting tools of prohibitive cost and of short life. Conversely, small tools may be developed which with the proper machine tools will produce wonderful results, but which again with unsuitable machines are complete failures.

We have been, and are still, passing through a period in our industrial development where reduction of expenses has become the watchword. Particularly is this true of those expenses which may be classified as production costs. Facing, as we now do, keenly competitive markets, it becomes necessary to cut the cost of production to the core, if the manufacturer is to show a balance on the right side of the ledger.

There seems to be but a scant likelihood that either raw-material or labor costs will recede to a lower level in the near future. In fact, we have recently seen slight increases in both. The lowering of production costs must therefore be accomplished through improvement in methods, and through increased productivity and efficiency of tools and equipment as compared with first costs.

It is the primary purpose of this paper to point out how greatly the first cost of small tools can be lowered, without sacrificing their efficiency, by the adoption of standards that will permit manufacturers of tools to produce on a quantity basis.

Classification of Small Tools

Twist drills, reamers, and milling cutters all are classed as small tools. In this paper only these three types will be considered. Usually the manufacturer classifies them as being either standard or special.

Standard tools are those sizes and designs which are regularly catalogued and carried in stock by the larger manufacturers, while special tools are those made up to the customers' specifications.

There exists at present a fair uniformity of general dimensions in the tools catalogued as standard by the various makers. This is a step in the right direction; but the belief is expressed here that this uniformity could be carried more into detail, and that the number of standard items listed could be cut almost in two without any serious handicap to the metal-working industries in general.

It is difficult to realize, by those not actively engaged in the small-tool business, what a wide variety of styles and sizes are catalogued as standard tools. An examination of several tool-manufacturers' catalogs shows the following average number of items:

Twist drills	3400 items
Reamers	2200 items
Milling cutters	4500 items

Roughly this makes a total of 10,000 items. Certainly this ought to be enough of a variety to take care of every conceivable requirement. That such is not the case, however, is illustrated by the fact that small-tool manufacturers are annually making thousands of items of tools not listed in their catalogs, and must continue to do so as long as their customers insist on having them.

Standard vs. Special Tools

It is conceded that there are numerous instances where special

---

[1] Chief Engineer, National Twist Drill & Tool Co. Assoc-Mem. Am.Soc.M.E.

Presented at the Springfield Regional Meeting of The American Society of Mechanical Engineers, Springfield, Mass., September 25–27, 1922.

tools are necessary; but the statement is made advisedly that in many shops from 40 to 60 per cent of the work now performed with special tools could be equally well performed with standard tools, *and at a much lower tool cost.* To accomplish this it would be necessary, however, to educate the designers of both the manufactured article itself, and of the various holding and locating fixtures, to the importance of adapting their designs to the most economical uses of tools.

Instances are numerous where no end of troubles are encountered in machining because the designers have paid more attention to the purely technical side of design than to the practicability of performing the various machine operations specified.

In the production of many manufactured articles the cost of perishable cutting tools, such as drills, reamers, and milling cutters, represents a large percentage of the total productive cost. As a consequence the question of efficient and long-lived tools has come in for considerable attention. The present tendency, however, seems to be toward the use of special tools where an increased production is desired, or where trouble is encountered.

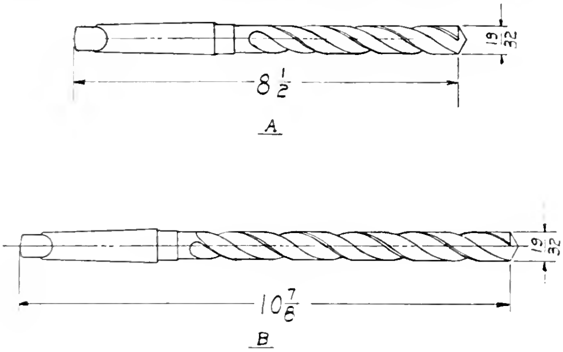


Fig. 1 Comparison of Standard-Length and Extra Long Taper-Shank Twist Drills

This is believed to be a fallacy in great many cases. For if a little time and effort is expended in adapting the conditions, such as surface speeds, chip thickness, and holding devices, it is often found that equally good or better results can be produced with standard tools than with special tools, although the latter must be obtained at a much higher price.

In addition to the higher price of special tools, it must be borne in mind that these are only made up in quantities as specified by the user. Hence the source of supply is restricted, and deliveries are subject to delays. Standard tools, on the other hand, can be purchased on the open market and can usually be delivered from the manufacturers' stock.

Relative Costs

Standard tools which are carried in stock by both manufacturers and dealers can naturally be made up in fairly large quantities. Usually from about five hundred to ten or twenty thousand of each size and kind can be put through the factory at one time. This means that many of the benefits accruing from quantity production are realized.

There is little time lost in setting up the machines, operators become more efficient on repetition operations, and in many instances it is possible to utilize multiple equipment and other time-saving devices.

The non-productive overhead incidental to every order is also spread over a great number of pieces, so that the amount chargeable against each piece is very small. All these conditions combined result in a low unit cost.

Compare this with the cost of producing special tools. These are as a rule ordered in small quantities ranging from one to ten or twenty pieces. Highly skilled all-around machine operators must be employed for this class of work. There is just as much time lost in setting up each of the various machines for one piece as for one thousand or ten thousand. There is no opportunity of using multiple equipment on such small numbers of pieces, nor do the machine operators acquire any increased efficiency from repetitions.

Non-productive overhead expenses are nearly as high for one or two pieces as for several thousand. The difference is that in one case these expenses must be absorbed by one or two pieces, while in the other case they can be distributed over a very great number. It is obvious how this will affect the respective unit costs, and eventually the price at which the tools must be sold.

Concrete examples of comparative costs will perhaps illustrate the point more forcibly. Let us compare the two twist drills *A* and *B*, Fig. 1. Both are $^{19}/_{32}$ in. in diameter and of identically the same design throughout except that drill *A* is of standard length or $8^1/_2$ in., while drill *B* is $2^3/_8$ in. longer, or $10^7/_8$ in. Five hundred of the drills *A* were made at one time, this being a standard size. The drills *B*, being special, could be made only in quantity as specified by the customer, in this case six.

The direct labor cost of *A* proved to be only 38 per cent of the corresponding cost of *B*. Adding the non-productive overhead, chargeable against the respective orders of which these drills were a part, the total cost of the standard drill *A* was found to be but 21 per cent of that of the special drill *B*.

Representing this in another way, we may say that the increase in length of *B* over *A* was 28 per cent, while the increase in cost was 480 per cent.

Similarly, we may compare the two milling cutters *C* and *D*, Fig. 2. The special cutter *C* is slightly smaller than the standard cutter *D*, yet, owing to the quantities manufactured in each case, the total cost of the cutter *C* was found to be 270 per cent higher than the corresponding cost of *D*.

These are but ordinary illustrations of conditions as encountered by every tool manufacturer.

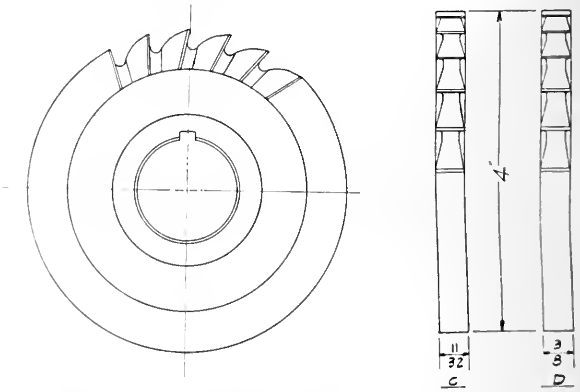


Fig. 2 Standard and Special-Size Milling Cutters

Necessarily the cost of producing must be reflected in the cost to the consumer. Pursuing this line of thought, it becomes evident that the high cost of special tools is eventually levied against the manufactured articles on which the tools are used, and in turn is passed on to the purchaser of these articles.

Let us suppose that a certain operation requires a special milling cutter costing \$30 and that the life of this cutter is 4800 pieces. If we are able to adapt this same operation to the use of a standard milling cutter of approximately the same dimension we shall have effected a considerable saving. This latter cutter can probably be bought for about \$18.

The tool cost for one operation is then reduced from \$6.25 to \$3.75 per thousand pieces. With a great number of machine operations on which such savings may be effected, it is easily conceivable that the results may mean the difference between a possible business loss and a tidy profit at the end of the year.

Elimination of Special Tools

It has already been stated that the total elimination of special tools is impracticable, for there will always be conditions now and then where a standard tool cannot be used; but there can be no doubt that the number of special tools used in the average manufacturing plant, with a little foresight, can be greatly reduced. Engi-

neers and designers responsible for the design of both the manufactured product and of the various jigs and fixtures, must be brought to realize the great economic advantage of standard tools over special tools. Especially is this true where production of large quantities of duplicate parts are involved.

A jig or fixture is a comparatively permanent thing, while cutting tools are in many cases very short-lived. Therefore a small additional expenditure, in order to adapt such jig or fixture to the use of standard tools, eventually becomes a highly profitable investment.

Numerous cases can be mentioned where such simple expedients as the shortening of a jig bushing or the slight reduction in height of some projection on a milling fixture will mean from 20 to 50 per cent reduction in tool costs for that particular operation, inasmuch as it will permit the use of standard tools.

From the author's own experience in the manufacturing of automotive parts there come to mind, too, several instances where the factory, in order to get out the required production, was compelled to ask the engineering department to alter its designs sufficiently so that practical and economical cutting tools could be used. It is a regrettable fact that many engineers, either through ignorance of, or through failure to attach sufficient importance to, small-tools requirements, are in this way wasting money that legitimately should be used either to reduce the cost of the goods or to pay a profit on the invested capital, as the case may be.

Technical schools and colleges would render a real service to the metal-working industries if they were to include in their machine shop curriculum at least a limited amount of instruction along these lines.

It may be properly argued that some of the tools now embodied in the tool manufacturer's standard list do not represent the highest degree of efficiency, and that there are certain other tools, now regarded as special, which will give better results. This is a sound and logical development of the small-tool industry, a development which should be encouraged through the elimination from the standard tool list of obsolete styles and designs, and the substitution of tools, developed through experience and research, that have proved more efficient under all conditions.

We have, for instance, the matter of numbers of teeth in milling cutters and numbers of flutes in reamers. The majority of manufacturers maintain a fair uniformity in this respect, based more or less on practical experience. However, materials and machine-tool equipment are being developed which in many cases demand numbers of teeth or flutes varying from the old established standard. As a consequence many users of tools are specifying numbers of teeth according to their own pet ideas. Obviously this at once classifies the tools as special, because it is impossible for the manufacturer to anticipate consumers' whims.

It seems reasonable to assume, though, that there is one number of teeth or flutes which in general will work most satisfactory. It is in cases such as these that standardization becomes important from an economic point of view.

If standards can be established, and these adhered to, the consumers will derive great benefits through the elimination of expensive special tools and the substitution of more moderately priced standard tools.

For the general good of the metal-working industries as a whole, a program of standardization should be carried out. Attempts should be discouraged to capitalize by attributing fancied advantages to minor construction details and charging special-tools prices for those which legitimately are standard. Standardization will undoubtedly go far toward the total elimination of such practices.

Reduction in the Number of Standard Tools

It is also believed that a material reduction in the number of tools now regarded as standard can be effected without hardship to any one.

A majority of the tools used in the metal-working industries today are made from high-speed steel. They are consequently expensive, due to the high cost of the raw material. When it is remembered that a small-tool manufacturer must carry in stock some 5,000 to 10,000 items of these tools, each in sufficient quantities to care for the possible requirements of the trade, it is easily seen that this imposes on him a large overhead, merely as interest on the investment involved. Therefore, the elimination of a number of items will mean a corresponding decrease in the price of those remaining. Some suggestions are given here, which if followed will accomplish much in this direction. It is at least hoped that these suggestions may serve as a basis for future action. The actual carrying out of the changes proposed must of course be left to the tool manufacturers, but they can do so only after the consumers have been educated to the great economy made possible.

Let us first consider the ordinary straight-shank twist drill with which every one is familiar. In the sizes up to and including 1/2 in. diameter we find from Tables 1 to 4, inclusive, 166 standard sizes listed, as follows:

Straight-shank wire drills	80
Straight-shank letter-size drills	26
Straight-shank drills—jobbers' lengths	31
Straight-shank drills—taper-shank lengths	29
Total	166

TABLE 1 STRAIGHT-SHANK WIRE DRILLS

No. by Gage	Decimal Diameter	No. by Gage	Decimal Diameter	No. by Gage	Decimal Diameter	No. by Gage	Decimal Diameter	No. by Gage	Decimal Diameter
80	0.0135	64	0.0360	48	0.0760	32	0.1160	16	0.1770
79	0.0145	63	0.0370	47	0.0785	31	0.1200	15	0.1800
78	0.0160	62	0.0380	46	0.0810	30	0.1285	14	0.1820
77	0.0180	61	0.0390	45	0.0820	29	0.1360	13	0.1850
76	0.0200	60	0.0400	44	0.0860	28	0.1405	12	0.1890
75	0.0210	59	0.0410	43	0.0890	27	0.1440	11	0.1910
74	0.0225	58	0.0420	42	0.0935	26	0.1470	10	0.1935
73	0.0240	57	0.0430	41	0.0960	25	0.1495	9	0.1960
72	0.0250	56	0.0465	40	0.0980	24	0.1520	8	0.1990
71	0.0260	55	0.0520	39	0.0995	23	0.1540	7	0.2010
70	0.0280	54	0.0550	38	0.1015	22	0.1570	6	0.2040
69	0.0292	53	0.0595	37	0.1040	21	0.1590	5	0.2055
68	0.0310	52	0.0635	36	0.1065	20	0.1610	4	0.2090
67	0.0320	51	0.0670	35	0.1100	19	0.1660	3	0.2130
66	0.0330	50	0.0700	34	0.1110	18	0.1695	2	0.2210
65	0.0350	49	0.0730	33	0.1130	17	0.1730	1	0.2280

TABLE 2 STRAIGHT-SHANK LETTER-SIZE DRILLS

Size by Gage	Decimal Diameter	Size by Gage	Decimal Diameter	Size by Gage	Decimal Diameter
A	0.234	J	0.277	S	0.348
B	0.238	K	0.281	T	0.358
C	0.242	L	0.290	U	0.368
D	0.246	M	0.295	V	0.377
E	0.250	N	0.302	W	0.386
F	0.257	O	0.316	X	0.397
G	0.261	P	0.323	Y	0.404
H	0.266	Q	0.332	Z	0.413
I	0.272	R	0.339	..	...

TABLE 3 STRAIGHT-SHANK DRILLS, JOBBERS' LENGTHS

Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter
1/32	0.03125	5/32	0.15625	9/32	0.28125	13/32	0.40625
3/64	0.046875	11/64	0.171875	19/64	0.296875	27/64	0.421875
1/16	0.9625	3/16	0.1875	5/16	0.3125	7/16	0.4375
5/64	0.078125	13/64	0.203125	21/64	0.328125	29/64	0.453125
3/32	0.09375	7/32	0.21875	11/32	0.34375	15/32	0.46875
7/64	0.109375	15/64	0.234375	23/64	0.359375	31/64	0.484375
1/8	0.125	1/4	0.250	3/8	0.375	1/2	0.500
9/64	0.140625	17/64	0.265625	25/64	0.390625	..	......

TABLE 4 STRAIGHT-SHANK DRILLS, TAPER-SHANK LENGTHS

Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter
1/16	0.0625	3/16	0.1875	5/16	0.3125	7/16	0.4375
5/64	0.078125	13/64	0.203125	21/64	0.328125	29/64	0.453125
3/32	0.09375	7/32	0.21875	11/32	0.34375	15/32	0.46875
7/64	0.109375	15/64	0.234375	23/64	0.359375	31/64	0.484375
1/8	0.125	1/4	0.250	3/8	0.375	1/2	0.500
9/64	0.140625	17/64	0.265625	25/64	0.390625	...	......
5/32	0.15625	9/32	0.28125	13/32	0.40625	...	......
11/64	0.171875	19/64	0.296875	27/64	0.421875	...	......

TABLE 5 PROPOSED STANDARD FOR STRAIGHT-SHANK DRILLS

Symbol	Decimal Diameter	Symbol	Decimal Diameter	Symbol	Decimal Diameter	Symbol	Decimal Diameter	Symbol	Decimal Diameter	Symbol	Decimal Diameter
80	0.0135	1/32	0.0313	50	0.0700	31	0.1200	7/32	0.2187	25/64	0.3906
79	0.0145	66	0.0330	49	0.0730	1/8	0.1250	1	0.2280	13/32	0.4062
1/64	0.0156	65	0.0350	5/64	0.0781	29	0.1360	15/64	0.2344	27/64	0.4219
78	0.0160	63	0.0370	46	0.0810	9/64	0.1406	0	0.2120	7/16	0.4375
77	0.0180	61	0.0390	44	0.0860	25	0.1495	1/4	0.2500	29/64	0.4531
76	0.0200	59	0.0410	43	0.0890	5/32	0.1562	17/64	0.2656	15/32	0.4687
75	0.0210	57	0.0430	3/32	0.0937	19	0.1660	9/32	0.2812	31/64	0.4844
74	0.0225	3/64	0.0469	40	0.0980	11/64	0.1719	19/64	0.2968	1/2	0.5000
73	0.0240	55	0.0520	38	0.1015	15	0.1800	5/16	0.3125	...	....
72	0.0250	54	0.0550	36	0.1065	3/16	0.1875	21/64	0.3281	...	....
71	0.0260	53	0.0595	7/64	0.1093	9	0.1960	11/32	0.3437	...	....
70	0.0280	1/16	0.0625	33	0.1130	13/64	0.2031	23/64	0.3594	...	....
69	0.0292	51	0.0670	32	0.1160	4	0.2090	3/8	0.3750	...	....

(Continued on page 777)

Power, Paper, Tools and Textiles Featured at Springfield Regional Meeting

New England Engineers Extend Hearty Welcome—Strong Papers Presented—Dean Kimball Broadcasts Important Message—New A.S.M.E. Section Formed

THE ENGINEERS of New England gathered at the Hotel Kimball, Springfield, Mass., on September 25–27, for an absorbing program of technical sessions, excursions and social events. This was the first regional meeting of The American Society of Mechanical Engineers and it was held under the auspices of the Engineering Society of Western Massachusetts and with the coöperation of the Associated Technical Societies of Boston and the A.S.M.E. Local Sections of New England and Eastern New York.

The program for the first day of the meeting was made up of sessions on power in the morning and paper in the afternoon, which were followed by a visit to the Woronoco plant of the Strathmore Paper Company. Here dinner was served and an address delivered by B. A. Franklin, vice-president of the Strathmore Paper Company, on the subject of management. Those not interested in paper were given an opportunity to visit the plant of the Fisk Rubber Company at Chicopee Falls. Dinner was also served and a talk on Rubber and Tire Manufacture was given by William Jameson.

The two simultaneous sessions on tools and textiles held the second morning of the meeting were followed by a luncheon at which the members of the Council of The American Society of Mechanical Engineers were the guests of honor. Mr. Charles L. Newcomb, chairman of the Regional Meeting Committee, presided, and informal addresses on subjects of interest to local engineers were made by Dean Dexter S. Kimball, President A.S.M.E.; J. L. Harrington, President-elect A.S.M.E.; Dr. H. C. Emerson, President Engineering Society of Western Massachusetts; Fred J. Miller, Acting Secretary A.S.M.E., and R. E. Rindfusz, Secretary of the American Writing Paper Company.

Following the luncheon, two automobile parties started, one for the industrial plants of Holyoke and the second to visit the college campuses near Holyoke. Both parties joined at Mt. Tom in time to view the marvelous panorama before sunset. In the meantime, Dean Kimball had gone to the wireless broadcasting station at East Springfield and after the guests were seated at dinner on the mountain they were greeted by a radio message from him.

Dean Kimball's Wireless Message

"I am always rejoiced when I see engineers gathered together for purely social purposes, because then one of the most important functions of the Society is being discharged. We constantly hear the question asked, 'What do I get out of the Society?' That is a fair question and merits a thoughtful reply.

"Engineering societies are somewhat like universities. They offer opportunities in certain directions, and only those who take advantage of these opportunities receive any benefit therefrom. Not the least of these opportunities is the privilege of mingling with fellow-workers in one's chosen field, and with others in allied fields of endeavor. Such intercourse is highly valuable in that it affords an opportunity to evaluate one's own ability and weakness by comparison with others, and such intercourse cannot fail to be mutually helpful in stimulating mental and personal growth.

"An active interest in a great professional society is also very helpful in evaluating the relative importance of the several callings and professions, and in these days of differentiated effort and refined specilization, such clearness of vision becomes increasingly important. Within every such society there are groups that honestly feel that they are the most essential cog in the machinery, and in a larger way this is true of the great congress of trades and callings that constitute industry. Anything that helps in evaluating these many activities is indeed valuable.

"And lastly, in these troubled times when the nations of the earth are seeking new philosophies of life, it is incumbent upon all men to consider carefully what influence their particular calling has had upon this complex thing we call civilization, and what influence this calling may exert in unraveling the tangled problems in which we now find ourselves involved. This applies with peculiar force to the engineer, for this present civilization is largely the work of his mind and hand and the civilization of the future will be largely what he wills it to be.

"In the congresses of engineers only is it possible to gather a concrete idea of what is moving in the minds of those engineers who outline progress and set the pace. The engineer who absents himself from membership in such societies or who, while a member, absents himself from the councils and social gatherings of his fellow-craftsmen, divorces himself from his greatest opportunity for growth and from his greatest opportunity to serve humanity."

The after-dinner program was most happily conducted by H. H. Bowman, President of the Springfield National Bank who was introduced by Dr. H. C. Emerson. The speakers were Mr. Charles L. Newcomb, Chairman of the Springfield Regional Meeting Committee, J. L. Harrington, President-elect of the A.S.M.E., Fred J. Miller, Acting Secretary of the A.S.M.E., and George E. Williamson, President of the Technical Association of the Paper and Pulp Industry. Music was rendered by the Deane Singing Club of Holyoke.

During the evening the members of the A.S.M.E. in Western Massachusetts were advised that their petition for the formation of a Local Section had been granted. An organization meeting was held and the following members were elected to serve on the Executive Committee until the end of the Society year: Chairman Charles L. Newcomb, Holyoke; Vice-Chairman George E. Williamson, Springfield; A. L. Bausman, Springfield; F. O. Wells, Greenfield; A. H. Blaisdell, Pittsfield. Robert W. Mitchell, Secretary and Treasurer of the Engineering Society of Western Massachusetts will also act as secretary of this new Section.

Appreciative mention should be made of the committees who planned the events, who offered a whole-hearted welcome to the guests and who conducted the ceremonies in a most effective manner. The Executive Committee was composed of Chas. L. Newcomb, Chairman, Geo. E. Williamson, Vice-Chairman; Dr. H. C. Emerson, J. Playdon, Jr., Secretary, Wm. G. Starkweather, W. B. Lewis, H. W. Dunbar, M. C. Nelson, Prof. S. W. Dudley, Stillman Shaw, H. E. Harris, C. K. Decherd, C. M. Flagg, B. S. Lewis, S. S. Roby, R. O. Ackerman, and J. J. Crain. The chairmen of the other committees were: Program and Meetings, A. S. Hall; Entertainment, Dr. H. C. Emerson; Publicity, Dr. R. E. Rindfusz; Reception, C. C. Chesney; Finance, John C. Robinson: Registration, Arrangements, Information, A. L. Bausman; Transportation, A. L. Trudo, and Invitations, G. E. Williamson.

Session on Power

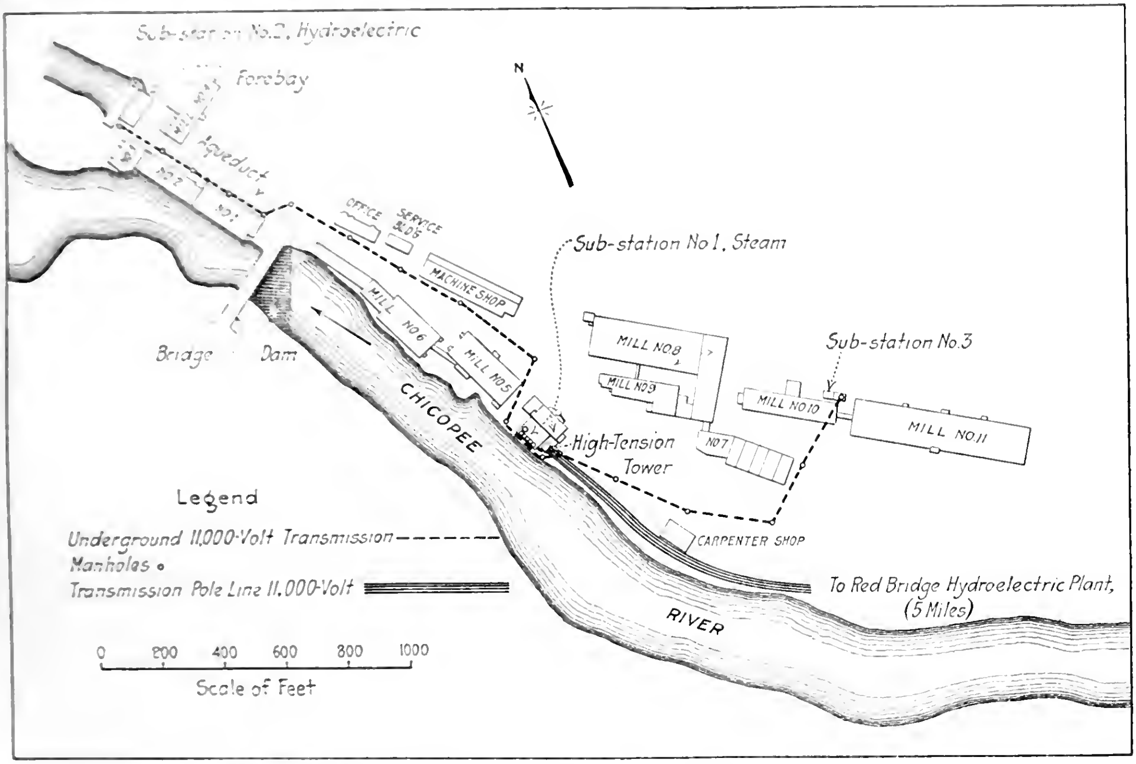
The opening event of the meeting was the Session on Power, which was called to order on Monday, September 25 at 10.00 a.m. in the Hotel Kimball. Mr. Charles L. Newcomb, Chairman of the Regional Meeting Committee greeted the guests, introduced the various officers and committee chairmen and then retired in favor of the presiding chairman for the session, Mr. C. C. Chesney, Manager and Chief Engineer of the Pittsfield Works of the General Electric Company.

The first speaker was Mr. R. A. Packard, Superintendent of Power and Shops of the Ludlow Manufacturing Association, whose paper was entitled Multiple Source of Power for Reliable Large Industrial Plant Operation. Mr. Packard emphasized the importance of continuity in industrial power-plant operation and in closing stressed the need for correct design of multiple source of power, proper installation, and efficient maintenance and operation. Mr. Packard's paper describes the power installation at Ludlow, designed especially for continuity of operation. It is given below, slightly abridged.

Multiple Source Power for the Ludlow Manufacturing Associates

In the generating, transmission and distribution of power for the Ludlow Manufacturing Associates in Ludlow, Mass., natural conditions have contributed largely to a satisfactory arrangement. The sustained flow of the Chicopee River at Red Bridge, 5 miles above the plant, affords a 50-ft. fall for several thousand kilowatts over a majority of the months of the year. Similarly, a modern hydro development at Ludlow in the mill yard delivers power under a 40-ft. head from the same water passed at Red Bridge. The steam power station, also located in the mill yard, acts as standby equipment, the building affording room for a central connecting point of the 11,000-volt transmission lines from the two hydroelectric plants. This latter building also serves as a substation for 550-volt distribution to the nearby mills. A substation in the mill yard hydro-plant also distributes 550-volt power service. From the steam power plant there is an underground 11,000-volt connection to the substation No. 3, where transformation to 550-volts supplies power to the largest group of mills. In this substation is a frequency-changer set, to reduce the Turners Falls Power Company's power from 60 to 40 cycles.

The Red Bridge plant has a water-storage reservoir of 185 acres, while the plant in Ludlow has but 62 acres. With these plants 5 miles apart, it is possible by manipulation of the water to keep the smaller lower reservoir from dropping too low under heavy power demand. The usual arrangement is to pull heavily on this plant when the mills start in the morning, to save water from wasting over the flashboards. At about 10 o'clock the water which passed Red Bridge at 7.30 commences to reinforce the reservoir at Ludlow. When the river flow runs low, the load at the Ludlow hydro-plant must necessarily be cut down until sufficient supply of water has reached it from Red Bridge. On such days, during the last two hours of the afternoon, the load on the former plant is increased to draw the water as low as possible so as to allow a single all-night service unit in operation at Red Bridge to fill up the restricted Ludlow reservoir.



Map Showing Multiple Sources of Power for Ludlow Manufacturing Associates

Of far more significance is the continuity of power service which this system upholds. An interruption of power in all the mills practically never happens. Whenever it does, it is more of a surge of frequency and voltage than anything else, due to a disturbance on some leg of the system. An accident at one plant may automatically dump its load to the remaining sources of power. Interruption of power service on a particular mill group never lasts more than two minutes, so flexible is the system for handling the situation. The correct design and proper control and overload protection have been installed along with correct designs for transmission and distribution. A dead short-circuit across one of the transmission lines, a breaking down of the insulation in the field coils of the 40-cycle end of the frequency-changer set, or lightning surge in the transmission line have given a minimum of trouble. Take, for example, the most severe test which any transmission system has been called upon to stand during the last few years—that of the hail and ice storm of Dec. 5, 1921. This storm carried both transmission lines down, due to high trees laden with ice which dropped across the wires. It was thought the "cut-back" along the line had been sufficient to include these particular trees, but the severity of the storm wrought havoc in a most uncanny manner. The three remaining sources of power at Ludlow were compelled to bear the burden of the load, allowing the mills to proceed with the usual program of production without much interference. The heating system in the mills was shut off and turned into the steam turbine. The temperature outside was not so cold that the heat given off from the process steam and electric power was not sufficient to maintain the rooms at a temperature reasonable under the unusual temporary conditions.

There are factories or mills which do not have the above described unique possibilities of feeder and station arrangement. In such properties, full significance should be given to the proper design and installation of a power system allowing ample transmission capacity for the expansion of the plant. It is much better to have provision for more than one main feeder, so that without disturbing cables already installed, additional capacity can be

placed in multiple with them. Care should be given to secure sufficient carrying capacity to allow uninterrupted service should a cable burn out. A proper installation should consist of well-made joints and firmly secured conduits or cables. One weak link in the system may affect the efficiency of the whole. Many large industrial plants have their own centrally located steam power stations. From the point of view of economy of distribution of steam and power, the proposition is good; the unique and clever designs of stations and the almost perfect development of machinery and apparatus have gone a long way toward securing reliability of operation, but it cannot quite equal a multiple source of power where failure of one automatically, or nearly automatically, calls on the other to support the load.

Some time ago, the Ludlow mills were served with an isolated boiler plant near the Ludlow hydroelectric plant, a left-over of the old-time, slow-speed Corliss Engine days. It had served its usefulness and was torn out. Concentration of steam generation can be most efficiently handled at the main steam plant. This illustrates conditions which have existed in other growing plants, the tendency in having too many sources of power both for steam and electricity, which when reduced in number and remodeled, have conduced to greater reliability and economy.

Once an ideal system of generation and transmission from a multiple source is in operation, its personnel of operation, inspection and maintenance is of great importance. A definite periodical examination of generating, transforming and distributing equipment is of prime importance. The cleaning and inspection of compensators will save heavy dividends. A large number of motors necessarily must be started and stopped by ordinary mill hands. No one should be allowed to handle such apparatus without first having been carefully instructed and without passing an examination satisfactory to the electrical maintenance foreman.

R. J. S. Pigott, works manager of the Crosby Steam Gauge and Valve Company, Boston, Mass., followed Mr. Packard with an address on Economies in the Use of Fuel. In his opening remarks, Mr. Pigott discussed the question of central-station power for the isolated plant and emphasized the difficulty of even stating fundamental principles that, without qualifications, would guide in the choice between the isolated plant and central-station service. He stressed the need for considering each problem on its individual merits and deciding on the basis of cheaper power costs. He also pointed out the necessity for the economical layout of piping systems, the use of stokers even in one-man plants, the operation of hammers by compressed air, the centralizing of air compressors and the intelligent installation and use of recording and indicating instruments if a proper economical operation is to be attained in the industrial plant.

The discussion at this session centered on the relative reliability and economy of the private plant as compared with the central station. This led to a consideration of the use of steam-metering devices, and R. E. Woolley, of the Schenectady Works, General Electric Company, told of the careful records that are kept by the 160 steam-flow meters in the shops of that company. The steam used in each shop is metered, totaled, and subtracted from the total steam produced. The remainder represents the losses, which are scrutinized carefully. Any variations in this figure lead to investigations and inspections.

Session on Paper

Mr. George E. Williamson, chief engineer of the Strathmore Paper Company, and president of the Technical Association of the Paper and Pulp Industry, presided at the session on Paper which was held Monday afternoon, September 25, in the Hotel Kimball. Two papers were presented—one on Applying Engineering Principles to the Selection of Paper, by Dr. R. E. Rindfusz, secretary of the American Writing Paper Company, and one on Steam Utilization in a Modern Newsprint Mill, by S. W. Slater and J. E. A. Warner, engineer and assistant engineer, respectively, of the St. Maurice Paper Co., Ltd., of Cape Madeleine, Quebec.

The paper on Steam Utilization in a Modern Newsprint Mill appeared in the September issue of Mechanical Engineering. An abstract of the paper by Dr. Rindfusz follows:

Applying Engineering Principles to the Selection of Paper

In the manufacturing and distributing of paper, as in any other class of industry, the applying of engineering principles or the using of scientific methods means simply the employment of the best available common-sense—collecting the pertinent facts and building a course of action from them, with an open mind that will allow modification when other or weightier facts may be brought to bear. A brief background of conditions in the paper industry is necessary for an understanding of the need of engineering practice in the selection of paper.

While it is beside the point to present a brief for or against the paper industry as compared with other industries, we of the paper business are forced to admit that in large measure, instead of directing our development in a far-sighted and common-sense manner, we have allowed it to drift. The paper industry has been cursed by a multiplicity of brands, both mill and private, though chiefly the latter. This grew up, perhaps, as a natural evolution. A certain brand of paper, for instance, would be found to have wide use. Some mill or paper jobber would desire to cut into this established business. To do this he would create a new brand closely resembling the other, but slightly lower in quality and price. The maker of the first brand might then fall into the temptation also to cheapen. By constant repetition of this process qualities were rendered unstable, and an immense number of confusing and meaningless brands put on the market. The competition became one of price, and the quality of paper applied to any given use tended gradually downward until it became almost the exception rather than the rule to find the right paper employed in any particular use.

The result of all this confusion in paper qualities and shortsightedness in sales policy has been the fostering of chaotic manufacturing conditions, complex distribution problems, and ineffective service to the needs of the consumer. It is evident, therefore, that engineering principles are needed for remedying this condition.

The chief users of paper have finally become awakened to the inefficient methods of manufacturing and distribution which they have been forced to support, and to the absurdities into which they have been led in their selection of papers. They have, very naturally, therefore, in many cases set up specific specifications based on paper testing. This is open to serious objection because paper-testing methods are not fully developed, and the translation of use requirements into terms of paper tests, and of the paper tests into terms of manufacturing skill, is indeed a difficult and roundabout procedure. The better procedure is for the manufacturer to make his papers each for a specific use, and after he has found a given paper thoroughly satisfactory for its particular use, then to establish his test specifications and employ them for the maintenance of quality. If a complete enough set of test specifications can be developed, they can then be transferred from the manufacturer to the purchaser, who can use them for judging the offerings of various makers.

To an engineer, it is at once obvious that the fixing of each different member of a line of products for a specific use can be possible only where a complete standardization has been brought about. In the paper industry seven phases of this standardization have been established. These are the standardization of:

1 Raw materials
2 Process
3 Product
4 Line (grade standardization)
5 Distribution
6 Price
7 Use.

It is only when the others have been brought about that the seventh phase, which we are now discussing, can become effectively applied.

The method employed in translating each individual requirement of a user into terms of the proper paper is really quite simple. We find that all of these requirements may be grouped under four main factors, namely:

1 Longevity, or the length of time for which the paper must resist deterioration
2 Treatment, or the amount of separating, of handling, fold-

ing, binding, or exposure to which the paper will be subjected

3 Impress, or the mechanical method of applying reading matter, illustrations, decorations, or rulings

4 Appearance, or the character or sense appeal of the paper itself.

The longevity of a sheet depends upon its chemical constituents. If it contains mechanical wood pulp, ground wood, such as we find in newsprint, its life will be only transient; if it is made of chemical wood pulp alone, or in preponderance, its life will be temporary; if of mixed cotton fiber and wood pulp in approximately equal proportions, it may be classed as semi-permanent; and if all, or very predominatingly cotton fiber, it is for all practical purposes permanent. The paper made from cotton rags upon which Gutenberg himself printed the Bible is, as is well known, still extant.

Of the four factors given above, the first three may be rated by physical and chemical tests. An analysis will give the key to the longevity of the sheet. The tensile strength, folding endurance, stiffness, bursting strength, etc., will give an indication of its resistance to severe treatment. Tests of its absorbency, surface, stiffness and opacity, as well as the actual application, will show its suitability for impress. Appearance alone is a sense appeal, and hence subject to personal opinion. Nevertheless, if a paper is to be classed as first grade in its appearance, its sense appeal must be so general as to be recognized by at least nine out of ten average and uninitiated observers. If it does not do this, it would in most cases be a waste of money to buy high-grade paper for the sake of its appearance since genuine paper experts are comparatively rare. The appeal of various finishes, such as the linen finish, or lawn finish, may usually be considered quite general within certain groups of users.

Management in the Paper Industry

Following the visit to the Woronoco plant to the Strathmore Paper Company, B. F. Franklin, vice-president of the company, delivered an address dealing with the general principles of management and their applications to the paper industry. Mr. Franklin stated that any adequate system of management to be successful must have ideals, aims, policies and realizations.

The most important ideal is that of service, as industry not only has the important reason for existence that it renders service to buyers, but also is a focusing device for increasing the service value of individuals engaged in industry. A second ideal is that underlying the desire to make people happy.

The speaker stated the four aims of management to be: profit for the perpetuation and expansion of the industry for service; the payment of fair wages; the manufacture of the best product for a particular use; and the marketing of this product with a fair profit.

The guiding policies of management must be, according to Mr. Franklin: proper selection and training of personnel; reward to employees in proportion to service rendered; maintenance of plant in up-to-minute condition of repair and improvement; and the constant knowledge of details of the business.

Some definite realizations must come from proper ideals, aims, and policies and the speaker treated them somewhat in detail. It must be realized, first, that success in industry is derived primarily from men and not from machinery. Furthermore, after a knowledge of the materials to be used in the industry, there must be a service of well-defined methods which he divided into administrative and technical. Administrative methods must be provided for costs, records of part performances, expense analysis and control, production planning, bonus payment, quality control, and for the human element which has not been properly treated to get the best results. In discussing technical methods, Mr. Franklin pointed out that the paper industry differed from all others in the intricacy of and variations in its processes. He spoke, however, very optimistically of the coöperation progress that had been made in the industry in standardization and development.

Session on Preservation of Wood Roofs

The textile men attending the meeting were very much interested in the paper by Wendell S. Brown, of F. P. Sheldon & Son, Providence, R. I., entitled The Preservation of Decaying Wood Roofs, which appears on page 709 of this issue of Mechanical Engineering. The paper has an important bearing on the roofs of buildings which house processes requiring moisture in the air. The discussion brought out under the chairmanship of Dr. H. C. Emerson, president of the Engineering Society of Western Massachusetts, will appear in the December issue of Mechanical Engineering.

Session on Standardization of Tools

Dr. E. C. Gilbert, works manager of the Chapman Valve Company, presided at the session held Tuesday morning, September 26, when two papers dealing with the standardization of tools were presented. The first paper, by Carl J. Oxford, chief engineer of the National Twist Drill and Tool Company, Detroit, Mich., dealt with the Standardization of Small Tools, and the second, by Fred H. Colvin and K. H. Condit, editors of the *American Machinist*, offered suggestions as to the Standardization of Machine Tools. These two papers appear in this issue of Mechanical Engineering.

On the subject of small tools, W. A. Viall, secretary of the Brown and Sharpe Mfg. Co., of Providence, R. I., in a written discussion agreed fully with Mr. Oxford in the statement that manufacturers' lists of small tools can be greatly reduced. Mr. Viall expressed surprise at the great demand for special tools which may vary but slightly from tools of standard dimensions, and he gave twenty-one items from a day's orders for cutters which varied by only small amounts in diameter, arbor size, and thickness from the stock article. His discussion closed with an especially strong plea for careful study by tool users of the lists of standard tools produced by tool manufacturers and the formulation of design, that will permit the use of standard small tools.

F. O. Wells, of Greenfield, Mass., emphasized the importance of small-tool standardization. He felt, however, that manufacturers and users must come together to determine real needs and to agree upon possible elimination in lists of manufactured small tools.

Arthur F. Murray, of the Westinghouse Electric and Manufacturing Co., Springfield, treated the subject from the standpoint of the user of small tools. He found that even with the large list of tools available for the manufacturer it was necessary for him to design special tools. Mr. Murray stated that designing engineers should be more familiar with methods for utilizing standard tools by reworking them for special use.

Elmer H. Neff, of the Brown and Sharpe Manufacturing Co., New York, stated as his opinion that the buyer must dictate as to the tools he requires. He disagreed with the idea that manufacturers could, without coöperation with the user, eliminate any of the list of tools to be supplied by a manufacturer of small tools.

Selby Haar, electrical and mechanical engineer, New York, agreed with the idea of treating special tools as modifications of standard tools.

Frank B. Gilbreth, consulting engineer, Montclair, N. J., spoke from the standpoint of one who has occasion to study the manner in which various manufacturers store their tools. Generally he found that there was a lack of a clear idea of the proper uses of the various tools, and that each user wanted something different. The standardization not only of small tools and machine tools but of every kind of a tool would produce tremendous savings in production costs.

In the discussion on Standardization of Machine Tools, Luther D. Burlingame, of the Brown and Sharpe Manufacturing Co., Providence, submitted a written discussion in which he endorsed heartily the manner in which Messrs. Colvin and Condit treated the principles of machine-tool standardization. He emphasized the principle that standardization is often a matter of elimination and also that it is useless to adopt theoretical standards which manufacturers and users will ignore. Where these two principles are followed, standardization does not hamper progress.

Mr. Burlingame recommended the adherence to the Morse and Brown and Sharpe tapers. In adopting standards for shafting keys he suggested that flat keys be eliminated for small sizes and square keys for large sizes. In the matter of screw threads Mr. Burlingame advocated the adoption of such threads as could be agreed upon by both Great Britain and America on a common standard based on the inch.

Governor Hartness Emphasizes Evils of Industrial Strife

Chief Executive of Vermont Discusses Problems of a Machine-made Civilization at Machine Tool Exhibition at New Haven, September 21-23—Messrs. Buckingham and Wikander Stress Standardization Principles—12,000 Appreciative Visitors See 135 Novel Machine Exhibits

BESIDES furnishing an array of interesting and novel exhibits of machine tools and machine-shop devices to over 12,000 visitors the New Haven Machine Tool Exhibition held September 21-23 in the Mason Laboratory provided a platform for a number of instructive addresses. Governor James Hartness, of Vermont, Past-President of the A.S.M.E., spoke very forcibly of the far-reaching influence of machine tools on present-day civilization and pointed out the need for constructive thought about future problems. The importance of standardization was stressed by Oscar R. Wikander, consulting engineer of New York, who told of the progress of German standardization and by Earl Buckingham, of the Pratt & Whitney Co., Hartford, Conn., who outlined fundamental standardization principles for precision production. Another interesting talk was given by Oswald W. Knauth, Secretary of the National Bureau of Economical Research, who presented some facts about individual incomes in the United States. Governor Hartness' remarks appear in full below as do liberal abstracts of the talks by Messrs. Knauth, Wikander and Buckingham. Other speakers were Henry B. Sargent, President of the New Haven Chamber of Commerce, who extended the greetings of the city to the exhibitors and visitors, Dean Charles Warren, Sheffield Scientific School, who spoke on Coöperation between Colleges and Industry and M. S. Liming, Manager of the Boston Chamber of Commerce who told of the Outlook for Industry in New England. In addition, William Calkins of Detroit described the design, manufacture and performance of twist drills and Gardner T. Swarts, Jr., of Providence, R. I., demonstrated an application of Graphic Control to Machine Tool Manufacture. A number of motion pictures were shown.

The 135 exhibits elicited so much favorable comment that the exhibition is being seriously considered as a permanent annual affair. The coöperation of the authorities of Sheffield Scientific School who permitted the use of Mason Laboratory and of the New Haven Chamber of Commerce who assisted whole heartedly in the arrangements should receive special mention. The success of the exhibition is due to the efforts of the Exhibition Committee and the Executive Committee of the New Haven Branch Connecticut Section of The American Society of Mechanical Engineers which assumed major responsibility. The names of the men who made up these committees are K. F. Lees, Chairman Executive Committee, H. R. Westcott, Chairman Exhibition Committee, A. C. Jewett, N. E. Horn, A. L. Breitenstein, G. A. Stetson, F. W. Shatts, S. W. Dudley, H. L. Seward, W. L. Bean, H. Gfroerer, Wm. Buxbaum.

INFLUENCE OF THE MACHINE TOOL IN AMERICA

By JAMES HARTNESS,[1] GOVERNOR OF VERMONT

THE machine tool has been a wonderful instrument in extending the efforts of man, in amplifying the product that he could turn out. The machine tool, as all know, is the father of machinery, and as such it is largely responsible for the serious condition that confronts us today.

One hundred years ago, or even fifty years ago, the world was a very different place from the world we have today. Then work was done more by hand, and nearly all families were more or less self-supporting in producing the things that they needed. Their own food they would grow, and make their own shoes, perhaps, and so on through the whole range of the necessities. Men worked hard to produce the bare necessities of life.

With the introduction and development of the machine tool and its product, machinery, man's efforts now produce in many instances a thousand times the value that was produced before he was aided by this machinery.

At the present time we are facing the result of the strikes in the coal mines and on the transportation systems, and we are learning, none too early, that our whole scheme of management of our industrial affairs, our financial affairs, and our business affairs, fails to keep pace with the development of the world as it has grown under the work of the machine tool and its products.

Our Government, which originally confined itself for the most part to maintaining peace within the state and uniting us against a foreign enemy, is now trying to handle matters of business, matters of engineering, matters of farming, matters of finance, with men elected to office by the popular ballot; and it is impossible to conceive of a quicker way to wreck a business or manufacturing concern, than to put it in the hands of men chosen in that manner.

Our constitution is undoubtedly the best in the world, and I would not propose the making of any material changes in it, but it is best for us to realize that something must be done to head off the danger that is threatened. At the time this Government was formed, when we declared our independence, there was not one-half of the danger to civilization that there is today. Then dangers were more easily seen. Today these forces are working within our own country.

We know well enough that one of the greatest misfortunes to our country is the interruption of work by strikes. These strikes are the result of conditions that should not exist. In some cases the men must strike to get a fair wage. On the other hand, men sometimes strike for more than a fair wage because they have been led to believe that they are entitled to more and that the larger portion is their just due; or possibly they have been told that the men managing the business have been handling it for their own personal good and have taken for themselves more than a just return, and that they—labor—have the same right to get out of it all they can, and by whatever means are necessary.

We know at the present time that the cities can be starved. We know that we can increase the death rate and increase suffering in them by shutting off transportation. We know that it is simply a matter of time when this will be done unless we who have built up this wonderful fabric, this wonderful machine, give some attention to regulating these matters.

We think we are a great people, and we point to the success we have achieved in various directions, yet our development has been along lines so narrow that we have failed to understand the bigger problems.

The doctors disagree as to what we should do. All who are doing essential work are necessary, but we can not agree at what is a fair adjustment of matters. We are going on using force, fighting, and in many ways interrupting the production of values before we get to the point of dividing them. This interruption of production reduces the amount that is to be divided. A strike makes it more difficult and more impractical for a manufacturer to pay higher wages. Yet we go on by this process of fighting, which is absolutely wrong.

We know what the conditions are under which working units produce the greatest value. The wonderful organizations such as are found in Connecticut and in the more highly developed industrial regions show clearly what is the best scheme to employ, yet we fail to put it in effect. Are we incompetent to arrive at some way of doing this? If we are, then our Government will not endure. If we are to be the strongest as a military nation in defending ourselves in war, to win out in the conquest of peace we must see to it that we so order our lives that men produce the

---

[1] Past-President, The American Society of Mechanical Engineers.

greatest value, and that the whole country functions as we know it should function.

We know it is wrong to force men to strike for a rate of pay that is their just due, and that it is equally wrong for them to strike for more than their share. If one department is being paid higher than another it enslaves the one getting the lower pay. We shall never settle this matter equitably, however, unless we arrange to accomplish it by some other means than fighting.

There is a way to do that. We have a representative form of government, and our representatives at Washington and at our state capitals react readily to public opinion. They are ready to give what the people demand. How can we get them then to see the light? We can do it by having the light seen by the people; every worker in every division must first learn that strikes and other interruptions to our production are harmful to the whole country, that there is less value to be divided when less is produced, and that whatever means are adopted to make an equitable division, there must not be an interruption of production. Every one will agree to that.

There is no hope of getting justice by depending on agricultural blocs, on various associations of the various interests, federations, and other groups. They simply fight to get the largest share possible. Then what shall we do? We must go back to the commission type of arbitration. It is true that this has been a failure in the past. Our laws would have gone wrong, however, if it had not been for our constitution and our arbitration will go wrong unless there is some scheme devised by which men sitting on such boards start not only as impartial members, but hold strictly to the letter of the economic law as it applies to our industrial life of today.

This is simply carrying out the principle of arbitration by boards functioning under a code that can be easily drawn by civilians when the deduce from our present practice a code of regulations that will define and limit the activities of those boards. Then we should have a board that would say whether the miner was getting more than his share, or the bootmaker, or this or the other worker. There would be taken into account the energy and initiative of invention as applied to business matters as well as machine design, and all those things that count for progress. There would be taken into account the spirit of the organization, the spirit of the management. There would be valued all those things that are valued today.

We must face this question, and so tonight while I might have talked about some other points, I wanted to bring out to my friends at Yale, my engineering friends, and the people of Connecticut, the fact that the machine tool that has built up this wonderful world of mechanism has also built up something truly menacing. We shall be strangled by interruption to our transportation, and unless we use our brains in adjusting this matter along lines far different from those followed at the present time, it will go very bad for civilization; it will go very bad for America, especially if Germany or some other country is found to be working truer to the laws of human industrial economics.

INCOME ANALYSIS IN UNITED STATES

By OSWALD W. KNAUTH,[1] NEW HAVEN, CONN.

A GROUP of men who served on the War Industries Board, and after the war came to the conclusion that what was needed in economics was more facts, proceeded to found an association called the National Association of Economic Research for the purpose of finding facts and giving all a basis from which to reason. This association has an extraordinarily unique group of directors. There are nineteen of them, varying from labor leaders to capitalists, and everything that goes out from the bureau must be scrutinized and passed on by them.

It was with the object in view of not only finding out what the income of the country was, but of finding it in such a way that no one could disregard it that this kind of association was formed, and the research made recently which resulted in our determining the variations in income during the last decade.

The question of the amount of income in the country is mainly important in determining whether or not the standard of living in the country can be raised. We have been having an insistent demand that the standard of living should be raised. Now, can it be increased? Will an increase in wages really increase the standard of living or will it simply raise prices? Is there enough being produced; for after all, we cannot use that which is not being produced. What share of the total production goes to so-called capital and management, what share to so-called labor? These are all questions on which we have had very little exact information.

We defined income as the money paid for the commodities and services of the country with the omission of things for which no price is commonly paid. That omission includes mostly housewives' labor, which probably should be included. But after all, any price one chooses to assign to the items omitted would be purely arbitrary, and we tried to stick to facts.

We found the income of the country was roughly $32,000,000,000 before the war, and that it rose with increase in prices to $54,000,000,000 in 1917, to $61,000,000,000 in 1918, to $66,000,000,000 in 1919, and to about $70,000,000,000 in 1920; and that this increase was entirely, or very largely, due to a rise in prices and not to an increase in the amount of commodities that were produced. This was shown when all these sums were made into uniform dollars. The expression "uniform dollar" means the value of a dollar on the basis of 1913. During 1916 to 1918 production increased greatly and in terms of 1913 dollars amounted to from $38,000,000,000 to $40,000,000,000. In other words it increased by about 20 per cent over the figure of $32,000,000,000 of prewar years. Since the war it has decreased about 10 per cent so that for 1920 and 1921 the figure should be about $37,000,000,000. In terms of per capita production this means $350 before the war, $400 during the war, and $360 to $370 in the years since the war. The Bureau as such does not interpret these figures. A number of people, however, have interpreted them and they have all come to the conclusion that they showed definitely that the economic problem in this country is not one of redistribution, is not one of taking away from those who have and giving to those who have not. Anything in that direction would be a mere pittance, and would do practically no good. Our real problem is one of increasing the goods that are produced if we are going to increase the amount of comfort that the people in this country are to have.

We went a step further than that and made a table showing the number of persons having incomes of the various sizes. We have 37,500,000 people in the country earning incomes. Of these 27,000,000 earn less than $1500 annually. If we call the middle class between those having incomes of between $2,000 and $10,000, there are about 5,000,000 in that class or about 15 per cent of the total. If we call the upper class those whose incomes range from $50,000 up, there are from 20,000 to 25,000 in that class. If we should confiscate the income of these 20,000 to 25,000 people we would be confiscating about 5 per cent of the national income. In other words we should be increasing the income of all others about 5 per cent which obviously would not make a very great difference.

The great bulk of our incomes—those of about two-thirds of the number of persons who receive them—are between $500 and $1500. There are several other interesting things. The normal distribution of income between capital and management on one hand and labor on the other is 30 per cent to capital and 70 per cent to labor. In 1918 this changed to 77 per cent to labor and 23 per cent to capital. In 1919 it was about the same. The 1920 figures are rather puzzling on account of the tremendous shifts in prices in that year, and we have not yet established the proper way to handle them.

The share of the national income actually paid in the form of wages is about 50 per cent of the total. That is not the whole share that goes to labor, however, for many people perform hand labor and receive some form of profits in place of wages while many people who do not perform hand labor receive wages.

Before the war, five per cent of our people received about thirty-three per cent of our national income. In 1919 that figure was reduced to twenty-four per cent and in 1920 it was still lower.

Undoubtedly the distribution of income is closely connected with the mysterious currents which we have learned to call business cycles. At the request of Mr. Hoover the Bureau of Economic Research has made some studies, but we have come to the conclusion that we are only at the beginning of real knowledge of the things effecting business movements.

---

[1] Secretary, National Bureau of Economic Research.

GERMAN INDUSTRY'S NEW EXPORT POLICY BASED ON STANDARDIZATION

By OSCAR R. WIKANDER,[1] NEW YORK, N. Y.

BEFORE the war the efforts of standardization in Germany were mostly confined to manufacturer's associations, and systematic efforts to obtain national standardization were the exception.

At that time the progress of standardization in Germany was greatly handicapped by the policy of German exporters to offer to sell a customer anything he wanted. Reports from our commercial agents in all exporting countries ten to fifteen years ago point out very strongly that the strength of German competition was due to this fact. If a man wanted to buy shovels with green blades and red handles, the Germans would furnish them that way, while the American firms would point out that the product of their company was so and so and the customer could either take it or leave it. Such a policy was obviously very harmful to any development of a standardization procedure, either national or international.

It took the war to arouse the German manufacturers to the enormous economic advantages to be gained by industrial standardization on a national scale, and it can therefore be said that standardization in Germany on the scale on which it is being carried out at the present time dates from the war.

Under the auspices of the Verein Deutscher Ingenieure, the Normenausschuss der Deutschen Industrie, which corresponds to the American Engineering Standards Committee, was formed and has since its organization established a great number of national standards. The Normenausschuss now represents the departments of the German Government and the principal industrial associations.

This well-organized and comprehensive activity on the part of the Normenausschuss is significant for two reasons. It will simplify and unify the industries of Germany and will thus prepare them to enter international trade again with all their prewar enthusiasm and all the advantages of mass production. The automatic machine tools of the United States and its other labor-saving devices will not alone suffice to meet this new form of competition. American industry must standardize.

When German industry has recovered from the effects of the war and again makes a systematic effort to regain its foreign commerce, the standards which it is now preparing will play a large part in this campaign. An effort will in all probability be made to induce the non-manufacturing countries to adopt their standards commercially thereby insuring among other things general interchangeability. Such adoption would give then an advantage over other exporting countries. British manufacturers with the assistance of the British Government and the British Engineering Standards Association are endeavoring to extend the use of British standards throughout the British Dominions and throughout other importing countries for the great advantages which it will give them in foreign commerce.

The financial and economic conditions of Germany will absolutely compel its industries to export a large part of their production for years to come. It is for this reason that they will endeavor to secure the adoption of their standards and products in foreign countries and will also give support to all efforts to secure the general adoption of international standards.

PRECISION, STANDARDIZATION AND PRODUCTION

By EARLE BUCKINGHAM,[2] HARTFORD, CONN.

IN ORDER to understand and solve economically problems of manufacturing, it is necessary to keep in mind certain basic principles. Most of them are self-evident, yet it helps to have them stated definitely.

The accuracy to which we can work depends upon the accuracy with which we can measure. The mere removal of material from the part under construction is seldom difficult. The critical point is knowing when to stop. In large degree, the accuracy to which we do work depends upon the accuracy with which we measure.

However, if we are to produce parts of a prescribed accuracy, we must choose a suitable method of machining them as well as have proper measuring equipment. In addition, the machine on which the parts are produced and the tools used to shape them must be sufficiently accurate. Although all these other conditions must be met, the fact remains that the accuracy to which we can work depends upon the accuracy to which we can measure, because to produce the accurate machines and tools we must be able to detect the nature and amount of the inaccuracies in order to correct them.

In order to get the maximum of accuracy, only a single surface or a single dimension can be controlled by any one tool or other single element of the machine. Take for example the cutting of a thread. If a die is used, the three main elements—the form, the lead, and the diameter—are controlled by one tool. Adjustment for diameter is possible, but the form and lead are fixed. Variations are introduced in the form and lead when the tool is hardened. When one die replaces another, the variations are different. When no great degree of accuracy is needed, the use of dies is satisfactory. If the requirements are severe, this method of cutting threads is out of the question; the thread can be cut on a thread-milling machine or chased in a lathe.

There has been a marked tendency in the past few years toward the design of machines that can finish a given piece in one or two operations. For a large number of mechanical parts, where a high order of accuracy is not demanded, this has proved a success, but for the production of parts with exacting requirements these machines are not always suitable because frequent adjustments of the various tools are necessary to meet the requirements. When the machine is running, the production is high; but when one tool is being adjusted, all other tools on the machine are idle.

At present the limitations of multiple-operation machines are better appreciated and more attention is given to the single-purpose, single-operation machine tools. When these machines are automatic, with magazine feed, the labor cost of producing parts on such equipment is no greater than on multiple-operation machines, the tools are much simpler and cheaper, the production is as large, and the possible accuracy is much greater.

It is possible to build a machine to perform any repetitive operation. Furthermore, such work can always be done mechanically with greater accuracy than by hand. However, it is not always simpler to do it mechanically. But if large quantities are required, sooner or later mechanical methods are devised to produce them. Take for example the lapping of flat surfaces. Ordinarily this is done by hand, and a great deal of time, skill, and patience is required to obtain a flat surface. The mechanical lapping of such surfaces is a relatively simple matter. Furthermore these mechanically lapped surfaces can be made flat to within two or three millionths of an inch, an achievement almost impossible with hand lapping.

The fundamentals of precision manufacture may be summarized as follows:

1 The accuracy to which we can work depends upon the accuracy with which we can measure.
2 In order to realize the maximum of precision in production, each single element of a surface that is being machined must be controlled independently.
3 To obtain the maximum production with the maximum of precision, single-purpose, single-operation machines are better than multiple-operation machines.
4 A mechanical operation properly performed will give a higher degree of accuracy than any hand operation.

The past seventy-five years has witnessed a remarkable advance in all manufacturing industries. This has been due in part to the introduction and development of interchangeable manufacturing methods. These have been possible solely because of the development of precision manufacturing equipment; and the production of equipment of this type has been possible largely because of improved measuring facilities.

Interchangeable manufacturing and standardization go hand

(Continued on page 776)

---

[1] Consulting Engineer.

[2] Engineer, Pratt & Whitney Co. Assoc-Mem. Am.Soc.M.E.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Refrigerating Machines with Air as the Agent

By MAURICE LEBLANC

A GENERAL consideration of the subject of refrigerating machines with air as the thermal medium, together with an analysis of the causes that make the ordinary air refrigerating machine inefficient, and a description of a new machine designed by the author

Conception of the New Machine. If it were possible to cool or heat the air in a cylinder without letting it escape while the piston remained stationary at either end of its stroke, it would be possible to realize the ideal cycle by means of a single cylinder and a single piston such as shown in Fig. 1.

Referring to Fig. 2, it is seen that the specific volume of air comprised between the piston and the head of the cylinder varies from V_2 to V_3. Therefore in this machine the volume $V_3 - V_1$ would have to be produced per kg. of air to make ice instead of as in ordinary machines a volume $V_3 + V_4$, or one 4.62 times smaller.

The area τ_1 measures the apparent power consumed by the compressor and the area τ in Fig. 2 the useful power. We have then—

$$\tau = \int_{p_2}^{p_1} Vdp - (P_1 - P_2)V_1 \ldots\ldots\ldots\ldots [1]$$

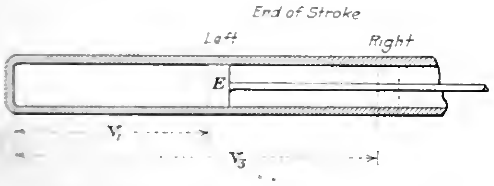


FIG. 1 DIAGRAM OF AN AIR REFRIGERATING MACHINE

On the other hand,

$$PV^k = P_2V_3^k \ldots\ldots\ldots\ldots [2]$$

hence—

$$\tau_1 = \frac{k}{k-1} P_2V_3 \left[\left(\frac{P_1}{P_2}\right)^{\frac{k-1}{k}} 1\right] - (P_1 - P_2)V_1 \ldots\ldots [3]$$

and—

$$\tau = \frac{k}{k-1} P_2(V_3 - V_2) \left[\left(\frac{P_1}{P_2}\right)^{\frac{k-1}{k}} 1\right] \ldots\ldots\ldots [4]$$

If we make ice, we have—

$$V_2 = 1.448\, V_1;\ V_3 = 1.684\, V_2;\ P_2 = 0.5710\, P_1;\ \left(\frac{P_1}{P_2}\right)^{\frac{k-1}{k}} = 1.1770 \ldots [5]$$

from which—

$$\tau_1 = 0.15631 P_1V_1; \quad \tau = 0.068124 P_1V_1 \ldots\ldots\ldots [6]$$

The ratio $\frac{\tau_1}{\tau}$ is here only 2.29 instead of 16.39. It becomes therefore possible in an air refrigerating machine to attain a sufficiently high order of mechanical efficiency. On the other hand, each kilogram of air supplies $C_p(T_3 - T_2) = 7.6$ frigories. If it be assumed, as is usual, that the ambient medium absorbs 10 per cent, it will still be found that each kilogram of air supplies 6.84 useful frigories.

As the volume to be produced per kilogram of air is $V_3 - V_2 = 0.684 V_1$, the volume to be produced per useful frigorie is $0.1 V_1$, and hence—

$$P_1V_1 = 29.272 T_1 = 8372 \text{ kg-m} \ldots\ldots\ldots\ldots [7]$$

An ammonia refrigerating machine must withstand an absolute pressure of 170,000 kg. per sq. m. (35,000 lb. per sq. ft.) if the condensing water delivered to it has a temperature of about 30 deg. cent. (86 deg. fahr.). If the same magnitude be assigned to the pressure P_1 in the above equation, we have $V_1 = 0.492$ cu. m. (17 cu. ft.). The volume that has to be produced per useful frigorie is therefore 4.92 liters.

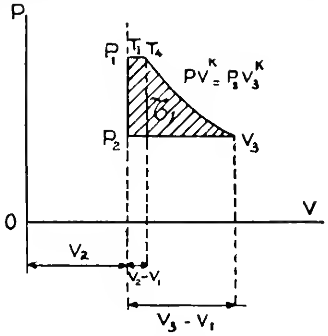


FIG. 2 CYCLE OCCURRING IN MACHINE SHOWN IN FIG. 1

A good ammonia machine, single-cylinder, double-acting, 270 mm. (10.6 in.) bore with a stroke of 450 mm. (17.7 in.) running at 110 r.p.m. will produce in ice making 140,000 frigories per hour, and in doing so the piston will traverse a volume of 2.425 liters per frigorie, or about half of the above volume.

We might therefore build a geometrically similar machine the respective linear dimensions of which would be half of those just specified, and run it at twice the speed. The bore of the cylinder of such a machine would then be 135 mm. (5.2 in.), the stroke 225 mm. (8.85 in.), and the speed 225 r.p.m. The average piston speed and the velocity of flow of the fluid through the ports would be the same as in the larger ammonia machine, but the machine would be eight times lighter and consume four times less power, so that it would utilize the materials of which it was constructed twice as well.

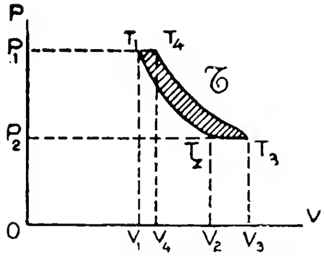


FIG. 3 STANDARD CYCLE OF AIR REFRIGERATING MACHINE

With air as the refrigerating medium it is therefore possible to build a light and less bulky machine, provided small cylinders (a number of them if necessary) and high speed are employed, conditions which can be easily satisfied in an air machine but not in an ammonia machine, since in the latter case, in order to reduce the heat exchange between the ammonia and the walls, it becomes necessary to make the cylinders as large as possible, which is the reason why all of these machines are of the single-cylinder type and why their efficiency rapidly falls off with increase of capacity.

The automobile engine, which is really a hot-air engine, is equal in output to a large single-cylinder slow-speed gas engine, but while of equal output, it is enormously lighter and less cumbersome than the latter. The same applies to an air refrigerating machine.

Because of this, if we should succeed in building a machine in which the pistons would have to cover only a volume $V_3 - V_2$ per kilogram of air, there would be no trouble in making it as light and

as little bulky as an ammonia machine of the same output. We cannot expect, however, to heat or cool the air in the cylinders of a machine without removing it therefrom. This would lead us back from Watt to Newcomen, but we can produce an exchange of air from one cylinder with that from another cylinder hotter or colder than the first, leaving the piston stationary and scavenging the air by some kind of a blower which would only have charging losses just as in a two-stroke single-cylinder internal-combustion engine.

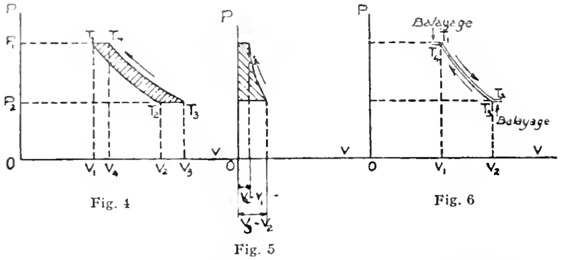


Fig. 4

Fig. 5

Fig. 6

Figs. 4, 5, 6 Various Cycles of Air Refrigerating Machine
(*Balayage* = scavenging.)

and the other compression, the two being infinitely close to one another. They represent the expansion curve of the cycle of Fig. 4. In this cycle the air taken in at the state $P_1V_1T_1$ is expanded and thereby brought to the state $P_2V_2T_2$. It is then through the scavenging process replaced by an equal volume of air having the state $P_2V_3T_3$. This latter is compressed and brought to the state $P_1V_4T_4$, and by a second scavenging process replaced by an equal volume of air at the initial state $P_1V_1T_1$. The work absorbed by the compression is equal to that delivered by the expansion and the area of the cycle is null. This can be obtained in practice by means of a special expander which the author calls a "Wattless" expander (*detendeur deWatté*), because it restores to the air all the work which the air furnished to it. Its apparent power consumption τ' is that of an ordinary compressor working with the cycle shown in Fig. 9 of the original paper, and we have, therefore,

$$\tau' = \int_{p_2}^{p_1} Vdp - (P_1 - P_2)V_1 \ldots\ldots\ldots\ldots [9]$$

provided—

$$PV^k = P_2V_2^k \ldots\ldots\ldots\ldots\ldots\ldots\ldots [10]$$

and hence—

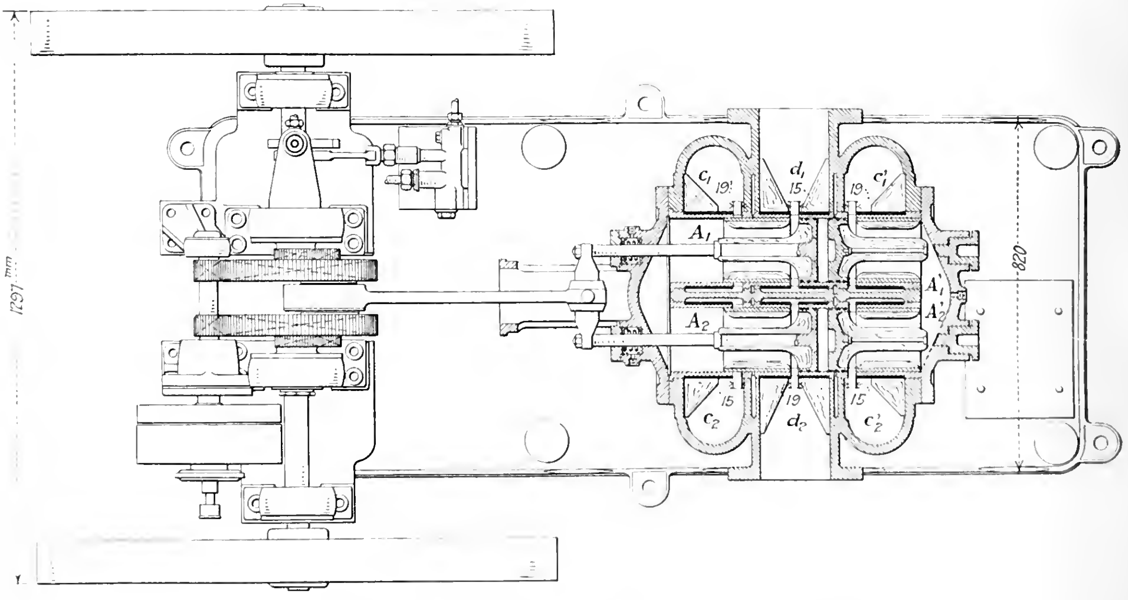


Fig. 7 "Wattless" Compressor of the LeBlanc Refrigerating Machine

The new machine is therefore fundamentally characterized by the following two features:

1 Its pistons in their travel cover only the volume $V_3 - V_2$ per kg. of air, and—

2 The exchange of air between the cylinders of the machine and its refrigerant and cooler is effected by scavenging means operated by blowers.

From this we may proceed to the consideration of the cycle of Fig. 3 reproduced in Fig. 4 as a superposition of the two cycles of Fig. 5 and Fig. 6. In the cycle shown in Fig. 5 the abscissa of the point of the compression curve having an ordinate P is equal to the difference of the abscissas of the points of the ordinates P of the compression curve, and the *expansion* of the first cycle. The area of the new cycle is equal to that of the old one, and the cycle is similar to the indicator diagram obtained on an ordinary compressor.

This cycle can be compared with that of a compressor provided with automatic poppet valves. The author calls it the "Watted" compressor (*compresseur Watté*), because all the work that it absorbs is given up to the air without any partial recuperation.

The cycle of Fig. 6 is composed of two curves—one expansion

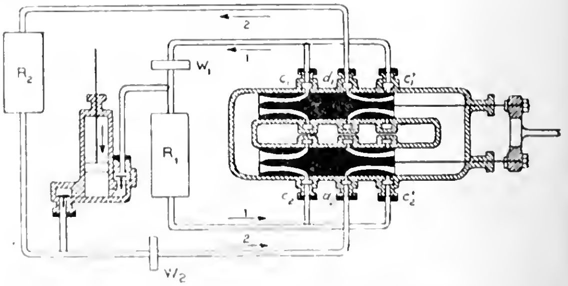


Fig. 8 Diagrammatic Arrangement of Essential Elements of LeBlanc Refrigerating Machine

$$\tau' = -\frac{k}{k-1} P_2V_2 \left[\left(\frac{P_1}{P_2} \right)^{\frac{k-1}{k}} 1 \right] - (P_1 - P_2)V_1 \ldots [11]$$

In ice making $\tau' = 0.08819P_1V_1$ kg-m. per kg. of air, while

the work r_1 absorbed by the "Watted" compressor is equal to 0.068124 $P'V'$ kg-m. per kg. of air.

The apparent output of a "Wattless" expander is therefore 1.29 times the power of the "Watted" compressor.

The cycle of Fig. 4 could be realized by means of a single-cylinder machine furnished with poppet intake and exhaust valves and a special device for scavenging, but this would produce a supercharging effect and the air in the process of being scavenged would have to pass valves which it would be difficult to make of sufficiently large cross-section.

Fig. 7 represents a "Wattless" compressor built at the Havre shops of the Compagnie Electro-Mecanique. It consists of twin double-acting cylinders A_1, A_1' and A_2, A_2', arranged symmetrically with respect to the axis of the machine.

Each of the cylinders is provided with three ports (c_1, c_1' and d_1 in the first, c_2, c_2' and d_2 in the second), these ports being located all along the circumferences normal to the axes of the cylinders and the ports c_1, c_1' being located at the same distance from port d_1. These cylinders have identical pistons which move together, their rods being connected on the outside and driven from the same crankshaft. In each of these pistons there are two circular ports located along circumferences normal to the axis of the piston, so that their distance is equal to the distance of the ports c and d of the cylinders. Each one of these ports is in constant communication with the interior of the nearest cylinder by a passage through the interior of the piston. Finally, the cylinder ends A_1, A_2 are in communication with each other as well as A_1', A_2'.

Fig. 8 shows how this apparatus is connected to the cooler and the evaporator and also how the scavenger blowers and "Watted" compressor are arranged. This figure shows the pistons at the end of their stroke to the left. At that time the piston ports on the left are opposite the ports c_1 and c_2, and those on the right opposite d_1 and d_2. The ports c_1' and c_2' are closed by the walls of the pistons. Between the ports c_1 and c_2 there runs a circuit comprising the cooler R_1 and the blower W_1. The current of air produced by this latter enters the machine through port c_2 and leaves through port c_1. It drives out the air content between these ports and replaces it by the air coming from the cooler R_1 at the state $P_1V_1T_1$. Between the ports c_1' and c_2' there is another circuit comprising the evaporator R_2 and the blower W_2 [W_2 is not shown in the drawing in the original article and has been inserted by the abstractor. Editor.] The current of air produced by this latter enters the machine through port c_2' and leaves through c_1'. It forces out the air contained between these two ports and replaces it by air from the evaporator at the state $P_2V_3T_3$.

When the pistons move from their position at the left end of the stroke to the right they close first the ports c_1, c_2, d_1 and d_2. The air at the state $P_1V_1T_1$ contained in the cylinder heads at the left expands and arrives at the state $P_2V_2T_2$ when the pistons uncover the ports d_1, d_2, c_1', c_2', the ports c_1, c_2 still remaining covered. At the same time the air at the state $P_2V_3T_3$ contained in the cylinder heads to the right is compressed and thereby changed to the state $P_1V_4T_4$. By scavenging the air at the state $P_2V_2T_2$ is replaced by air at the state $P_1V_3T_3$, and air at the state $P_1V_4T_4$ by the air at the state $P_1V_1T_1$.

The "Wattless" expander causes a constant passage of air from the cooler to the evaporator, this air being then taken by the "Watted" compressor which draws it in at its exit from the evaporator R_2 in order to drive it into the cooler R_1.

The use of the "Wattless" compressor permits carrying out the scavenging only with ports of large section. As a rule the seat of the poppet valve of the compressor has a diameter one-third that of the cylinder and hence a section one-ninth as large, and even this is cumbered up at the guide so that at most only two-thirds of the cross-section may be utilized for the flow of air. In all, the useful section of a poppet valve is about 1/13.5 the cross-section of the cylinder.

While the ports in the LeBlanc machine cannot be made the full length of the circumference of the cylinder, they are nevertheless about three-fourths of that length, which gives quite a large space for the scavenging.

The machine shown diagrammatically in Fig. 8 consists of a "Watted" compressor, a "Wattless" expander, an evaporator, a cooler and two blowers. The machine working with saturated vapor would comprise only a "Watted" compressor, an evaporator and a cooler. Hence the cost of replacing saturated vapor by air is represented by the presence of a "Wattless" expander and two blowers. Since, however, it is possible to build the machines with smaller cylinders working at high speeds, the increase in machinery is not material. In addition to this the cost of construction of these machines is much smaller than that of ammonia machines, as less expensive materials can be used owing to the absence of corrosive action. Furthermore, while gas-tightness is as important here as in the case of ammonia machines, small leakages, if they should develop, would be devoid of danger, because of the nontoxic character of the medium employed.

The remainder of this very interesting article cannot be abstracted owing to the lack of space. (*Revue Universelle des Mines*, vol. 14, no. 3, Aug. 1, 1922, pp. 1-36, 16 figs., *td*A)

Short Abstracts of the Month

AERONAUTICS

Experimental Research on Air Propellers, W. F. Durand and E. P. Lesley. National Advisory Committee reports Nos. 14, 30, and 64 comprise the results of a series of wind-tunnel tests on model forms of air propellers, extending over a three-year program of experimental work. These reports were made progressively and each without reference to the results given in preceding reports and relating to forms perhaps adjacent in geometrical form and proportion. These reports thus represent a survey, made in three parts, of a somewhat extended area covering a considerable number of model forms and proportions and varying in various characteristics in a systematic and regular manner.

At the conclusion of the work thus carried on in parts it has seemed desirable to review the entire series of results, to examine through graphical and other appropriate means the nature of the history of the characteristics of operation as related to the systematic variation in characteristics of form, proportions, etc., through the entire series of such variations; to check doubtful points of repetition of test; to remove inconsistencies where found, and generally to develop, for the series of models represented by these tests, a consistent set of results as judged by the relation of those for any one model of those for all models adjacent in geometrical form and proportion.

It is the purpose of the present report to give the results of this general analysis and review of these series of experimental observations. (Report no. 141 of *National Advisory Committee for Aeronautics*, 1922, 82 pp., numerous illustrations and tables, *e*A)

BUREAU OF STANDARDS (See Engineering Materials)

ENGINEERING MATERIALS (See also Metallurgy)

Effect of Temperature, Deformation and Rate of Loading on the Tensile Properties of Low-Carbon Steel below the Thermal Critical Range, H. G. French. An apparatus for determining tensile properties of metals at high temperatures (including limit of proportionality) is described in this paper in detail. Results of tensile tests at temperatures from 20 to 465 deg. cent. of various grades of 1/2-in. boiler plate are also given, including (*a*) A.S.T.M. firebox steel; (*b*) marine boiler steel; and (*c*) railway firebox steel.

A section of the report is largely devoted to a discussion of the effects of different amounts of rolling at room temperature and at blue heat (300 deg. cent.) on the properties of such steels throughout the range given, and data are presented to show the effects of partial annealing, particularly at temperatures near the blue-heat range, on the cold and blue-rolled metal.

A series of experiments are described to show some effects of tensional elastic overstrain on the proportional limit, tensile strength and ductility of low-carbon steel at different temperatures, together with the subsequent behavior of the steel in both tension and compression upon aging.

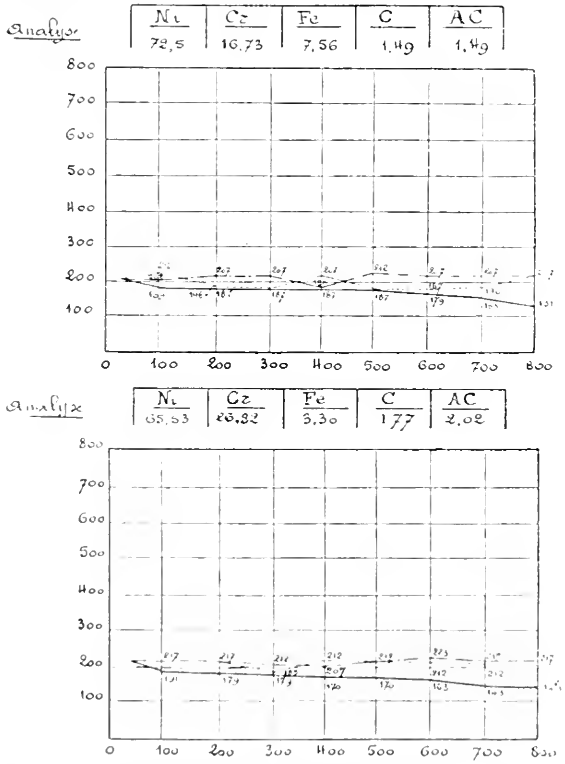
A modified form of the original apparatus is described whereby several rapidly moving dials indicating both stress and strain are simultaneously and repeatedly photographed by a motion-picture camera when rapid rates of loading are used.

Included also are results of tests showing the effects of both rapid and slow loading on the tensile properties of boiler plate at various temperatures.

In the general summary is given a brief discussion of the observed effects in the light of the amorphous-metal theory, and to illustrate typical fractures photomicrographs are included. (Abstract of *Technologic Paper no. 219 of the Bureau of Standards, e*)

High-Temperature-Resisting Alloys

Tubes for the Claude Nitrogen-Fixation Process, Leon Guillet. In the Claude ammonia process tubes or cylinders are submitted simultaneously to a temperature of 650 deg. cent. (1202 deg. fahr.) to a pressure of the order of 1000 atmos., and the action of hydrogen gas. The life of the tube, that is, its ability to resist the destruction wrought by these three factors, determines the commercial value of the process and has led to vigorous search after suitable materials.



Figs. 1 and 2 Curves Showing the Variation of Hardness with Temperature of Heat-Resisting Alloys

(Abscissas in deg. cent; ordinates in kg. per sq. mm.)

In this connection, the author mentions some of the work done at the Imphy Steel Works in France on chrome-nickel steels and also chrome-cobalt alloys.

Figs. 1 and 2 give curves determined since the war on the preservation of hardness by some of these new alloys at the higher temperatures—of interest because of the scarcity of information on the subject.

It would appear that steel containing around 13 per cent of chromium retains a good deal of its hardness up to about 600 deg. cent. (1112 deg. fahr.), but the A. T. G. metal developed by Chévenard at the Imphy Steel Works exceeds it in its ability to retain hardness at the higher temperatures. A remarkable feature about the A. T. G. metal is that in addition to large percentages of nickel and chromium it also contains a substantial amount of tungsten. The A. T. G. composition is said to have been definitely developed as early as the end of 1913.

Among other things, Chévenard developed an ingenious method for measuring the behavior of metals at the higher temperatures, which consists in registering on a photographic plate as a function of time the elongation of a wire carrying a given weight and maintained at a constant temperature. For a certain time an essentially constant velocity of elongation V is observed. In general, the curves $V = f\ (T)$ for different loads have a clearly apparent inflection, so that a temperature θ may be considered as separating the region of rigidity (practically speaking) from the region of viscosity. Everything else being equal, the border-line temperature θ is located higher for alloys of the A. T. G. type than for other alloys.

In the Claude process the metal of the tubes or cylinders has, however, to withstand not only the higher temperatures but also the action of gases. The author tested two tubes. One was made of ordinary steel with which Claude made his first experiment under a pressure of 1000 atmos. in 1907. This showed that the metal had been strongly attacked by hydrogen after 60 hours of operation at 550 deg.

The second tube was made of the Imphy metal. Because of improper operation it burst after 3300 hours of service. Unlike the common steel tube, it showed no decarburization due to the action of hydrogen. Apparently chrome and tungsten form carbides which are not attacked by hydrogen. In fact, the author suggests that it would have been comparatively easy to make a carbon-free alloy by using Mond nickel or electrolytic nickel and chromium prepared by the thermit process or specially refined. The percentage analysis of this second tube is given as carbon 0.44, nickel 60.40, chromium 8.70, tungsten 2.52, manganese 1.80, iron 24.73, or a total of 98.59 per cent, the nature of the remainder of 1.41 per cent not being indicated.

In this connection it may be of interest to point out that nichrome, according to a paper by A. Bensel before the American Society for Steel Treating (abstracted in Mechanical Engineering, vol. 43, no. 9, Sept., 1921, p. 612), contains nickel, 60 per cent; chromium, 12 per cent; iron 26 per cent; and carbon, silicon, manganese, etc., 2 per cent. (*Memoires de la Société des Ingénieurs Civils de France*, vol. 75, series 8, nos. 4-5-6, April to June, 1922, pp. 320-325, 4 figs., *deA*)

Corrosion of Steel—Copper Steels

The Corrosion of Iron and Steel, Sir. Robert Hadfield, Hon. Mem. Am.Soc.M.E. This paper refers to the wastage of the world's iron and steel due to corrosion and describes a number of experiments recently carried out by the author with regard to copper steel.

Careful estimates, it is stated in the paper, appear to show that there is a present annual loss of over 40,000,000 tons of iron and steel under corrosion, together with the consequent removal of material rendered unserviceable.

The author's research was conducted on fourteen types of various materials—in all, 1330 specimens.

As regards the resistance to corrosion of steel containing copper, the author refers to work of American investigators, in particular, B. M. Buck, and to experiments by Prof. O. Bauer of Berlin. From his own tests he draws the following conclusions.

1 *Atmospheric Corrosion.* Copper steel is rather less corroded than ordinary steel, but especially so in the more corrosive industrial atmosphere at Attercliffe. This applies to both material with rolling scale on and with the same removed. Material with the scale removed is more resistant than with the scale on, confirming what is generally found to be the case.

2 *Sea Water.* Ordinary steel corrodes the more rapidly at first; subsequently the rate of corrosion for both materials slows up, indicating a certain degree of "self-protective" action, which is rather more pronounced for ordinary steel. At the end of 16 weeks, however, the total extent of the corrosion of copper steel is still less than that of ordinary steel. The relative behavior of the material with scale on and that with the scale removed is the same as for atmospheric corrosion.

3 *Tap Water.* There is little to choose between the two mate-

rials, which maintain a fairly constant rate of corrosion over nearly four months. The tap water, which initially is not so corrosive as sea water, over the longer period is more corrosive, due to the absence of self-protective action of the steels against this medium. In this case no specimens were tested with their rolling scale on.

4 *Fifty Per Cent Sulphuric Acid.* With original scale on, both materials are attacked very rapidly at first; while, however, the rate is maintained when reimmersed after a three weeks' exposure and weighing, the steel containing copper is only very slowly attacked. During the three months' period of the second immersion the rate is only about one-sixteenth of the rate during the first period of three weeks. Apparently, therefore, when the scale has become detached and the attack takes place more directly on the surface of the steel, the steel containing copper is very resistant to a 50 per cent solution of sulphuric acid. That this is so was confirmed by a seven days' test on a freshly prepared and polished specimen free from scale.

5 *Twenty Per Cent Sulphuric Acid.* A seven days' test on specimens with the scale removed, while showing more vigorous action than the 50 per cent solution, confirms the great superiority of the steel containing copper against attack by sulphuric acid.

In the author's tests, therefore, the conclusions arrived at, both from the American and the German tests, as to the superior resistance of mild steel containing a small percentage of copper to atmospheric corrosion, are borne out—not, however, to the extent shown by the American tests. The superiority amounts to about 10 per cent in pure air, increasing to about 25 per cent in an industrial atmosphere. As in the German tests, the results of immersion in sulphuric acid point strongly to the amount of sulphurous impurity carried by the air.

The author's tests, so far as immersion in ordinary water is concerned, confirm Dr. Cushman's opinions and also the German conclusions: that is, no advantage for the copper steel is to be looked for in this direction. In sea water the above tests indicate, at any rate for a comparatively short period of exposure (a few months), a certain superiority for the copper steel. With a very long period of exposure, however, it is possible this superiority may be wiped out or even negatived, and in this respect again they bear out Dr. Cushman and the German conclusions. The excellent results obtained in America for the copper steels are, to a certain extent, ascribed by the author to the superior physical conditions of the steel as compared with the ordinary mild steel.

Microscopic examination of the materials shows a difference in structure between the copper steel and ordinary mild steel. While both materials show the usual character of mild steel, i.e., mainly ferrite grains with carbon distributed in the form of carbide of iron, the carbide in the case of the steel containing copper is invariably confined to the grain junction; in the mild steel the carbide is indiscriminately distributed throughout the material.

The author includes a few words of caution in regard to forming general conclusions as to whether a small percentage of copper as a constituent of steel is really desirable for general service conditions. He claims that a small copper content, say, 0.16 to 0.25 per cent, is beneficial, provided the condition is that of *bare* metal exposed to atmospheric corrosion, especially in a sulphurous atmosphere, but no recorded tests have yet shown that *coated* metal would be benefited by a copper content.

Unquestionably, in the majority of service conditions, iron or steel is subjected to either total or partial immersion in natural waters, or some sort of liquid phase. It is by no means certain that, under such conditions, a copper content in steel might not actually be deleterious, and it is fair to state that this opinion is held very strongly by Dr. Cushman and other investigators who have been long studying these problems. The study is exceedingly difficult, owing to the fact that a given type of iron or steel, which may behave very well under one set of conditions, will quite reverse its behavior under another set. It is necessary, therefore, to proceed with extreme care before drawing important conclusions on the basis of any tests so far carried out, which might be the means of inducing steel manufacturers generally to introduce copper as a commercial constituent of mild steels.

It should be noted that if such a practice came into general use, the scrap of the steel-manufacturing countries would become greatly infected with copper, which is not thereafter removable by the various refining processes now employed. If future experience should tend to show that a copper content was in many cases deleterious rather than beneficial, this would be a most serious and important consideration. (*Proceedings of the Royal Society*, Series A, vol. 101, no. A 713, Sept. 1, 1922, pp. 472–486, *cg.I*)

FOUNDRY

Melting Steel and Cast Iron Together in the Cupola, J. Hogg. In the plant with which the author was connected the charge was made up of foundry scrap (runner heads, risers and gates), pig iron of proper brands, and semi-steel, in particular turnings.

After a few days of running it was found that the metal was too hard, which was obviously due to the fact that foundry scrap from semi-steel melting contained a higher percentage of low-carbon material than similar scrap from pure gray-iron operation. It was necessary, therefore, to reduce the steel added to the charge for a few days, by which softer metal was obtained without affecting the density or the tensile result.

The writer often used steel in amounts of 15 per cent and it is fairly satisfactory, provided the metal is poured hot. In general, a fall of temperature at pouring is favored, because of the danger of hard spots. If the metal is at all "dull," blowholes are almost certain to appear in machining.

A simple hardness test is used. A small sample of the iron is polished and then boiled for a few moments in sodium picrate. The combined carbon will assume a rich brown color, and its amount from day to day can be easily judged. This may be used as a special test for hardness and can be carried out by means of a low-power microscope.

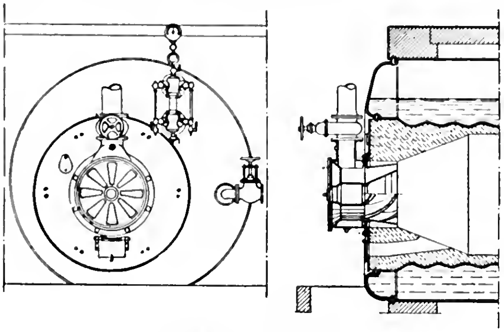


Fig. 3 Muller Gas Burner

The author does not recommend the addition of steel to the metal in the ladles because it lowers the temperature of the metal in the ladle, which is vitally undesirable. (Paper before the Lancashire Branch of the Institution of British Foundrymen, abstracted through *The Foundry Trade Journal*, vol. 26, no. 314, Aug. 24, 1922, pp. 160–161, *p*)

FUELS AND FIRING

Gas Burner for Blast-Furnace Stoves or Boilers

Muller Gas Burner, A. Thau. Description of the Muller gas burner, the particular feature of which (Fig. 3) is that by means of a number of fixed, peculiarly twisted blades, the gas entering the burner is forced into a rotating corkscrew motion on its way to combustion. The front portion of the burner is divided by the blades into a number of radially distributed compartments alternately conveying gas and serving as air inlets. The peculiar twist of the blades is such, however, that the screwlike partitions have different pitches for gas and air, so that the free available area is differently proportioned in accordance with the heating value of the gas.

The burner differs from the majority of similar apparatus, in that no attempt is made to force the gas and air into an intimate mixture inside the burner body, and upon leaving the burner mouth the gas and air are divided into a number of fine streams distributed over the periphery in proper rotation.

The way in which gas and air leave this burner and enter, for instance, a boiler tube can best be explained by comparing it with rope making. As in rope making, the single yarns are issued over a distributing ring, and in the case of a thick rope keep turning around all the time, so there shoot from this burner thin streams of air and gas through the annular burner mouth that form inside the boiler tube a large hollow rotating column resembling a hollow rope. It is very interesting to observe this rotating combustion by throwing a small, fairly hard-pressed ball of paper into the burner, whereupon its spiral passage through the whole length of the tube can be plainly observed. To attain such a way of combustion was a step forward, since with most other burners in which the flame burns simply on a horizontal axis within the tubes, an intimate contact by means of which every single spot of the inner tube plate is covered by the flame cannot be attained without a great excess of heat and consequent waste. Data of performance of the burner are given in the original article and it is stated that the burner properly designed may be applied either to blast-furnace stoves or boilers, such as Lancashire or Cornish.

Since 1919 over 300 burners of this type have been installed for various purposes (the author refers apparently to Swedish practice) and have shown their ability to handle severe fluctuations of gas pressure. (*Blast Furnace and Steel Plant*, vol. 10, no. 9, Sept., 1922, pp. 470–472, 1 fig., *d*)

GAS PRODUCERS

Stassano Electric Gas Producer

Stassano Electric Gas Producer, Dr. of Eng. Gwosdz. Considerable interest has been directed recently toward the development of an electrically operated gas producer, particularly in countries where water power is ample and coal expensive, e.g., in the Scandinavian countries and Italy. There the idea arose that it might be worth while to gasify coal by electrically generated heat. In view of the comparative scarcity of information on this development, the following description of the (Italian) Stassano electric gas producer may be of interest.

Fig. 4 shows a design which is said to be in actual operation. The combustion chamber designed to take 400 kw. consists essentially of a cylindrical iron jacket ending at the bottom in a water seal and having on the top a cover equipped with the usual charging hopper with double doors. The shaft has a grate at the bottom and is lined the entire height with fire-brick.

At three different heights in the shaft there appear sets, three in each, of equally spaced electrodes passing through the shaft wall and directed toward the vertical axis of the shaft. The electrodes project part way into the chamber. At the places where they pass through the wall, water cooling is provided and the electrodes are of course electrically insulated from the wall.

A little above the lower set of electrodes there are provided in the wall a number of comparatively small openings through which porcelain tubes are inserted. These tubes serve for admitting steam or air. In addition to these openings a number of peep holes are provided to permit inspection of the fire.

The three groups of electrodes are connected in parallel to the generating circuit. The gas-outlet pipe is set directly under the top cover.

To start the producer a layer of fuel in not too large lumps is placed over the grate. When this layer is heated up more fuel is gradually added until the coal in the shaft reaches up to the level of the topmost series of electrodes. When at that time, the current is cut in it flows immediately through the entire column of coal in the furnace, forming small arcs in jumping from one piece of coal to another, and these numerous arcs generate and gradually increase the heat until the entire fuel bed reaches a very high temperature. The time necessary for this depends on the available electrical energy and the amount of coal in the furnace.

Means are provided for shaking the fuel bed and thereby assisting in the uniform heating of the coal.

If now means for the gasification of the fuel, such as air or steam, be admitted through the porcelain tubes referred to above, the same chemical processes take place as in an ordinary gas producer, the oxygen of the air and steam being converted into carbon monoxide, while the hydrogen from the decomposition of steam is set free. Therefore, by proper manipulation the producer can be made to deliver either producer gas or water gas.

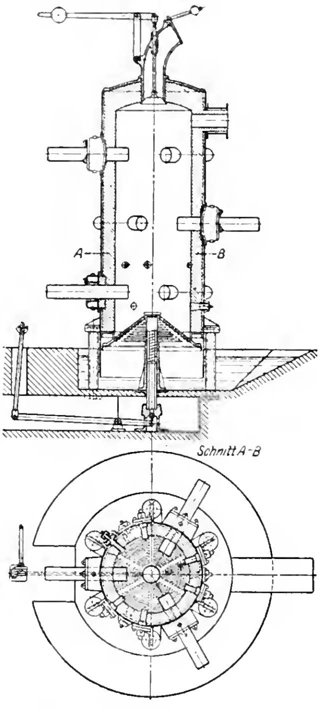


Fig. 4 Stassano Electrically Heated Gas Producer

Under certain conditions, the most vital of which is low price of electrical energy, electrical gasification presents considerable advantages, especially for operating industrial furnaces requiring very high temperatures. These advantages consist in a material saving in fuel per unit of gas produced, which is said to amount to one-half in Stassano producers making water gas from coke. Furthermore, this process makes it possible to obtain regularly a water gas of high heating value. (*Motor und Auto*, vol. 19, no. 15, Aug. 31, 1922, pp. 205–207, 1 fig., *d*. Based on an article by Ernesto Stassano, *Il Gasogeno termo-elettrico* in *La Metallurgia Italiana*, Dec. 31, 1922(?), pp. 575–623)

HYDRAULIC ENGINEERING (See Mechanics)

INTERNAL-COMBUSTION ENGINEERING (See also Machine Parts, Marine Engineering)

Tellurium as an Anti-Knock Compound, H. A. Doerner. In discussing the properties and possible uses of tellurium the author states that the use of $^{2}/_{10}$ of 1 per cent of diethyl telluride in gasoline as an anti-knock compound has been reliably reported. It is said to eliminate carbon deposits and to produce greatly increased efficiency when used in motors designed to operate on very high compression. A special type of engine is said to be required to produce these results, hence its general use in motors will not be feasible unless the motor industry should conform to the required type. This step in turn would be dependent on a supply of tellurium adequate to treat all the motor fuel. For this purpose 1500 tons of tellurium per year would be required, and as the possible annual supply of tellurium from the present best-known sources—copper refineries—is said to be only about 125,000 lb., a much larger supply must be developed; the discovery of new uses not dependent on so large a supply would result in wider utilization of present resources. (*Reports of Investigations of the Bureau of Mines*, Serial no. 2385, Aug., 1922, 3 pp., *g*)

MACHINE PARTS

Piston Rings, John Magee. All piston-ring manufacturers prefer to make rings with the finished surfaces ground to size. It is easier to hold accurate dimensions on a grinding machine than it is on a lathe. However, hard castings and hard spots in castings are machined without difficulty or detection by grinding. For this reason piston rings with a *turned* finish on the diameter dimension should be specified. Neither the scleroscope nor the Brinell hardness test will disclose hard spots in castings. A ground finish may cover up many hard spots or a hard scale. The production of a turned surface is a somewhat slower process for the manufacturer, but it guarantees a uniform soft wearing surface.

Flatness is very essential, since a serpentine condition will allow leakage around the back of the ring through the ring groove. If all

of the internal stresses are not removed during the process of machining, the ring is apt to warp sidewise. Therefore width dimensions should be inspected with a light gage instead of with a micrometer. With a ring lying on a perfectly flat surface, a side warp will cause it to register oversize. With measurements at intervals the two points of a micrometer might indicate a parallel width on a ring considerably warped.

The most common "defect" in the manufacture of piston rings is the elliptical ring, generally termed "out-of-round;" tolerance may vary according to the amount that the ring is likely to be worn in on the block. At best it is desirable to keep the variation within very low limits, say, 0.00025 in. to 0.00050 in. If the tolerance is expressed in light-gage terms, it is much more simple for inspection, because the light gage is at present the most practical inspection device for locating out-of-round rings.

No accurate data are available for determining the poundage or wall pressure of piston rings to accomplish definite purposes. Actual experiments conducted at different times for different purposes seem to indicate that a poundage in excess of 4 lb. per sq. in. of bearing surface is needed to prevent collapse under pressure. Therefore a poundage of 5 lb. per sq. in. has commonly been specified for all purposes.

There seems to be a diversity of opinion as to the proper gas opening or expansion allowance. This is probably due to the difference in the estimated temperatures to which a piston ring is subjected. Using 0.0000056 per in. per deg. as the coefficient of expansion of cast iron, a minimum opening allowance for maximum expansion is obtained by multiplying this coefficient by the circumference of the ring. (*The Journal of the Society of Automotive Engineers*, vol. 11, no. 3, Sept., 1922, pp. 273–274, *p*)

Worm-Gear-Type Speed-Reduction Trains

Reduction and Change-Speed Gear. Description of a form of speed-reducing and change-gear mechanism recently introduced by an English concern. The outstanding feature of the system is the exclusive use of worms and worm wheels instead of the usual spur wheels.

From Fig. 5 it appears that the two shafts *A* and *B* are mounted transversely to the driving and driven shafts *C* and *D*, which are coaxial. Driving connection is established by the worm *E* and worm wheel *F*, the worm gear *G* gearing with the worm on the driving shaft *C*, and worm *H* engaging a worm wheel on the driven shaft *D*.

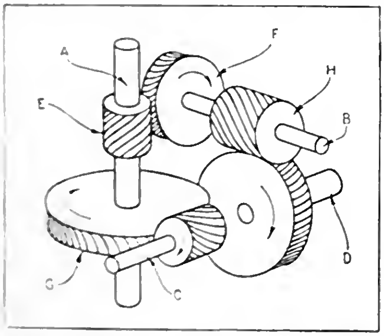


Fig. 5 H. R. Reduction and Change-Speed Gear, General Diagram

In this example a reduction to the third power is obtained, i.e., once for each three sets of worms and worm wheels employed. It is claimed that with the simple gear it is possible to obtain a ratio as high as 100,000 to 1, while by the introduction of two additional elements the gears can be compounded to give a speed ratio of 10.000.000 to 1.

The same principle may be readily adapted for speed changing in that by the addition of one unit a three-speed gear is obtained. If required, the driven shaft can be made to rotate in the same direction as the driving shaft at all speeds.

Fig. 6 shows an arrangement being a 100 to 1 reduction gear for a $^1/_7$-hp. drive at 750 r.p.m. Another illustration in the original article shows a 30,000 to 1 reduction for driving a conveyor plant arranged for a $^1/_7$-hp. drive at 960 r.p.m. The speed of the final shaft is 1.92 revolutions per hour, and some idea of the power transmitted may be gathered from the fact that the torque on this shaft is approximately 400,000 to 500,000 in-lb.

It is claimed that an efficiency of from 80 to 90 per cent is obtained on gearing having ratios up to 250 to 1. (*Engineering Production*, vol. 5, no. 101, Sept. 7, 1922, p. 224, 3 figs., *d*)

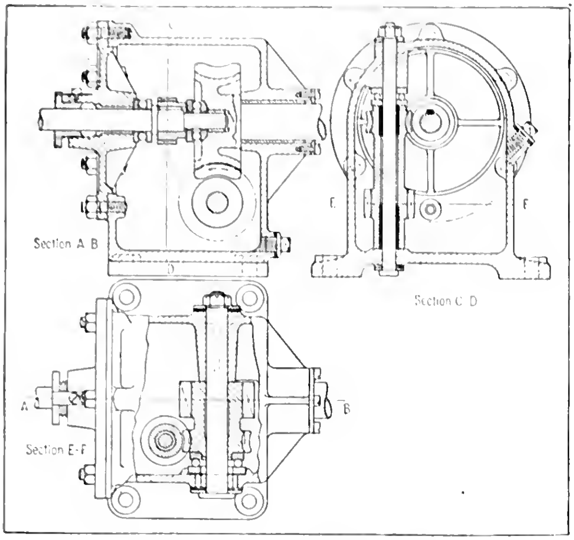


Fig. 6 H. R. 100 to 1 Reduction Gear

MARINE ENGINEERING

Prospects of the Marine Diesel Engine

The Propelling Machinery of the Cargo Carrier of the Future, James Richardson. The shipping industry of the seagoing nations of the world is now faced with the necessity of increasing tonnage, notwithstanding the fact that the total tonnage today available is generally in excess, certain classes being excepted, of the freight-carrying demands. The author is therefore looking forward to the building of a considerable amount of new tonnage in the near future.

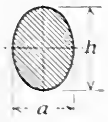
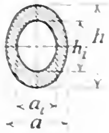
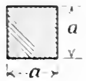
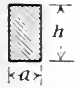
For fast passenger traffic, such as liners in the transatlantic service, the problem appears to have been solved for the time being by the use of steam generated on oil fuel. For the average cargo carrier the burning of fuel oil under boilers with the present prices ruling for coal and oil is uneconomical. On the other hand, oil has considerable advantages as a fuel, and, all conditions considered, the Diesel oil engine as the most economical consumer of liquid fuel makes a most compelling appeal.

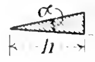
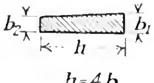
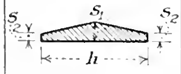
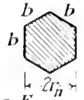
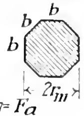
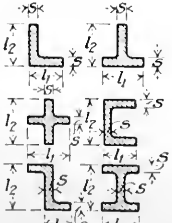
The present position of the Diesel engine is gradually but surely strengthening. There are now available more types of marine propelling plants of all kinds, and particularly of Diesel engines, than ever previously, and the Diesel engine has recently received indirect advantage from the troubles which have been experienced with double-reduction gearing.

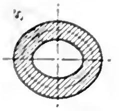
The maximum powers for which the Diesel engine can definitely be stated to be suitable are today 300 b.hp. per cylinder and 16 cylinders; i.e., two engines, each of eight cylinders, a total of 4800 b.hp. or the equivalent of 5500 steam i.hp. total, is the standard for the larger class of motor vessels. However, the time is not far distant when Diesel engines of 400 to 500 b.hp. per cylinder will be operating at sea with success.

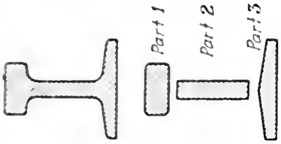
The Diesel engine still remains a massive and somewhat complicated power plant, and no movement toward simplification has yet definitely set in. Undoubtedly, when ship owners and their superintendents have come to appreciate the principles of operation of this prime mover, a number of so-called "gadgets" at present introduced as safeguards and in order to make assurance doubly sure, will be discarded. Only in this way does it seem possible definitely to attain greater simplicity. As regards reducing the mass of the engine, there are only two ways in which this can be achieved: either by increasing the mean effective pressure in the cylinders or the piston speed. The governing factor in the design of all internal-combustion engines is the heat-flow factor. The greater the cylinder

TABLE 1 TORSIONAL STRENGTH OF BARS (See page 740)

NO.	CROSS-SECTION	MOMENT	STRESSES
1	 $2r_a$	$M = \frac{\pi}{2} r_a^4 G\vartheta$	At points on circumference: $\tau_{max} = r_a \; G\vartheta$ At distance r from center: $\tau = r \; G\vartheta$
2	 $2r_i$ $2r_a$	$M = \frac{\pi}{2}(r_a^4 - r_i^4) G\vartheta$	At points on outside circumference $\tau_{max} = r_a \; G\vartheta$ At distance r from center: $\tau = r \; G\vartheta$
3	 $h : a = n > 1$	$M = \frac{\pi}{16} \frac{n^3}{n^2+1} a^4 G\vartheta$	At terminal points of the minor axis a: $\tau_{max} = \frac{n^2}{n^2+1} a G\vartheta$ At terminal points of the major axis h: $\tau = \frac{1}{n} \tau_{max}$
4	 $h : a = h_i : a_i = n > 1$	$M = \frac{\pi}{16} \frac{n^3}{n^2+1} (a^4 - a_i^4) G\vartheta$	At terminal points of the minor axis a: $\tau_{max} = \frac{n^2}{n^2+1} a G\vartheta$ At terminal points of the major axis h: $\tau = \frac{1}{n} \tau_{max}$
5		$M = 0.1404\, a^4 G\vartheta$	In middle of sides. $\tau_{max} = 0.6753\, a G\vartheta$ At the ends of the sides the stress is nil
6	 $h : a = n > 1$	$M = n \psi_3 a^4 G\vartheta$ where $n\psi_3 \sim \frac{1}{3}\left(n - 0.630 + \frac{0.052}{n^4}\right)$	In the middle of the long sides: $\tau_{max} = \psi_1 \; a G\vartheta$ where $\psi_1 \sim 1 - \frac{0.65}{1+n^3}$ At the corners: $\tau = 0$
7	 $h : a = n > 4$	$M \sim \frac{1}{3}(a^3 h - 0.630 a^4) G\vartheta$	At points of the long sides with the exception of the ends: $\tau = \tau_{max} \sim a \; G\vartheta$ In the middle of the short sides: $\tau = 0.7425\, b \; G\vartheta$ At the corners $\tau = 0$

NO.	CROSS-SECTION	MOMENT	STRESSES
8		$M = \frac{h^4}{15\sqrt{3}} \; G\vartheta = \frac{b^4}{46.188} G\vartheta$	In the middle of the sides: $\tau_{max} = \frac{h}{2} G\vartheta = \frac{b}{2.309} G\vartheta$ At the corners: $\tau = 0$
9	 $\alpha < 15°$	$M \sim \frac{1}{12} hb^3 - 0.105 b^4$	At points on the long sides near the base line: $\tau_{max} \sim b \; G\vartheta$ At the corners $\tau = 0$
10	 $h = 4b_1$	$M \sim \frac{1}{12} \frac{h(b_1^4 - b_2^4)}{b_1 - b_2} - 0.105(b_1^4 + b_2^4)$	At points on the long sides near the wider base line b_1: $\tau_{max} \sim b_1 \; G\vartheta$ At the corners $\tau = 0$
11		$M \sim \frac{1}{12} \frac{h(s_1^4 - s_2^4)}{s_1 - s_2} - 0{,}210 s_2^4$	In the middle of the long sides $\tau_{max} \sim s_1 \; G\vartheta$
12	 Area $= F_a$	$M = 0.533 r_m^2 F_a \; G\vartheta$	$\tau_{max} = 1.223\, r_m \; G\vartheta$
13	 Area $= F_a$	$M = 0.520\, r_m^2 F_a \; G\vartheta$	$\tau_{max} = 1.164\, r_m \; G\vartheta$
14	Bent strip of constant width 	$M = \frac{1}{3}(lb^3 - 0.63 b^4) G\vartheta$	At the points on the long sides with the exception of ends the stress is: $\tau \sim b \; G\vartheta$ On the concave side the stress is somewhat larger and on the convex side somewhat smaller.
15	 $l_1 > 4s$; $l_2 > 4s$ Radii of Fillets $= s$	$M = \frac{1}{3} l_t \; s^3 \; G\vartheta$ For ∟: $l_t = l_1 + l_2 - 1.6\, s$; For ⊥: $l_t = l_1 + l_2 - 0.9\, s$; For +: $l_t = l_1 + l_2 - 0.15 s$, For ⊏ and z: $l_t = 2l_1 + l_2 - 2.6 s$; For I: $l_t = 2l_1 + l_2 - 1.2 s$	At points on the border line with the exception of the ends $\tau \sim s \; G\vartheta$ At the Fillets τ is about 16 Per Cent higher

NO.	CROSS-SECTION	MOMENT	STRESSES
16		$M \sim \frac{1}{3}(l_{t1} s_f^3 + l_{t2} s_s^3) G\vartheta$ For ⊏ and Z is: $l_{t1} = 2l_1 - s_f$ $l_{t2} = l_2 - 1.6 s_f$ for I is: $l_{t1} = 2l_1 - 1.26 s_f$ $l_{t2} = l_2 - 1.67 s_f$ $+ 1.76 s_f$	$\tau_{max} \sim s_f G\vartheta$ along the sides of the flange. At points on sides of the web: $\tau \sim s_s G\vartheta$ At points on the fillets the stress is slightly higher
17	Any Ring of Constant Width 	$M \sim 2(F_a + F_i)\frac{F_m s}{U_m} G\vartheta$ F_a = area enclosed by the outer lines F_i = area enclosed by the inner lines F_m = area enclosed by the intermediate ring lines U_m = length of the intermediate ring lines s = width of ring	The average value of the stress in the ring: $\tau_d = 2G\vartheta \frac{F_m}{U_m}$

NO.	CROSS-SECTION	MOMENT	STRESSES
18	Section with a small semi circular notch 	The moment is equal to the moment of an unnotched cross-section	At point P_1 there is a local increase of stresses to about twice that in the unnotched cross-section
19	Section with a small angular notch 	The moment is equal to the moment of an unnotched cross section	At point P_1 the local stress up to the value $\tau = \infty$
20	Composite cross-section of two sections connected by web - 	The moments M_1, M_2, etc for the various separate parts have to be found as functions of the values of their cross-sections and of $G\vartheta$. For the total cross-section, $M \sim M_1 + M_2 + M_3$, etc.	The stresses in the individual parts have to be computed as functions of the value of cross-section and $G\vartheta$. For the composite cross-section the stresses are the sum of those of the parts, with the exception of slight variations at the junctions

dimensions, the more vital is this consideration. This factor, expressed in pounds of fuel consumed per square inch of combustion-volume surface per unit of time, is directly dependent upon the piston speed; and for a constant factor of heat flow, the lower the piston speed, the higher the mean effective pressure possible. The converse is equally true.

The tendency for some years past has been to reduce this heat-flow factor with increasing size, but the gradual improvements in materials and designs which have permitted of increasing size, as already stated, now allow augmented heat flow by increasing the mean effective pressure in the cylinders and the piston speed.

The piston speed with a single-acting internal-combustion engine can well be considerably higher than with steam practice because of two considerations: firstly, because the maximum pressure for which bearing surfaces are designed is only maintained for approximately 12½ per cent in the case of four-stroke engines and 25 per cent of the cycle for two-stroke engines; and secondly, because the pressures on the bearing and guide surfaces are not reversed as with double-acting steam engines. The inclination, therefore, especially with four-cycle machinery is to increase piston speed. With twin-screw ships of relatively high speed, revolutions higher than is usual with steam machinery can be adopted without impairing to any serious extent the overall propulsive efficiency. With single-screw vessels, especially those of low speed, the propeller speed must be kept low, and long-stroke engines will increasingly be adopted to attain a high piston speed and good propeller efficiency.

One point that is not perhaps sufficiently emphasized, is that with Diesel machinery, the higher the power per cylinder, the greater the weight per horsepower, so that for a given power of ship there is a definite saving in machinery weights when twin-screw engines are adopted in comparison with single-screw machinery. This saving in weight means a certain reduction in cost, although the lesser machinery cost is balanced by the increased cost of hull, due to the extra bossing of the stern and the two tunnels for the two lines of shafting. The chief advantage of single-screw machinery lies in the reduction in personnel which is possible, as obviously an increased engine-room complement is required to superintend and to maneuver two engines. Nevertheless, for powers above 2000 to 3000 shaft hp. twin-screw Diesel engines will be the rule for some time to come and are to be advocated.

The saving in fuel costs with Diesel machinery must be considered in conjunction with the lubricating-oil consumption, which is higher than with steam machinery. At first this subject was not perhaps fully appreciated, but today it can confidently be stated that with the latest internal-combustion machinery the problems associated with the necessary lubrication of the piston rings and the forced feed to the main bearings have been most conscientiously attacked, and the consumption of lubricating oil has been reduced to a figure of relatively small importance. One and one-half gallons of lubricating oil for all purposes per ton of fuel oil consumed should be the relation, and has been attained.

As regards personnel which also affects upkeep, it is stated that there is available an increasing number of engineers conversant with the first principles of internal-combustion engines, among others those from the ranks of engineers of engine-building concerns.

As regards auxiliary services, Diesel-engined ships can employ electric drive economically and effectively. The author therefore comes to the conclusion that the motorship has arrived today at the position where the ship owner has few remaining doubts as to the capacity of the oil engine. The factors of cost are still acting as deterrents to some extent, but when next marine construction is energetically pursued, the motorship will be in the far front if Great Britain is to maintain its supreme position as a sea going and trading nation. Today at sea the tonnage of motor ships is 6.5 times what it amounted to in 1914, and of the present total more than one-half represents 149 vessels of over 3000 tons. (Paper read before Section G of the British Association at Hull, Sept. 12, 1922, abstracted from advance proof by special courtesy from *Engineering*.)

MECHANICS

Stresses Due to Gravity in Pipe Lines of Large Diameter and Their Rational Construction, Karl R. Carlsson. The author claims that notwithstanding the great importance of proper design in pipe lines of large diameter in connection with hydraulic installations—because of their great cost and the necessity of maintaining them in reliable operation—exact methods of calculation of stresses are lacking to a considerable extent. While it is true that as early as 1910 Engr. Otto Froelich published in the Journal of the Austrian Society of Engineers and Architects fundamental methods for the accurate calculation of stresses in pipe lines, there is, nevertheless, a still more exact method which the author describes in the present article.

The stresses in the pipe walls are considered by the author as shear stresses induced in the pipe (viewed as a beam) by the weight of water contained therein. It is assumed that these shear stresses are distributed over the circumferential cross-section of the pipe as shown by the equations of equilibrium based on linear elongations and normal stresses; and with this assumption as a basis the shear stresses and bending moments produced by the water pressure are computed for one ring element of the pipe. The calculation of the stresses led to a design of a new type of support bracket for pipe lines, this being based on the idea that in order to avoid excessive local stresses in the thin pipe wall, it is necessary, at the points where the pipe is supported by the bracket, to provide reinforcement rings of proper cross-section that will take up the bearing stresses. The stresses induced in such a ring, as the author shows, are exclusively a function of the shear stresses in the cross-section of the pipe in the immediate neighborhood of the ring, and of the direction of the bearing stresses. The author gives methods for computing all these stresses. This part of the article, being of a mathematical character, is not suitable for abstracting, though of very considerable interest. (*Schweizerische Bauzeitung*, vol. 80, no. 10, Sept. 2, 1922, pp. 105–109, 7 figs., *tm*)

A Table of the Torsional Strength of Bars

Torsional Strength of Bars, Constantin Weber. The author gives a general solution for determining the torsional strength of bars, together with the more important precise and approximate solutions for various problems. He also discusses the influence of normal stresses in the axial direction at considerable twists and the distortion of some of the cross-sections. He claims that some of the data given in engineering handbooks are incorrect and finally presents his results for the various cross-sections in tabular form.

The reasoning of the author may be briefly summarized as follows (The article is mathematical and not suitable for abstracting):

Let us assume that a homogeneous elastic prismatic bar is being stressed by a pair of forces whose plane of action is at right angles to the axis of the bar. This produces a twist of cross-sections of the bar located at a distance of 1 cm. from each other, the twist being through the comparatively moderate angle of torsion δ.

The shear stress T and the moment of torsion M may be expressed by formulas given for every case in Table 1, pp. 738–739, while the functional relation between $T_{\max}$ and M depends on the distance from δ. In the case of long rectangular cross-sections and large angles of twist, owing to the presence of non-uniform elongations, there are normal stresses in the longitudinal fibers of the metal. In the case of two flange cross-sections, the center lines of the flanges lying at the two opposite ends of the cross-section produce, owing to the twisting, an angle of δh_t between them, where h_t is the distance of the flange from its center of gravity. If, on the other hand, because of the construction of the element, the way the body is held, or the symmetrical stresses applied to it, the flanges parallel to each other, a distortion of the flange will take place remain such that the moment of torsion is determined not by the torsional stresses but by the shear stresses $Q = M/h_t$. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, nos. 31–32, Aug. 12, 1922, pp. 764–769, *ptA*)

METALLURGY

Chromium Alloy Steel Cast Centrifugally, L. Cammen. This article is probably the first account of the successful production of an alloy-steel casting by the centrifugal process. The chief feature is the attainment directly of a structure which only the most careful and time-consuming forging or rolling, with subsequent heat treatment, can develop in the same kind of alloy steel cast as an ingot. The centrifugally cast chromium steel, unworked and heat treated, is at least equal in structure and properties to similar metal treated by present methods. To this is added the possibility of producing an alloy with higher carbon and chromium than can be secured in ordinary working by present methods. (*Iron Age*, vol. 110, no. 11, Sept. 14, 1922, p. 655, 1 fig., *g*)

Data Concerning the Influence of Velocity of Solidification on Double-Carbide Steels, P. Oberhoffer. The author carried out a series of tests in order to determine to what extent velocity of solidification affects the structure of steels which, according to the theory propounded by Guillet, contain double carbides. This would refer in particular to such ternary systems as iron-carbon-chromium and iron-carbon-tungsten steels.

Daeves (*Zeit. Anorg. Chemie*, 1921, 118, pp. 55–66) has shown that the freezing temperature is not materially affected in the case of steel by additions of chromium and tungsten, and that it lies around 1140 deg. cent. This makes the question of solidification as affecting the structure of steel of importance also in connection with the forging of these steels.

The author carried out a series of tests on steels containing various proportions of carbon and chromium—from 0.585 to 1.510 carbon and from 1.815 to as high as 13.45 per cent chromium—the highest chromium contents corresponding as a rule to the lowest carbon. All the samples were melted in crucibles and some were permitted to cool in the crucible in which they were melted, thus providing a very slow cooling, while others were cast in chill molds.

The original article gives very interesting photomicrographs, which indicate that while slowly cooled samples had a clearly dendritic cross-grained structure, the rapidly cooled samples had a very fine globularized grain.

The most interesting results were obtained, however, when the author forged the ingots from 45 mm. (1.77 in.) square to 15 mm. (0.50 in.) square, which means a reduction of area of nine to one. From photomicrographs given in the original article it would appear that forging stretched out the carbide network which was not held in solution in the direction of the elongation of the bar. The steel which was slowly cooled in the crucible showed even after the forging the ledeburite-like eutectic in its typical form, though distinctly stretched out in the form of strings. On the other hand, the samples cooled in chill molds are practically free from any appearance of eutectic and show the carbide distributed with great uniformity.

Various physical tests (tensile, hardness, etc.) were carried out on the forged samples, and while the results obtained do not give any absolutely clear picture of the relations between the two materials, the values for chill-cast test pieces have been uniformly higher than those for slowly cooled material. (*Stahl und Eisen*, vol. 42, no. 32, Aug. 10, 1922, pp. 1240–1242, 6 figs., *e*)

MOTOR-CAR ENGINEERING (See also Steam Engineering)

Rushmore System of Vapor Cooling for Automobiles

Evaporating Type of Cooling System, A. Ludlow Clayden. The evaporating or vapor cooling system provides for running the cooling water in the jacket at the temperature of boiling, but at the same time preventing the formation of large steam bubbles and condensing the steam formed directly it breaks away.

The system particularly described by the author is the so-called Rushmore system. In it the jacket design of the engine is unchanged and a very small positive pump of gear or piston type is substituted for the centrifugal. The radiator is empty of water, but the outlet from the cylinder jacket goes to the bottom tank and not to the top tank as in the majority of other vapor cooling systems.

The water, therefore, when it begins to warm up, circulates from the bottom tank through the jacket back to the tank, and so on. When steam begins to form it has only one outlet as it cannot back up against the water being continuously forced in at the bottom

of the jacket. Hence the mixture of water and steam is driven down the outlet pipe to the bottom tank. Within this tank is a cross-tube pierced with many small holes above and below. In this the steam and water separate, the steam emerging in bubbles or jets from the upper holes. Immediately on its escape this steam comes in contact with the empty radiator core, into which it rises until the cold metal has condensed it, whereupon the water trickles back to the tank and returns to the jacket.

In this system the formation of large steam pockets is prevented by the forced water flow and the continuous separation of steam from water. The Rushmore system is actually not open freely to the atmosphere, but the top tank is supplied with a relief valve blowing off at 4 or 5 lb. pressure. This gives a boiling point slightly above 212 deg. fahr., but the effect of the valve is more than that. Starting up with the normal quantity of water and with the radiator filled with air, no cooling will occur until the steam begins to force air out through the valve. The system will operate at approximately 220 deg. fahr. consistently until all the air is displaced, which will not happen unless a hill or some other call for full power brings nearly all the radiator surface into play.

On reducing power after such a condition there will be a radiator filled with steam instead of air. The steam condenses promptly and so reduces the pressure, the valve being a blow-off of the non-return type. From that point onward, till air is again deliberately or accidently let in, the vacuum will vary and the boiling point with it. In actual practice the jacket temperature fluctuates from a few degrees under 212 up to a maximum of about 220 deg. fahr.

There are some peculiar advantages in the Rushmore system which deserve particular mention. First, the high temperature of whatever part of the radiator is working, means maximum heat transfer. With water cooling and a mean radiator temperature of 160 deg. fahr. and the air at 80 deg. fahr., the mean difference is 80 deg. With Rushmore's system the working surface is never cooler than 210 deg., which means a difference of 130 deg. fahr. and a consequent increase in radiator efficiency of over 60 per cent. Second, if alcohol is added in winter to prevent freezing, it will be condensed automatically. The alcohol will boil out of the water before steam forms, of course, but it will act precisely like the steam, being condensed in the radiator and recirculated. Since the system is closed there is no loss of alcohol by evaporation.

But perhaps the most important feature of all is that the admission of steam at the bottom of the radiator makes the air displacement automatic, so that the system needs only one very simple and small pump. Also the high average radiator temperature and high rate of transfer mean a small radiator and consequent economy in first cost. Finally, the small radiator and the small pump economize both weight and power. One advantage of the bottom admission also is that the water has no greater distance to trickle back than that through which the steam rises within the core, so that even in the coldest weather, there is no possibility of the water freezing after it is condensed, so long as the engine is running.

It may be added that the Rushmore system can be arranged with a water filler actually on the bottom tank, but that the customary top cap can be used since, if too much water is put in, it is merely blown out just as the air is ejected.

Steam systems appear really likely to show perceptible economies in weight and in power required to operate them, while also providing a nearly perfect constant-temperature control of a fully automatic sort, with an extremely simple release valve as their most intricate part. They are so simple that their principle can be grasped at once by the least intelligent of operators. When closed, as in the type described, loss of water is less likely than with a water system, and when the water is too low the effects are precisely similar to those of the conventional system. (*Automotive Industries*, vol. 47, no. 11 Sept. 14, 1922, pp. 509–511, 2 figs., *d*)

PHYSICS

Experiments on the Ignition of Gases by Sudden Compression, H. T. Tizard and B. R. Pye. In a previous paper the first-mentioned author showed that when a mixture of a combustible gas or vapor with air was suddenly compressed, explosion might take place after an interval the duration of which depended on the temperature reached by the compression.

According to that paper, the observed ignition temperature must depend not only on the properties of the combustible substances, but also on the conditions of experiment and particularly on the rate of loss of heat from the gas at the ignition temperature.

It was further shown that the period of slow combustion before explosion takes place also depends on the properties of the combustible substances, and a theory was briefly developed connecting the "delays" observed at different temperatures with the effect of a rise in temperature on the rate of combustion, i.e., with the so called temperature coefficient of the reaction.

The object of the experiment described in this paper was to test these theories quantitatively and to attempt to deduce from the results the temperature coefficient in certain typical cases.

The indicator used was of the standard Hopkinson optical type, properly calibrated as regards the pressure scale in two ways.

The results of the investigation are summarized as follows:

a Quantitative experiments confirm the view that at the lowest ignition temperature the heat evolved by the combustion of a gas just exceeds that lost to the surroundings.

b From measurements of the rate of loss of heat just below the ignition temperature, and of the intervals between the end of compression and the occurrence of ignition at different temperatures, it is possible to deduce the temperature coefficient of the gaseous reaction.

c The temperature coefficients so obtained are confirmed by the increase in the minimum ignition temperature which is observed when the gas is in a turbulent state.

d The results show that the temperature coefficient of the combustion of carbon bisulphide is much lower than that of heptane or ether. This is in agreement with the relative tendencies of these fuels to detonate in an internal-combustion engine.

e The results do not agree with the radiation theory of chemical reaction.

f Some evidence is put forward to show that the rate of reaction on sudden compression is independent within wide limits of the concentration of the combustible gas, and depends only on the amount of oxygen present. This evidence, however, is incomplete. (*The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, vol. 44, no. 259, July, 1922, pp. 79–121, 11 figs. and one plate, *em*)

POWER-PLANT ENGINEERING

Steam Reducing Valve, C. C. Brown. Description of a valve used in the plant of a large western sugar refinery where live steam is passed in considerable quantities from the 150-lb. main header to the 10-lb. exhaust header.

The specifications for the valve were that it could be set so that it would open up at 9 lb. and allow enough live 150-lb. steam to pass into the exhaust header to bring the exhaust pressure up to 10 lb. and maintain it there. At 10 lb. the valve was shut off.

The valve, made of bronze, is of the balanced chronometer type with self-grinding ports. It is placed in a 6-in. line between the two headers, the 10-lb. exhaust header being further protected by a Cochrane multi-port exhaust atmospheric relief valve of sufficient capacity to relieve the 10-lb. header. The valve is operated by a lever and crank system and is hooked up in such a way that if anything happens to the regulator or hydraulic cylinder, the valve will fall shut. The actual opening and closing of the valve is performed by a hydraulic cylinder controlled by a Spencer-type regulator. This regulator is described and illustrated in the original article. (*Power Plant Engineering*, vol. 26, no. 18, Sept. 15, 1922, pp. 912–913, 4 figs., *d*)

SPECIAL MACHINERY

Use of Geophone in Locating Compressed-Air Leaks, Byron O. Pickard. An Arizona mining company recently demonstrated a new use for the geophone by successfully locating leaks in compressed-air lines which were buried under from $1^1/_2$ to $2^1/_2$ ft. of fine rock fill. The following information is abstracted from data sent to the Bureau of Mines by the superintendent of the mine.

The company has two parallel main compressed-air lines, about one and one-half miles long, buried under an average of two feet

of fine rock fill. One of the lines is a 4-in. high-pressure (1000 lb.) main, and the other a 10-in. low-pressure (90 lb.) main. The two mains are separated by a 10- to 30-ft. interval and run from the compressor plant to the No. 2 shaft, where they are taken underground. A pump is also buried in the immediate vicinity.

Several leaks, not audible enough to be located, were developed in the mains. Various methods were suggested that did not seem practicable to the management. Finally, the company obtained a Bureau of Mines geophone and experimented with it. The first tests were conducted while the pumps were running and while there was noise on the concrete pavement, all of which caused so much vibration in the geophone that it was impossible to detect the leaks.

A second attempt was made at the close of the day shift when the compressors were not operating and when the pumps could be shut down. The valves in the far end of the surface lines were closed, and the lines were pumped to full pressure (90 lb. and 1000 lb., respectively).

Geophone readings were then taken at 7- to 8-ft. intervals directly over the lines. Several leaks—some very large—in the high-pressure line were audible with the geophone at distances varying from 15 to 30 ft. A considerable leak in the low-pressure line was found at a distance of 10 ft. After detecting the leaks, no difficulty was found in locating them exactly.

"At this time," said the superintendent of the mine, "we are unable to state how large a leak must be in order to be located under 2 ft. of loose fill by the geophone. The fill we worked over was quite loose and dry and seemed to be quite unfavorable for the work in question. However, we have no hesitancy in saying that the instrument is a valuable adjunct to our business."

Under date of June 10 he supplements this statement as follows: "Our final observations, so far as air leaks are concerned, are that the instrument can be depended upon to locate the small leaks. I believe that we located everything of importance in our high-pressure line and we located some large leaks in our low-pressure line. However, in the latter there is a section which has been badly corroded, to the point of being full of pin-point leaks; while the aggregate area of these pin holes is considerable, yet we cannot locate the resulting leaks with the geophone."

The geophone will be found useful for many purposes in locating invisible unknown sources of vibration that transmit sound waves detectable by delicate instruments. The geophone used by the Bureau of Mines is an improved type of the French military geophone. The instrument and its uses are described by Alan Leighton in Bureau of Mines Serial No. 2102, published as a Report of Investigations, March 1920. (*Reports of Investigations, Bureau of Mines, Department of the Interior*, Serial No. 2380, Aug., 1922, *g*)

SPECIAL PROCESSES (See also Engineering Materials)

Boscarelli System of Sheet Rolling. Description of a system employed by an Italian society, the particular features of which are as follows: The bars are heated in a large regenerating furnace burning lignite gases. From the furnace they are carried by an inclined belt conveyor to live rollers, and thence through an underground passage to the roughing stands.

Each train consists of two stands of roughing and two stands of finishing mills. In front of each stand there is an automatic device for lifting the bars to the level of the rolls. This lifting device is provided with a controller which arrests the bars in front of the stands.

In the Boscarelli feed system the sheet bars are fed forward by live rollers from the furnace and are automatically lifted off the live rollers when in position by a power-driven lifting table and fed by the table to the mill stand. The device comprises a lifting and tilting table actuated by the piston rod of a cylinder.

The original article shows schematically the ordinary sheet-mill operation and the Boscarelli system, the difference between the two being the greater simplicity of the new system. Thus, in rolling sheets 40 in. by 80 in. in thicknesses from 0.8 mm. to 3 mm. (0.031 in. to 0.118 in.) the sheet bars at the roughing stand are rolled down to the thickness suitable for doubling, thus cutting out the usual operation of reheating the roughened-out sheets. In the new Terni (Rome) plant all sheets 40 in. by 80 in. from 0.2 mm. up to 0.7 mm. thick are rolled with only one reheating operation.

It is stated that the production of sheets 40 in. by 80 in. of usual gages can be brought up to from 70 to 100 tons in 24 hours, or 30 to 40 per cent more than the usual production with a like number of stands. (*The Iron and Coal Trades Review*, vol. 105 no. 2842, Aug. 18, 1922, pp. 220–221, 5 figs., *d*)

STEAM ENGINEERING (See also Marine Engineering)

Winslow Unitary-Type Boiler

The Winslow Automotive Boiler, Chas. B. Page. Description of the Winslow boiler, together with efficiency curves. This boiler is of the unitary system, each section being a complete boiler in itself. The tubes are welded into the headers.

In the boiler as now made, all sections deliver steam to a common equalizing header and receiver water from an equalizing feed pipe or mud drum (See Fig. 7). The larger or cold-end header is located well outside of the furnace wall; the smaller or hot-end header is well inside the path of the ascending gases of combustion. Therefore, when heat is applied to the boiler its first action is to expand the water contained in that part of the section in front of the cold-end header. Expansion and ebullition cause the water to flow rapidly toward and upward in the hot-end header. The difference in water levels thus created causes a return flow by gravity to the cold-end header, the rate of circulation following in accordance with the temperature of the fire.

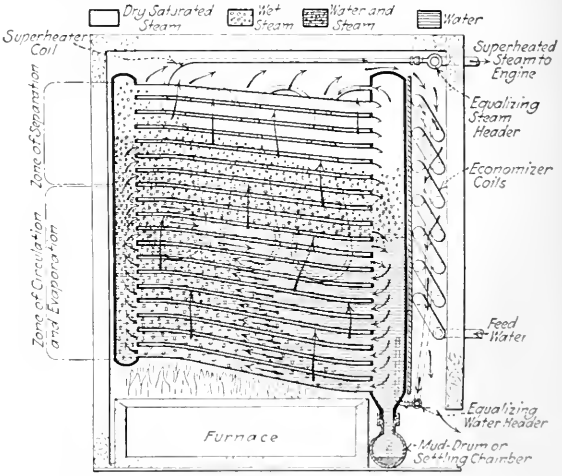


Fig. 7 Cross-Section of the Winslow Automotive Boiler

It is said that the boiler can be run dry, even when heated to a bright red, and cold water can be pumped in while it is in that heated condition without causing damage.

One of the boilers used on a car by the author of the paper is 22 in. wide, 31 in. high and 34 in. long. The heating surface, including horizontal water tubes only, is 93$^1/_2$ sq. ft. The temperature of saturated steam at the average boiler pressure is 473 deg. fahr. with a superheat of 179 deg.

Data of tests on this boiler at a commercial laboratory are given in the original article. It is stated that evaporation tests were also made at the Armour Institute of Technology. (*The Journal of the Society of Automotive Engineers*, vol. 11, no. 3, Sept., 1922, pp. 265–272, 11 figs., *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Work of A.S.M.E. Boiler Code Committee

THE Sub-Committee on Unfired Pressure Vessels herewith submits a code covering vessels of this type as its progress report.

This Code is to be considered as a preliminary report to be published and given as widespread publicity as possible so that all interested in the manufacture of pressure vessels may have an opportunity to digest thoroughly its provisions. It is hoped that any one interested will make such comments, criticisms, and suggestions as may seem to him advisable. If changes are advocated, specific recommendations of substitute provisions should be made. All communications should be sent to Mr. C. W. Obert, Secretary, Boiler Code Committee, 29 West 39th St., New York, N. Y.

But for the difficulty in reconciling differences of opinion in connection with autogenous welding the Code could have been promulgated long since. Several hearings on the subject of welding generally, notably at the Annual Meeting in December, 1921, and at the Atlanta Meeting, May, 1922, have been held. While there is still much about which there is a wide lack of accord, the situation is much cleared, so that in view of a persistent demand of long standing for a code covering unfired pressure vessels, it seems possible and advisable to proceed. However, the rules covering welding have been exceedingly difficult to formulate. It is the intent not to impose too great restrictions by outlining specific methods to an extent that might eliminate other methods equally good or better, but as far as possible to establish fundamentals applicable to any method and to safeguard by inspection and test to the fullest extent possible. The advance that is being made in autogenous welding is recognized and without doubt more liberal rules than those herein proposed will eventually be permitted.

In view of numerous reported failures of welded vessels, it has been deemed advisable to lean toward the side of safety in bringing out rules governing a relatively new and rapidly growing industry, with the idea of broadening them out as the art advances rather than to be so lenient at the start that resulting accidents might set back its development.

Also it has been deemed advisable to formulate rules which will not unduly handicap the smaller manufacturers of welded tanks, for it will readily be appreciated that what might not be abjectionable to larger manufacturers might be unduly burdensome to smaller ones, and it is the intent not to impose undue hardship. In this connection attention is called to provisions permitting a higher pressure for ammonia vessels than for air vessels. This is done in recognition of the extent to which the manufacture of ammonia containers has been perfected by the larger manufacturers and which degree of perfection can hardly be hoped for in the case of air and other pressure vessels built by less completely equipped makers.

Grateful acknowledgment is made of the work done by the Sub-Committee on Welding of the Boiler Code Committee and of the constructive assistance rendered by the Committees of the American Society of Refrigerating Engineers and the American Welding Society, and also that of the many individuals who have given of their time and knowledge in order to promote the development of the engineering profession and the public welfare.

It is the hope of the Committee that the publication of this Code, which has been several years in preparation, will result in further coöperative suggestions that will make it possible to submit in the very near future a final draft.

Respectfully submitted,

SUB-COMMITTEE OF THE BOILER
CODE COMMITTEE ON UNFIRED
PRESSURE VESSELS

E. R. FISH, *Chairman*
WM. H. BOEHM
C. E. BRONSON
E. C. FISHER
S. F. JETER
WM. F. KIESEL, JR.
JAMES NEIL
H. V. WILLE.

A.S.M.E. BOILER CODE

PART I—SECTION VI

PRELIMINARY REPORT ON RULES FOR THE CONSTRUCTION OF UNFIRED PRESSURE VESSELS

NOTE. When this Section is incorporated in the Boiler Code, it will be desirable to add the words "AND OTHER PRESSURE VESSELS" at the top of front cover and of the title page, and on page 3 of the Code. Also the sentence in italics on page 3 will be changed to read as follows:

> These rules do not apply to boilers *and other pressure vessels* which are subject to Federal inspection and control, nor to vessels for containing hot water for domestic supply.

Also to insert, after bracket in line beginning Part I, the following:

"SECTION VI—UNFIRED PRESSURE VESSELS"

CLASSIFICATION

U-1. The vessels to which these rules apply are divided into three classes

Class A: Vessels for containing liquids at temperatures above their boiling points at atmospheric pressure, inflammable substances, or any gas, over 6 in. in diameter, more than 1.5 cu. ft. in volume and carrying over 15 lb. pressure per sq. in., except pressure vessels used in domestic water supply and those provided for in Class C.

Class B: Vessels for containing liquids, the temperatures of which are under control so as to be below their boiling points at atmospheric pressure, over 9 in. in diameter, more than 4 cu. ft. in volume and carrying over 30 lb. pressure per sq. in. but not to exceed 125 lb. pressure per sq. in. For pressures over 125 lb. per sq. in., the rules in Class A vessels apply.

Class C: Vessels for carrying on cooking or similar heating processes of food, medicinal or other chemical preparations, having surfaces coated with glass or similar enamel; and limited to a maximum allowable working pressure of 150 lb. per sq. in.

U-2. Safety Appliances. In cases where there is a possibility that the maximum allowable pressure may be exceeded, all pressure vessels shall be protected by safety and relief valves and indicating and controlling devices as will insure their safe operation. All such devices shall be so located and installed that they cannot readily be rendered inoperative. The relieving capacity of safety valves shall be such as to prevent a rise of pressure in the vessel of more than 6 per cent above the maximum allowable working pressure and their discharges carried to a safe place.

U-3. Corrosive Chemicals. All presssure vessels which are to contain substances having a corrosive action upon the metal of which the vessel is constructed should be designed for a pressure in excess of that which it is to carry, to safeguard against early rejection.

CLASS-A VESSELS

U-4. Class A vessels may be constructed of any metal other than steel of qualities herein specified, if the following rules are complied with:

The maximum allowable unit working stress used in any of the metals selected except as otherwise provided in this section, shall be determined by the following formula:

$$S = 0.0125\, El\, (e + 8), \text{ but not more than } 0.4\, El, \text{ or } 0.2T$$

where S = maximum allowable unit working tension stress, lb. per sq. in.
El = elastic limit of material used
T = tensile strength of material used
e = elongation of material used, in per cent, in 8 in.

Unit working stress in rivets in single shear shall be taken as 80 per cent of S.

Working stress in rivets in double shear shall be double that of single shear.

Staybolt values other than those given in par. U-33 for allowable stress per sq. in. of net section shall be taken as follows:

When e is not over 10 per cent, = 60 per cent of S
When e is from 10 to 20 per cent, = 70 per cent of S
When e is over 20 per cent, = 80 per cent of S.

U-5. Class A vessels may be constructed of steel of qualities specified in Par. U-7.

U-6. Specifications are given in the Rules for Power Boilers, Pars. 23–178, for the important materials that may be used in the construction of pressure vessels, and where such materials are used they shall conform thereto. The elastic limit of steel may be taken as $^{5}/_{9}$ of the yield point.

U-7. Steel plates for any part of a pressure vessel required to resist stress produced by internal pressure, shall be of flange or firebox quality as designated in the Specifications for Boiler Plate Steel, except as hereinafter provided.

U-8. Steel plates and other material for any part of a pressure vessel which is to be constructed with other than riveted joints or by a combination of the two methods must be of qualities as provided in the specifications for the particular kind of joint to be used.

Ultimate Strength of Material Used in Computing Joints

U-9. Tensile Strength of Steel Plate. In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates where herein provided, which is the minimum of the stipulated range, or 55,000 lb. per sq. in. for all steel plates, except for special grades having a lower tensile strength. If plates are to be subjected to a temperature in excess of 600 deg. fahr. the weakening effect on the tensile strength due to the temperature must be taken into consideration when calculating stresses, and in applying the hydrostatic test.

U-10. Crushing Strength of Steel Plate. The resistance to crushing of steel plate shall be taken at 95,000 lb. per sq. in. of cross-sectional area.

U-11. Strength of Rivets in Shear. In computing the ultimate strength of rivets in shear, the following values in pounds per square inch of the cross-sectional area of the rivet shank shall be used:

Iron rivets in single shear	38,000
Iron rivets in double shear	76,000
Steel rivets in single shear	44,000
Steel rivets in double shear	88,000

The cross-sectional area used in the computations shall be that of the rivet shank after driving.

U-12. Thickness of Plates. The minimum thickness of any plate under pressure shall be $^{1}/_{4}$ in., except that for diameters 24 in. and under the minimum thickness may be $^{3}/_{16}$ in.,

U-13. The minimum thicknesses of shell plates, and dome plates after flanging, shall be as follows:

When the Diameter of Shell is				
24 In. or Under	Over 24 In. to 36 In.	Over 36 In. to 54 In.	Over 54 In. to 72 In.	Over 72 In.
$^{3}/_{16}$ in.	$^{1}/_{4}$ in.	$^{5}/_{16}$ in.	$^{3}/_{8}$ in.	$^{1}/_{2}$ in.

U-14. The minimum thickness of butt straps for double strap joints shall be as given in Table U-1. Intermediate values shall be determined by interpolation. For plate thickness exceeding $1^{1}/_{4}$ in., the thickness of the butt straps shall be not less than two-thirds of the thickness of the plate.

TABLE U-1 MINIMUM THICKNESSES OF BUTT STRAPS

Thickness of shell plates, in.	Minimum thickness of butt straps, in.	Thickness of shell plates, in.	Minimum thickness of butt straps, in.
$^{3}/_{16}$	$^{3}/_{16}$		
$^{1}/_{4}$	$^{1}/_{4}$	$^{17}/_{32}$	$^{7}/_{16}$
$^{9}/_{32}$	$^{1}/_{4}$	$^{9}/_{16}$	$^{7}/_{16}$
$^{5}/_{16}$	$^{1}/_{4}$	$^{5}/_{8}$	$^{1}/_{2}$
$^{11}/_{32}$	$^{1}/_{4}$	$^{3}/_{4}$	$^{1}/_{2}$
$^{3}/_{8}$	$^{5}/_{16}$	$^{7}/_{8}$	$^{5}/_{8}$
$^{13}/_{32}$	$^{5}/_{16}$	1	$^{11}/_{16}$
$^{7}/_{16}$	$^{3}/_{8}$	$1^{1}/_{8}$	$^{3}/_{4}$
$^{15}/_{32}$	$^{3}/_{8}$	$1^{1}/_{4}$	$^{7}/_{8}$
$^{1}/_{2}$	$^{7}/_{16}$		

Construction and Maximum Allowable Working Pressures

U-15. The maximum allowable working pressure is that at which a pressure vessel may be operated as determined by employing the factors of safety, stresses, and dimensions designated in these Rules.

Wherever the term maximum allowable working pressure is used herein, it refers to gage pressure, or the pressure above the atmosphere, in pounds per square inch.

U-16. The maximum allowable working pressure on the shell of a pressure vessel or drum shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength stamped thereon, as provided for in the Specifications for Boiler Plate Steel, the efficiency of the longitudinal joint, the inside diameter of the course, and the maximum allowable unit working stress.

$$\frac{S \times t \times E}{R} = \text{maximum allowable working pressure, lb. per sq. in.}$$

where S = maximum allowable working tension stress in lb. per sq. in.
= 11,000 lb. per sq. in. for plate stamped 55,000 lb. per sq. in. as herein provided, and 10,000 lb. per sq. in. for special shell plates for welding (Pars. U-100 and U-101).
t = minimum thickness of shell plates in weakest course, in.
E = efficiency of longitudinal joint
R = inside radius of the weakest course of the shell or drum, in.

In seamless cylinders a joint efficiency of 100 per cent may be used.

Joints

U-17. The efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate. In the case of a riveted joint this is determined by calculating the breaking strength of a unit section of the joint, considering each possible mode of failure separately, and dividing the lowest result by the breaking strength of the solid plate of a length equal to that of the section considered.

U-18. The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

a If $\frac{P}{D}$ is 4 or less, the minimum values shall be $1^{3}/_{4}D$

b If $\frac{P}{D}$ is over 4, the minimum value shall be:

$$1^{3}/_{4}D + 0.1\,(P - 4D)$$

where P = pitch of rivets in outer row where a rivet in the inner row comes midway between two rivets in the outer row, in.
P = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between two rivets in the outer row, in. (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced)
D = diameter of the rivet holes, in.

U-19. On longitudinal joints, the distance from the centers of rivet holes to the edges of the plates, except rivet holes in the ends of butt straps, shall be not less than $1^{1}/_{2}$ and not more than $1^{3}/_{4}$ times the diameter of the rivet holes; this distance to be measured from the center of the rivet holes to the calking edge of the plate before calking.

U-20. *a* The strength of circumferential joints of pressure vessels the heads of which are not stayed by tubes or through braces, shall be at least 50 per cent of that required for the longitudinal joints of the same structure.

b When 50 per cent or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of through tubes or stays, in consequence of the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints.

U-21. The riveted longitudinal joints of a shell or drum which exceed 48 in. in diameter, shall be of butt and double-strap construction. This rule does not apply to the portion of a shell which is staybolted to the inner sheet.

U-22. The longitudinal joints of a shell or drum not more than

48 in. in diameter, may be of lap-riveted construction; but the maximum allowable working pressure for lap-riveted construction shall not exceed 150 lb. per sq. in.

U-23. Butt straps and the ends of shell plates forming the longitudinal joints shall be rolled or formed by pressure, not blows, to the proper curvature.

U-24. Domes. The requirements of Pars. U-21 and U-22 shall apply to riveted longitudinal joints of domes except that for domes 24 in. and less in diameter for pressures exceeding 100 lb., the longitudinal joints may be lap-riveted if the factor of safety is not less than 8.

The flange of a dome 24 in. or over in diameter shall be double-riveted to the boiler shell. Where the flange of the dome is the only reinforcement for attachment to the shell, the diameter of the dome shall not exceed one-half the diameter of the shell or barrel of the boiler.

Flanges of domes shall be formed with a corner radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plate for plates over 1 in. in thickness.

Dished Heads

U-25. Convex Heads. The thickness required in an unstayed dished head with the pressure on the concave side, when it is a segment of a sphere, shall be calculated as follows:

Where $P \times L$ is equal to or less than 4860, the formula to be used shall be as follows:

$$t = \frac{PL}{13{,}200}$$

Where $P \times L$ is greater than 4860, then the following formula shall be used:

$$t = \frac{PL}{20{,}000} + {}^{1}/_{8}$$

where t = thickness of plate, in.
P = maximum allowable working presure, lb. per sq. in.
L = radius to which the head is dished, in.

Where two radii are used, the longer shall be taken as the value of L in the formula.

Where the radius is less than 80 per cent of the diameter of the shell or drum to which the head is attached, the thickness shall be at least that found by the formula by making L equal to 80 per cent of the diameter of the shell or drum.

Concave Heads. Dished heads with the pressure on the convex side shall have a maximum allowable working pressure equal to 60 per cent of that for heads of the same dimensions with the pressure on the concave side.

When a dished head has a manhole opening, the thickness as found by these Rules shall be increased by not less than $^{1}/_{8}$ in. over that called for by the formula.

U-26. When dished heads are of a less thickness than called for by Par. U-25, they shall be stayed as flat surfaces, no allowance being made in such staying for the holding power due to the spherical form.

U-27. The corner radius of an unstayed dished head measured on the concave side of the head shall not be less than three times the plate thickness up to $t = {}^{1}/_{4}$, and not less than $3t^2$ for thicker plates.

U-28. A manhole opening in a dished head shall be flanged to a depth measured from the outside of not less than three times the required thickness of the head.

Braced and Stayed Surfaces

U-29. The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where

P = maximum allowable working pressure, lb. per sq. in.
T = thickness of plate in *sixteenths* of an inch.
p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, in.
C = 112 for stays screwed through plates not over $^{7}/_{16}$ in. thick with ends riveted over
C = 120 for stays screwed through plates over $^{7}/_{16}$ in. thick with ends riveted over
C = 135 for stays screwed through plates and fitted with single nuts outside of plate
C = 150 for stays with heads not less than $^{1}/_{3}$ times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate
C = 175 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than $0.4p$ and thickness not less than T.

If a flat plate not less than $^{3}/_{8}$ in. thick is strengthened with a doubling plate covering the full area of the stayed surface and securely riveted thereto and having a thickness of not less than $^{2}/_{3}$ T, then the value of T in the formula shall be three-quarters of the combined thickness of the plate and doubling plate but not more than one and one-half times the thickness of the plate, and the value of C given above may also be increased 15 per cent.

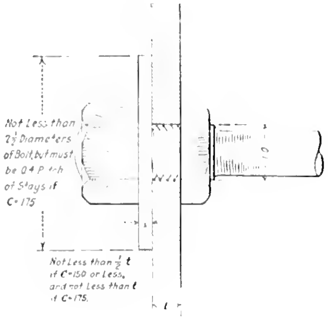


Fig. U-1 Acceptable Proportions for Ends of Through Stays

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

Acceptable proportions for the ends of through stays with washers are indicated in Fig. U-1.

U-30. Staybolts. The ends of screwed staybolts shall be riveted over or upset by equivalent process.

U-31. Structural Reinforcements. When channel irons or other members are securely riveted to the heads for attaching through stays, the transverse stress on such members shall not exceed 12,500 lb. per sq. in. In computing the stress, the section modulus of the member shall be used without addition for the strength of the plate. The spacing of the rivets over the supported surface shall be in conformity with that specified for staybolts.

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the pressure vessel, and provided that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

U-32. a The maximum spacing between centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined as in Par. U-29 using 135 for the value of C.

b The maximum between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head, shall be determined by the formula in Par. U-29, using 175 for the value of C.

c The maximum distance between the inner surface of the shell and the centers of braces of other types shall be determined by the

formula in Par. U-29, using a value of C equal to 1.3 times that value of C which applies to the thickness of plate and type of stay as therein specified.

d In applying these Rules and those in Par. U-29 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

U-33. The formula in Par. U-29 was used in computing Table U-2. Where values for screwed stays with ends riveted over are required for conditions not given in Table U-2, they may be computed from the formula and used, provided the pitch does not exceed $8^1/_2$ in.

U-34. The distance from the edge of a staybolt hole to a straight line tangent to the edges of the rivet holes may be substituted for p for staybolts adjacent to the riveted edges bounding a stayed surface. When the edge of a stayed plate is flanged, p shall be measured from the inner surface of the flange, at about the line of rivets to the edge of the staybolts or to the projected edge of the staybolts.

TABLE U-2 MAXIMUM ALLOWABLE PITCH, IN INCHES OF SCREWED STAYBOLTS, END RIVETED OVER

Pressure, Lb Per Sq In.	Thickness of Plate, In. $^5/_{16}$	$^3/_8$	$^7/_{16}$	$^1/_2$	$^9/_{16}$	$^5/_8$	$^{11}/_{16}$
	Maximum Pitch of Staybolts, In						
100	$5^1/_4$	$6^3/_8$	$7^3/_8$	...	...	...	...
110	5	6	7	$8^3/_8$	..	...	...
120	$4^3/_4$	$5^3/_4$	$6^3/_4$	8		...	...
125	$4^5/_8$	$5^5/_8$	$6^5/_8$	$7^3/_4$	...	...	...
130	$4^5/_8$	$5^1/_2$	$6^1/_2$	$7^5/_8$		...	...
140	$4^1/_2$	$5^3/_8$	$6^1/_4$	$7^3/_8$	$8^3/_8$	...	...
150	$4^1/_4$	$5^1/_8$	6	$7^1/_8$	8	..	...
160	$4^1/_8$	5	$5^7/_8$	$6^7/_8$	$7^3/_4$		...
170	4	$4^7/_8$	$5^5/_8$	$6^3/_4$	$7^1/_2$	$8^3/_8$	...
180		$4^3/_4$	$5^1/_2$	$6^1/_2$	$7^3/_8$	$8^1/_8$	...
190	...	$4^5/_8$	$5^3/_8$	$6^3/_8$	$7^1/_8$	$7^7/_8$	...
200	.	$4^1/_2$	$5^1/_4$	$6^1/_8$	7	$7^3/_4$	$8^1/_2$
225	..	$4^1/_4$	$4^7/_8$	$5^7/_8$	$6^1/_2$	$7^1/_4$	8
250	...	4	$4^5/_8$	$5^1/_2$	$6^1/_4$	$6^7/_8$	$7^5/_8$
300	...	...	$4^1/_4$	5	$5^5/_8$	$6^1/_4$	7

U-35. The diameter of a screw stay shall be taken at the bottom of the thread, provided this is the least diameter.

U-36. The least cross-sectional area of a stay shall be taken in calculating the allowable stress, except that when the stays are welded and have a larger cross-sectional area at the weld than at some other point, in which case the strength at the weld shall be computed as well as in the solid part and the lower value used.

U-37. Holes for screw stays shall be drilled full size or punched not to exceed $^1/_4$ in. less than full diameter of the hole for plates over $^5/_{16}$ in. in thickness, and $^1/_8$ in. less than the full diameter of the hole for plates not exceeding $^5/_{16}$ in. in thickness, and then drilled or reamed to the full diameter. The holes shall be tapped fair and true, with a full thread.

U-38. The ends of steel stays upset for threading, shall be thoroughly annealed.

U-39. *a* The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay, and the area occupied by the stay shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in lb. per sq. in., gives the load to be supported by the stay.

b The maximum allowable stress per square inch at point of least net cross-sectional area of stays and staybolts shall be as given in Table U-3. In determining the net cross-sectional area of drilled or hollow staybolts, the cross-sectional area of the hole shall be deducted.

U-40. Where it is impossible to calculate with a reasonable degree of accuracy the strength of a pressure vessel or any part thereof, a full-sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test.

RIVETING

U-41. Drilling of Holes. All rivet holes and holes in braces and lugs shall be drilled full size or they may be punched not to exceed $^1/_4$ in. less than full diameter for material over $^5/_{16}$ in. in thickness, and $^1/_8$ in. less than full diameter for material not exceeding $^5/_{16}$ in. in thickness. Plates, butt straps, braces, heads and lugs shall be firmly bolted in position by tack bolts for drilling or reaming all rivet holes in plates except those used for the tack bolts.

U-42. Rivets. Rivets shall be of sufficient length to completely fill the rivet holes and form heads at least equal in strength to the bodies of the rivets. Forms of rivet heads that will be acceptable are shown in Fig. U-2.

TABLE U-3 MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

Description of Stays	Stresses, Lb. per Sq. In. For lengths between supports not exceeding 120 diameters	For lengths between supports exceeding 120 diameters
a Unwelded or flexible stays less than 20 diameters long, screwed through plates with ends riveted over..........	7,500	.....
b Hollow steel stays less than 20 diameters long, screwed through plates with ends riveted over	8,000	....
c Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and line *b*..	9,500	8,500
d Steel through stays exceeding $1^1/_2$ in. diameter.	10,400	9,000
e Welded portions of stays	6,000	6,000

CALKING

U-43. Calking. The calking edges of plates, butt straps and heads shall be beveled to an angle not sharper than 70 deg. to the plane of the plate, and as near thereto as practicable. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $^1/_8$ in. Calking shall be done with a round-nosed tool.

MANHOLES

U-44. Manholes and Handholes. An elliptical manhole opening shall be not less than 11 by 15 in., or 10 by 16 in. size. A circular manhole opening shall be not less than 15 in. in diameter.

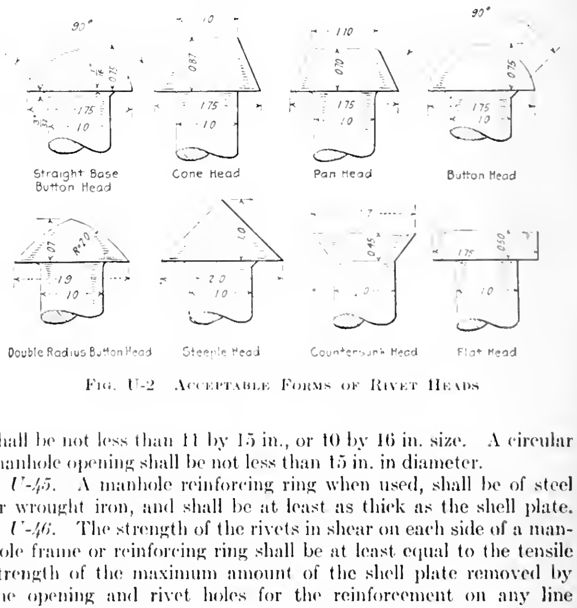


Fig. U-2 Acceptable Forms of Rivet Heads

U-45. A manhole reinforcing ring when used, shall be of steel or wrought iron, and shall be at least as thick as the shell plate.

U-46. The strength of the rivets in shear on each side of a manhole frame or reinforcing ring shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole, or other opening.

U-47. Manhole plates shall be of wrought steel or shall be steel castings.

THREADED OPENINGS

U-48. A pipe connection 1 in. in diameter or over shall have not less than the number of threads given in Table U-4. Diameters of less than 1 in. pipe size shall have at least four threads.

If the thickness of the material in the pressure vessel is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, or a boss may be built up by an autogenous welding process, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 125 lb. per sq. in., a connection riveted to the pressure vessel to receive a flanged fitting shall be used for all pipe openings over 3 in. pipe size.

TABLE U-4 MINIMUM NUMBER OF PIPE THREADS FOR CONNECTIONS

Size of pipe connection, in.	1 and $1^1/_4$	$1^1/_2$ and 2	$2^1/_2$ to 4 inclusive	$4^1/_2$ to 6 inclusive	7 and 8	9 and 10	12
Number of threads per inch	$11^1/_2$	$11^1/_2$	8	8	8	8	8
Minimum number threads required in opening	4	5	7	8	10	12	13
Minimum thickness of material required to give above number of threads, in.	0.0348	0.433	0.875	1	1.25	1.5	1.625

U-49. Supports. All vessels must be so supported as to properly distribute the stresses arising from the weight of the vessel and contents. Class A vessels over 16 in. in diameter must be so arranged that the interior and exterior of the vessel may be inspected. In the case of vertical cylindrical vessels subject to corrosion, the bottom head, if dished, must be with the pressure on the concave side to insure complete drainage.

Lugs or brackets when used to support a vessel shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on steel and rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. U-10 and U-11.

U-50. In laying out the plates for Class A pressure vessels, care must be taken to leave one of the stamps required in the Specifications for Boiler Plate Steel, so located as to be plainly visible when the vessel is completed; or in case these are unavoidably cut out, the heat number, quality of plate, minimum tensile strength and maker's name shall be accurately transferred as to form by the pressure vessel manufacturer, to a location where these stamps will be visible. The form of stamping shall be such that it can be readily distinguished from the plate maker's stamping.

U-51. Every Class A pressure vessel shall conform in all details with these rules, and when so constructed shall be stamped with the legend provided for in Par. U-54.

U-52. Each vessel constructed under these rules shall be tested under hydrostatic pressure to 50 lb. in excess of the working pressure when same does not exceed 100 lb., and to $1^1/_2$ times the working pressure for pressures above 100 lb.

U-53. Every Class A pressure vessel shall be inspected at least once by a state or municipal inspector of boilers, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the vessel is built, and in the state in which it is to be used, if known, which inspection shall be when the hydrostatic pressure test is on. A data sheet shall be filled out and signed by the manufacturer and the inspector, which data sheet together with the stamping on the vessel, will denote that it was constructed in accordance with these rules. Every Class A pressure vessel fabricated in whole or in part by a welding process shall, when the size of the shell permits, be internally inspected before being finally closed to inspection.

U-54. Each such pressure vessel shall be marked in the presence of the inspector, A.S.M.E. Std. P.V., the class, and with the manufacturer's name and serial number, and working pressure. These markings shall be stamped with letters and figures at least $^5/_{16}$ in. high on some conspicuous portion of the vessel, preferably near a manhole, if any, or handhole. These stamps shall be arranged substantially as follows:

A S M E STD P V.

A

Serial No

Max W P. lb

Mfrs No

(Mfrs Name)

and shall not be covered with insulating or other material. The symbol authorized for use on power boilers shall not be used on pressure vessels.

CLASS-B VESSELS

U-55. Vessels of this class may be constructed of untested open-hearth steel in which case the maximum allowable unit working stress shall be 10,000 lb. per sq. in.

U-56. Crushing and shearing values and butt strap thicknesses shall be as specified in Pars. U-10, U-11, and U-14.

U-57. Maximum allowable working pressure and calculation of riveted joints shall be as specified in Pars. U-15, U-16, U-17, U-18, and U-20, except that the maximum allowable unit working stress in Par. U-16 shall be 13,750 lb. per sq. in. for plate stamped 55,000 lb. per sq. in. as herein provided, and 12,500 lb. per sq. in. for special steel plate for welding (Pars. U-100 and U-101).

U-58. The longitudinal joint of a shell or drum may be of lap-riveted construction.

U-59. Use Pars. U-25, U-26, U-27, and U-28 for calculating the thickness of heads, modifying the formula in Par. U-25 to read as follows:

$$t = \frac{PL}{18{,}000}$$

U-60. The design of braced and stayed surfaces shall be in accordance with the rules provided in Pars. U-29, U-30, U-31, U-32, U-33, U-34, U-35, U-36, U-37, U-38, and U-39, except that the working pressure determined may be increased 25 per cent.

U-61. All rivet and staybolt holes may be punched full size.

U-62. Rivets shall be of sufficient length to fill the rivet holes and form full heads.

U-63. Calking shall be done with a round-nosed tool.

U-64. The provisions for manholes and handholes as given in Pars. U-44, U-45, and U-46 shall apply to Class B vessels.

U-65. Manhole plates may be of wrought steel, steel castings, or cast iron.

U-66. The provisions of Par. U-48 shall be followed for pipe connections.

U-67. The provisions of Pars. U-2, U-3, and U-49 shall govern safety appliances, supports, etc.

U-68. The provisions of Par. U-4 shall apply to vessels of Class B, except that the formula given shall be modified as follows:

$$S = 0.0125\,El\,(e + 16), \text{ but not more than } 0.65El \text{ or } 0.25T$$

U-69. Each vessel constructed under these rules shall be tested under hydrostatic pressure to 50 lb. in excess of the working pressure when same does not exceed 100 lb., and to $1^1/_2$ times the working pressure for pressures above 100 lb.

U-70. Pressure vessels constructed in accordance with the rules for Class B vessels may be stamped by the manufacturer only, with the legend provided in Par. U-71. When the manufacturer elects to so stamp vessels of this class, records of the kind of material and all details of construction must be kept and a data sheet giving this information must be furnished the purchaser or user if demanded.

U-71. When Class B pressure vessels are stamped in order to indicate that they comply with this Code, the provisions of Par. U-54 shall apply, except that the class letter shall be B instead of A, and the presence of an inspector is not necessary.

CLASS-C VESSELS

U-72. Material. All vessels under this classification shall be made of steel plate not under $^1/_4$ in. nor more than $^5/_8$ in. in thickness and welded by the oxy-acetylene, electric-arc or forge-welding processes. If forge welding is used the requirements of Pars. U-111 to U-135 shall be followed. Except for forge welding, all plates shall conform to the following specifications:

a Manufacture: The plate shall be made by the open-hearth process and must be free from physical defects such as cracks, seams, scabs, splinters, slivers, etc. Any plate not conforming to these specifications may be rejected.

b Chemical Analysis: The composition shall be as follows:

Carbon	0.08–.15 per cent (.12 preferred)
Manganese	0.30–.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.05 per cent
Silicon	not over 0.25 per cent

c Physical Properties: The plate shall be of the following physical properties:

Tensile strength, max., lb. per sq. in.	60,000
Yield point, min., lb. per sq. in.	26,000
Elongation in 8 in., min., per cent	1,500,000 Tensile Strength

d The yield point shall be determined by the drop of the beam of the testing machine at a speed not exceeding $^1/_2$ in. per minute.

e The plate shall be of good welding quality.

U-73. The maximum allowable working pressure for single-shell vessels shall be determined by the following formula:

$$P = \frac{4500\, t}{R}$$

where t = thickness of plate in in.
R = inside radius

U-74. The formula given in U-25 shall be used in calculating the thickness of heads necessary for the various pressures and diameters.

U-75. The ratio of diameter to thickness of plate in no case shall exceed 320.

U-76. *Welded Seams.* All surfaces to be welded must be cleaned preparatory to welding, by sandblasting, chipping, or any other approved method of cleaning.

U-77. For metallic arc welding the following specification for welding wire shall apply:

Carbon	not over 0.18
Manganese	0.40–0.60
Silicon	not over 0.06
Phosphorus	not over 0.04
Sulphur	not over 0.04

Any approved brand of arc-welding wire conforming to the above specification may be used which has been found by practice to give good results. The wire shall be cold drawn and must flow freely and evenly. It may be used bare, coated or covered.

For acetylene welding any approved brand of gas welding wire may be used.

U-78. Class C vessels will be considered under two types, single-shell vessels and jacketed vessels.

U-79. Longitudinal and circumferential seams of single-shell vessels welded by either the oxy-acetylene or electric-arc processes shall be double-V welded.

The weld on the inside of single-shell vessels may be ground flush with the surface of the plate.

U-80. Jacketed or double-shell vessels may be of two types, one in which one of the heads of the inner vessel forms the sealer apron for the jacket, and one in which the sealer apron is joined to the shell of the inner tank at some point between the heads, forming a partially jacketed vessel.

U-81. In all cases the inner vessel of a jacketed tank shall be of the same construction as a single-shell tank.

U-82. The longitudinal seam of the jacket and the seam joining the head to shell on all jacketed vessels welded by either the oxy-acetylene or electric-arc process shall be double-welded.

U-83. In jacketed vessels where the sealer apron is welded to the cylinder of the inner tank, the weld may be made from one side only, provided the thickness of the metal deposited is equal to or greater than the thickness of the sealer apron.

U-84. In jacketed vessels where the top head of the inner tank forms the sealer apron, the head may be welded to the shell of the inner tank from the inside only, provided the thickness of the weld after grinding is equal to or greater than the thickness of the head.

U-85. All cylinders shall be rerolled after welding.

U-86. All vessels shall be tested to a hydrostatic pressure equal to the working pressure.

VESSELS CONSTRUCTED WITH WELDED OR BRAZED JOINTS

U-87. All Class B vessels may be fabricated by means of autogenous or forge welding, or brazing provided the rules governing the method adopted and as given in Pars. U-92 to U-151 of the Code are followed.

U-88. The following Class A vessels may be fabricated by means of autogenous welding with the exception of longitudinal seams when the rules given in Pars. U-92 to U-110 are followed:

a Air tanks in which the pressure does not exceed 150 lb. per sq. in.

b Tanks for containing other than noxious or explosive gases other than ammonia, when the pressure does not exceed 150 lb. per sq. in.

c Tanks for containing liquids other than those which are noxious or explosive, when the pressure does not exceed 150 lb. per sq. in.

d Tanks for containing ammonia shall be built for a maximum allowable working pressure of 250 lb. per sq. in. and installed in connection with safety valves to prevent this pressure being exceeded.

U-89. Class A vessels for any uses or pressures may be fabricated by means of forge welding when the rules given in Pars. U-111 to U-135 are followed.

U-90. Class A vessels for any pressures and for any temperatures not exceeding 450 deg. fahr., may be fabricated by means of the brazing process when the rules given in Pars. U-136 to U-151 are followed.

U-91. The design and construction of all vessels with welded or brazed joints shall conform to and be based upon the formulas, specifications and data which are given in this Code.

RULES FOR THE AUTOGENOUS PROCESS OF WELDING

U-92. *Processes.* The autogenous process, so-called, shall consist of welding by means of either the oxy-acetylene process or the electric-arc process, using a metallic electrode, either bare, coated or covered.

U-93. When properly welded by the autogenous process, the strength of a joint may be taken as a maximum of 28,000 lb. per sq. in. of net section of plate.

U-94. *Terms.* The term *base metal* as used herein shall mean the metal or metals of which the vessel is constructed and which are joined together by the welded seam.

U-95. *Filling Material.* The term "filling material" as used herein shall mean the weld rod, filling rod, electrode or other metal which is used to join together two sections of the base metal, or metals. The following material has been shown to give acceptable results and may be used:

For Oxy-Acetylene Welding

Carbon	not over 0.06 per cent
Silicon	not over 0.08 per cent
Manganese	not over 0.15 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent
or	
Carbon	0.18 to 0.22 per cent
Manganese	0.40 to 0.50 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent
Nickel	3.0 to 3.5 per cent

For Electric-Arc Welding

Carbon	not over 0.06 per cent
Silicon	not over 0.08 per cent
Manganese	not over 0.15 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent
or	
Carbon	0.12 to 0.18 per cent
Silicon	not over 0.06 per cent
Manganese	not over 0.40 to 0.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent

U-96. *Weld Metal.* The term *weld metal* as used in this code shall mean the metal of which the welded seam is composed after welding is completed, and which is described as being the metal deposited between the edges and for the purpose of joining the sections of the base metal. This metal may be, and usually is, a combination of base metal and filling metal, modified in the process of fusing.

U-97. *Material for Base Metal.* The base metal shall not exceed $^5/_8$ in. thickness and shall be made by the open-hearth process, of soft and good weldable quality, and shall conform to the following requirements:

Chemical Properties and Tests

U-98. *Chemical Composition:*

Carbon	not over 0.15 per cent
Manganese	not over 0.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.05 per cent

The silicon, nickel, or chromium content shall not be of such amount as will affect adversely the welding qualities of the plate, and in any event shall not exceed 0.05 per cent.

U-99. Ladle Analysis. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, and sulphur. This analysis shall be made from a test ingot taken during the pour of the melt. The chemical composition thus determined shall be reported to the purchaser, or his representative, and shall conform to the requirements specified in U-98.

Physical Properties and Tests

U-100. Tension Tests. *a* The base metal shall conform to the following requirements:

Tensile strength, max., lb. per sq. in.	55,000
Yield point, min., lb. per sq. in.	24,000
Elongation in 8 in., min., per cent	$\frac{1{,}500{,}000}{\text{Ten. Str.}}$

b The yield point shall be determined by the drop of the beam of the testing machine at a speed not exceeding $^1/_2$ in. per minute.

U-101. Test Specimens, Bend Tests, Finish, Etc. The test specimens, bend tests, homogeneity tests, number of tests, permissible variation in gage, finish, marking, inspection, rejection, shall conform with the requirements of the Specifications for Boiler Plate Steel.

U-102. Method of Welding. Seams, or joints may be welded on both sides by the double-V method, so-called, or on one side only with a single-V, using the butt-strap method in which the butt strap is tacked clear of the sheet at least $^1/_{16}$ in., or by such other method as will best assure the joint being filled with sound metal thoroughly fused, and to a thickness in excess of the maximum thickness of the plate, not less than 10 per cent, nor more than 15 per cent, see Fig. U-3, (*a*).

There shall be no valley either at the edge or in the center of the joint and the weld shall be so built up that the welded metal will present a gradual increase in thickness from the surface of the sheet to the center of the weld. At no point shall the sheet on one side of the joint be offset with the sheet on the other side of the joint in excess of one-quarter of the minimum thickness of the sheets, or plates.

U-103. Longitudinal Joints. Where vessels are made up of two or more cylinders, the welded longitudinal joints of adjacent sections shall be 180 deg. apart.

U-104. Distortion. The cylinder, or barrel of a vessel shall be substantially circular at any section, and to meet this requirement shall be reheated, rerolled or reformed.

U-105. Dished Heads. Dished heads convex to the pressure shall have a skirt not less than 3 in. long and shall be inserted into the shell with a driving fit in excess of the full length of the skirt, welded to the shell with a V'ed weld, heated to the annealing point, the shell to be constricted on the end to a diameter not less than 1 in. smaller than the original diameter.

Dished heads concave to the pressure shall have a skirt not less than one-tenth the diameter of the shell but not less than 3 in. long, and shall be attached to the cylinder by a butt weld.

U-106. Hemi-Spherical Heads. Hemi-spherical heads concave to the pressure shall have a skirt not less than 1 in. long, and shall be attached to the cylinder by a butt weld.

U-107. Nozzles. Nozzles in heads or shells over 3 in. and not to exceed 8 in. nominal size, shall be of forged or rolled steel with a flared skirt. These nozzles shall have a forged, rolled or Van Stone flange for pipe connections. The method of welding shall be as shown at (*a*), Fig. U-3.

U-108. Nipples. Nipples or couplings over 2 in. and not to exceed 3 in. nominal pipe size, shall be inserted from the inside through the sheet or plate, shell or head to a flange or shoulder and welded thoroughly from the bottom of the V'ed shell plate and with a fillet, as shown at (*b*) and (*c*) in Fig. U-3. The thickness of the nipple or coupling wall and shoulder shall be not less than extra heavy pipe-size standard. Nipples of this type smaller than 3 in. may conform to this same construction.

Threaded nipples 3 in. nominal pipe size and under, may be made of extra heavy steel pipe or steel tubing with corresponding thickness of wall, inserted in a hole with V'ed edges in the shell or head, and welded full with a fillet as specified before in this paragraph and as shown at (*d*) and (*e*) in Fig. U-3. Threaded connections for pipes 3 in. and under may be made by using an extra heavy pipe-size coupling inserted in a hole with V'ed edges in the shell or head and welded full with a fillet as before specified for nipples of like size and shown at (*e*) in Fig. U-3. Threaded connections for pipes 3 in. and under may also be made by building up a boss of filling metal thoroughly fused to the plate or sheet, and then drilling and tapping through both boss and sheet; the outside diameter of the boss shall be not less than the outside diameter of the boss of an extra heavy cast fitting of like pipe size, all as shown at (*f*) in Fig. U-3. The height of the boss and tapping shall be such that when a nipple is screwed into place, the inner end of the nipple, which shall have the full number of threads, shall be at least flush with the inner surface of the plate or sheet.

U-109. Hydrostatic Tests. While subject to the hydrostatic pressure herein before specified, a thorough hammer or impact test shall be given. This impact test shall consist of striking the sheet on both sides of the welded seam a sharp vibratory blow with a 2- to 6-lb. hammer with a handle similar to a blacksmith's striking hammer, the blows to be struck 2 to 3 in. apart and within 2 to 3 in. of, and on each side of, the seam—the blows to be as rapid as a man can conveniently strike a sharp, swinging blow, and as hard as can be struck without indenting or distorting the metal of the sheet. During this test the shell shall be completely filled with water.

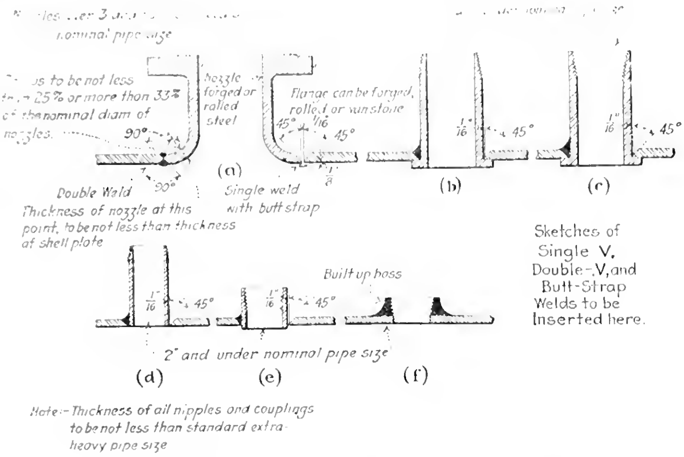


Fig. U-3 Methods of Autogenously Welding Nozzles

U-110. Defective Welds. Welded seams, or joints, which do not pass this test without leaks, distortion or other signs of distress shall not be accepted until the defects are remedied and a further test applied which shall be successfully passed. Defective sections of a welded seam may be cut out and rewelded provided the value of the sheet has not been definitely lowered, and where this shall be brought into question a coupon shall be cut out across the weld at this point or points in question and subjected to microscopic or other examination.

RULES FOR FORGE WELDING

U-111. The plate for any part of a forge-welded vessel, on which welding is done, shall be of forge welding quality in accordance with the following specifications:

U-112. Process. The steel shall be made by the open-hearth process.

U-113. Chemical Composition. (*a*) The steel shall conform to the following requirements as to chemical composition:

Carbon	for plates ¾ in. or under in thickness	not over 0.18 per cent
	for plates over ¾ in. in thickness	not over 0.20 per cent
Manganese		0.40–0.60 per cent
Phosphorus		not over 0.04 per cent
Sulphur		not over 0.05 per cent

(b) The composition of steel for forge welding plates should preferably be free from silicon, nickel or chromium. Where these elements are present the maximum quantity of any one shall not exceed 0.05 per cent.

U-114. Ladle Analysis. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulphur. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in U-113.

U-115. Check Analysis. An analysis may be made by the purchaser from a broken tension test specimen representing each melt. The chemical composition thus determined shall conform to the requirements specified in U-113.

U-116. Tension Tests. a The material shall conform to the following requirements as to tensile properties:

Tensile strength, max., lb. per sq. in.	55,000
Yield point, min., lb. per sq. in.	24,000
Elongation in 8 in., per cent	$\frac{1{,}500{,}000}{\text{Tens. str.}}$

b The yield point shall be determined by the drop of the beam of the testing machine, at a speed not exceeding $^1/_2$ in. per minute.

U-117. Modifications in Elongation. a For material over $^3/_4$ in. in thickness, a deduction from percentage of elongation specified in U-116 *(a)* of 0.25 per cent shall be made for each increase of $^1/_{32}$ in. of the specified thickness above $^3/_4$ in., to a minimum of 20 per cent.

b For material under $^5/_{16}$ in. in thickness, a deduction from the percentage of elongation in 8 in. specified in U-116 *(a)* of 1.25 per cent shall be made for each decrease of $^1/_{32}$ in. of the specified thickness below $^5/_{16}$ in.

U-118. Bend Tests. The test specimen shall bend cold through 180 deg. flat on itself without cracking on the outside of the bent portion.

U-119. Test Specimens. a Test specimens shall be prepared for testing from the material in its rolled condition.

b Test specimens shall be taken longitudinally and except as specified in Par. *(c)* shall be of the full thickness of material as rolled. They may be machined to the form and dimensions shown in Fig. U-4, or with both edges parallel. (See Fig. 1, page 13, of Part 1, Section 1, of the A.S.M.E. Boiler Code.)

c Test specimens for plates over $1^1/_2$ in. in thickness may be machined to a thickness or diameter of at least $^3/_4$ in. for a length of at least 9 in.

d The machined sides of rectangular bend test specimens may have the corners rounded to a radius not over $^1/_{16}$ in.

U-120. Number of Tests. a One tension and one bend test shall be made from each melt; except that if material from one melt differs $^3/_8$ in. or more in thickness, one tension and one bend test shall be made from both the thickest and the thinnest material rolled.

b If any test specimen shows defective machining or develops flaws it may be discarded and another specimen substituted.

c If the percentage of elongation of any tension test specimen is less than that specified in U-116 *(a)* and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

U-121. Finish. The finished material shall be free from injurious defects and shall have a workmanlike finish.

U-122. Marking. The name or brand of the manufacturer and the melt number shall be legibly rolled or stamped on all finished material. The melt number shall be legibly marked, by stamping if practicable, on each test specimen.

U-123. Inspection. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's work which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

U-124. Rejection. a Unless otherwise specified, any rejection based on tests made in accordance with U-115 shall be reported within five working days from the receipt of samples.

b Material which shows injurious defects subsequent to its acceptance at the manufacturer's works willl be rejected, and the manufacturer shall be notified.

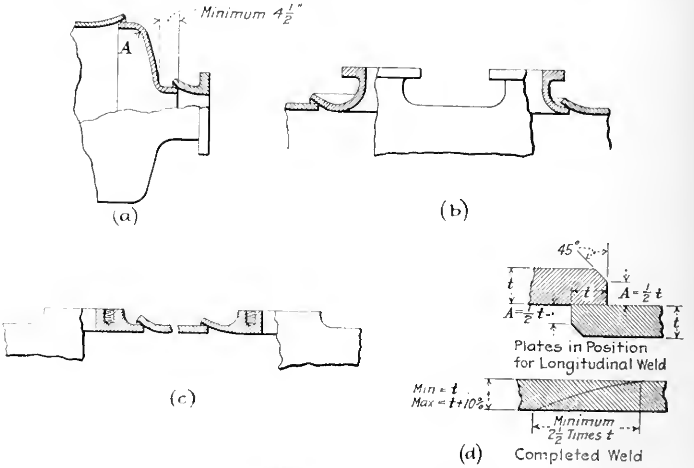


Fig. U-5 Methods of Forge Welding

U-125. Rehearing. Samples tested in accordance with U-115, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for rehearing within that time.

U-126. The minimum thickness of any plate shall be $^1/_4$ in., but in no case shall the thickness of shell plate be less than the diameter of the vessel divided by 200.

U-127. The efficiency of the joint when properly welded by the forge welding process may be taken as 85 per cent of the minimum ultimate strength of the plate for Class A vessels and as 95 per cent for Class B vessels.

U-128. Corner Radius of Dished Heads. The corner radius of a dished head measured on the concave side of the head, shall be not less than 6 per cent of the inside diameter of the head [see *A* at *(a)*, Fig. U-5].

U-129. Depth of Flange. The depth of flange on the flanged and dished head measured from a point tangent to the corner radius of the head to the end of the flange, shall be not less than 5 in.

U-130. Heating. The heating agent shall be suitably prepared water gas or other heating medium by which equivalent or superior results will be obtained, and shall be applied to both sides of the section and adjacent surfaces, and precaution shall be taken to see that the flame is of a type that will minimize the possibility of burning or oxidizing the metal and that it be free from all impurities which would tend to introduce foreign elements into the steel. The temperature of the flame for heating the surfaces shall be under constant and close control.

U-131. Welding. The edges that are to be welded together shall be lapped a distance at least equal to the thickness of the plate to be welded. All plates 1 in. thick and under shall be welded without scarfing; plates more than 1 in. thick, if desired by the manufacturer, may be scarfed, the scarf to start at least one-half

the thickness of the plate from the side next to the weld [see *A* at (*d*), Fig. U-5]. After the material has been brought up to the proper welding temperature, it shall be placed between an anvil and a hammer, or between rolls, or mandrel and roll, or between mandrels, and the plates welded together by a pressure, applied by the hammer or rolls, or mandrels, which will actually displace the material while the welding action is occurring. The metal in and adjacent to the weld shall not be worked at what is termed the critical blue heat temperature of the steel, that is, between about 400 and 800 deg. fahr.

The thickness of the weld for all longitudinal and circumferential seams or special welds [see (*d*), Fig. U-5] shall be as follows:

Minimum = t
Maximum = t plus 10 per cent

The contact line of completed forge weld shall be equal to at least two and one-half times the thickness of the plate (t) as shown at (*d*), Fig. U-5.

U-132. Annealing. All longitudinal and circumferential welds shall be annealed by heating to the proper temperature to relieve strains and then allowed to cool slowly. All longitudinal welds on cylindrical vessels shall be heated not less than 8 in. each side of the center of the weld or the entire shell, after which they shall be re-rolled to a commercially true cylindrical form. If any vessel has been distorted out of shape it must be reformed and then annealed or reformed at a proper annealing temperature. In a finished cylindrical shell the variations in diameters shall not exceed 1 per cent of the mean outside diameter when measured at any section. When a straight edge two diameters long is laid longitudinally on the outside of a shell, it shall be possible to so set the straight edges that no part of the edge will come farther than 1 per cent of the mean outside diameter from the outer surfaces of the shell.

U-133. Inlet and Outlet Connections. All connections less than 5 in. standard pipe size may be attached by autogenous welding as specified in the code for autogenous welding. Nozzles 5 in. and over shall be attached by forge welding or by riveting.

If nozzles are attached by forge welding, they shall be of forge or rolled steel material, seamless tubing, or forge-welded pipe, attached to shell by forge welding, by either of the two methods shown at (*b*), Fig. U-5 or attached to a bead by forge-welding as shown at (*a*), Fig. U-5. Either the nozzle or shell may be flared for this purpose.

Saddle flanges may be used if made of forged steel and may be attached by forge welding or riveting by either of the two methods shown at (*c*), Fig. U-5.

All dished heads may be attached to shell by forge welding as shown at (*a*), Fig. U-5, or by riveting. (Note corner radius *A* referred to in Par. U-128).

U-134. Hydrostatic Tests. Vessels with seams or joints made by the forge welded process shall be subjected to the test specified in Par. U-109.

U-135. Every vessel with forge welded joints shall be inspected during its entire construction at the shop where manufactured. In the case of Class A vessels, the inspection and stamping shall be as provided in Pars. U-53 and U-54.

RULES FOR BRAZING

U-136. Steel plates for any part of a brazed vessel shall be made by the open-hearth process and shall not exceed $^5/_8$ in. in thickness. Plates $^1/_4$ in. thick or heavier may be of either flange or firebox quality as provided for in the Specifications for Boiler Plate Steel.

Chemical Properties and Tests

U-137. Sheets lighter than $^1/_4$ in. shall have the following properties:

U-138. Chemical Composition.

Carbon	not over 0.24 per cent
Manganese	not over 0.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.05 per cent

U-139. Ladle Analysis. An analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the specifications given above.

U-140. Check Analysis. An analysis may be made by the purchaser from a broken tension test specimen which shall conform substantially to the requirements specified above.

Physical Properties and Tests

U-141. Tension Tests. The material shall conform to the following requirements as to tensile properties:

Tensile strength, max., lb. per sq. in.	70,000
Yield point, min., lb. per sq. in.	28,000
Elongation in 8 in., min., per cent	$\frac{1,500,000}{\text{Ten. Str.}}$

except that this may be reduced by $2^1/_2$ per cent for each $^1/_{16}$ in. under $^5/_{16}$ in.

U-142. Bend Test. The bend-test specimen shall bend cold through 180 deg. without cracking on the outside of the bent portion when bent around a pin the diameter of which is equal to the thickness of the specimen.

U-143. Number of Tests. Two tension tests and two bend tests shall be taken from each heat, but not both tension or both bend tests from the same slab.

U-144. Sheets less than $^1/_4$ in. in thickness shall not be required to be stamped at the mill on account of the small size and light weight of the sheets. The manufacturer must mark each tank in some permanent manner which will enable him to identify the heat from which the sheet in each tank has been rolled.

U-145. When the safety of the structure does not depend upon riveting in the joints, rivet holes may be punched full size.

U-146. For threaded openings, if the thickness of material in the pressure vessel is not sufficient to give the number of threads specified in U-18, the openings may be reinforced by a plate brazed to the shell, or have a boss built up by the welding process.

U-147. The strength of the joint when properly brazed may be taken as 95 per cent of the minimum ultimate strength of the plate.

U-148. Longitudinal seams shall have the edges of the plate lapped a distance of not less than eight times the thickness of the metal. The lap shall be held closely in position substantially metal to metal, by stitch riveting or other sufficient means. The brazing shall be done by placing the flux and brazing material on one side of the joint and applying heat until this material comes entirely through the lap and shows uniformly along the seam on the other side. Sufficient flux must be used to cause the brazing material to so appear promptly after reaching the brazing temperature. The brazing material used shall be such as to give a joint having a shearing strength of at least 10,000 lb. per sq. in.

U-149. Head Seams. Heads shall be driven into the shells with a tight driving fit, and shall be thoroughly brazed in approximately the same manner as the longitudinal seam for a depth or distance from the end of the shell equal to at least four times the thickness of the shell metal.

U-150. Vessels with seams or joints made by the brazing process shall be subjected to the test specified in Par. U-109.

U-151. If it is desired to stamp vessels with brazed joints, in order to indicate that they have been constructed in accordance with this Code, the provisions of Pars. U-53 and U-54 for Class A vessels, or of Pars. U-70 and U-71 for Class B vessels must be followed using the proper class letter in the authorized stamping.

Boiler plate, unless it is of the very best material, is often the cause of many troubles in the welding of the tubes into the sheet. The very method of making the plate tends to poor and non-uniform structure unless strict instructions are given as to the cropping, and are followed out. The impurities that go to the central part of the ingot will form flaws that will untimately find their way into the weld and in time result in leaks and fractures.

In determining the best method of welding the tubes into the tube sheet, consideration is given to three things: (1) the effect of the welding on the metal of both the tube and the tube sheet; (2) the effect of the final outline of the tube end, the tube sheet and the deposited metal, upon the hot gases entering the tube; (3) the amount of work required to perform the entire operation from start to finish. (*Power*, October 10, 1922, p. 558.)

Revision of Heating Boiler Section of A.S.M.E. Boiler Code, 1922

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the Society in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be invited and where they may present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Heating Boiler Section of the Code, as a result of the interpretations issued. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote special consideration to the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

These revisions in the rules are here published and it is the request that they be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

Preliminary Report on Rules for the Construction of Boilers used Exclusively for Low-Pressure Steam Heating, Hot-Water Heating, and Hot-Water Supply

These rules are divided into two sections: Section 1 applying to steel-plate boilers, and Section 2 applying to cast-iron boilers. They do not apply to economizers or feedwater heaters.

SECTION 1—STEEL-PLATE BOILERS

H-1. These rules for steel-plate boilers shall apply:

a To all steam boilers for operation at pressures not exceeding 15 lb. per sq. in.

b To steel-plate hot-water boilers not exceeding 60 in. in diameter, or 160 lb. working pressure, or temperatures not exceeding 250 deg. fahr.

c For conditions exceeding those specified above, the rules for power boilers shall apply.

H-2. Wherever the term maximum allowable working pressure is used herein, it refers to gage pressure or the pressure above the atmosphere in pounds per square inch.

H-3. The maximum allowable working pressure shall not exceed 15 lb. per sq. in. on a steel-plate boiler built under these rules to be used for low-pressure steam heating.

The maximum allowable working temperature at or near the outlet of a hot-water steel-plate boiler shall not exceed 250 deg. fahr., or the maximum allowable working pressure 160 lb. per sq. in.

H-4. All steel-plate steam-heating and hot-water boilers shall be designed for a factor of safety of not less than 5, but in no case shall the pressure on which the factor of safety is based be considered less than 30 lb.

MATERIALS

H-5. Specifications are given in the Rules for Power Boilers, Pars. 23-178, for the important materials used in the construction of boilers, and where so given the materials herein mentioned for boiler parts required to resist internal pressure shall conform thereto except as specified herein for autogenously welded boilers.

H-6. Steel plates for any part of a boiler where under pressure, also manhole and handhole covers and other parts subjected to pressure, and braces and lugs when made of steel plate, shall be of firebox or flange quality as designated in the Specifications for Boiler-Plate Steel, except for base metal as specified for autogenous welding.

H-7. Braces when made of parts welded together shall be of wrought iron of the quality designated in the Specifications for Refined Wrought-Iron Bars.

ULTIMATE STRENGTH OF MATERIAL

H-8. Tensile Strength of Steel Plate. In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates as herein provided, which is the minimum of the stipulated range, or 55,000 lb. per sq. in. for all steel plates except for special grades having a lower tensile strength.

H-9. Crushing Strength of Steel Plate. The resistance to crushing of steel plate shall be taken at 95,000 lb. per sq. in. of cross-sectional area.

H-10. Strength of Rivets in Shear. In computing the ultimate strength of rivets in shear, the following values in pounds per square inch of the cross-sectional area of the rivet shank shall be used:

Iron rivets in single shear	38,000
Iron rivets in double shear	76,000
Steel rivets in single shear	44,000
Steel rivets in double shear	88,000

The cross-sectional area used in the computations shall be that of the rivet shank after driving.

MINIMUM THICKNESS OF PLATES AND TUBES

H-11. The minimum thickness of any boiler plate under pressure shall be $^1/_4$ in.

H-12. The minimum thickness of shell plates, heads and tube sheets for various shell diameters of steel-plate heating boilers shall be as shown in Table H-1.

TABLE H-1 MINIMUM ALLOWABLE THICKNESS OF SHELL PLATES

Diameter of Shell, Tube Sheet or Head	Minimum Thickness Allowable under Rules: Shell, in.	Minimum Thickness Allowable under Rules: Tube Sheet or Head, in.
42 in. or under	$^1/_4$	$^5/_{16}$
Over 42 in. to 60 in.	$^5/_{16}$	$^3/_8$
Over 60 in. to 78 in.	$^3/_8$	$^7/_{16}$
Over 78 in.	$^7/_{16}$	$^1/_2$

H-13. The minimum thickness of butt straps for double-strap joints shall be as given in Table H-2. For plate thickness exceeding $^3/_4$ in., the thickness of butt straps shall be not less than two-thirds of the thickness of the plate.

TABLE H-2 MINIMUM THICKNESS OF BUTT STRAPS

Thickness of Shell Plates, in.	Minimum Thickness of Butt Straps, in.
$^1/_4$	$^1/_4$
$^9/_{32}$	$^1/_4$
$^5/_{16}$	$^1/_4$
$^{11}/_{32}$	$^1/_4$
$^3/_8$	$^5/_{16}$
$^{13}/_{32}$	$^5/_{16}$
$^7/_{16}$	$^3/_8$
$^{15}/_{32}$	$^3/_8$
$^1/_2$	$^7/_{16}$
$^{17}/_{32}$	$^7/_{16}$
$^9/_{16}$	$^7/_{16}$
$^5/_8$	$^1/_2$
$^3/_4$	$^1/_2$

H-14. The minimum thickness of tubes used in water-tube or fire-tube boilers measured by Birmingham wire gage, shall be as given in Table H-3.

TABLE H-3 TUBES FOR WATER-TUBE AND FIRE-TUBE BOILERS

	Minimum Thickness of Tubes
Diameters 1 in. or over but less than $2^1/_2$ in.	No. 13 B.W.G.
Diameters $2^1/_2$ in. or over but less than $3^1/_4$ in.	No. 12 B.W.G.
Diameters $3^1/_4$ in. or over but less than 4 in.	No. 11 B.W.G.
Diameters 4 in. or over but less than 5 in.	No. 10 B.W.G.
Diameters 5 in.	No 9 B.W.G.

JOINTS

H-15. Efficiency of a Joint. The efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate.

H-16. Riveted Boiler Joints. Longitudinal lap-riveted joints

will be allowed on all boilers when the diameter of the boiler shell does not exceed 60 in. (Welded boiler joints—See Pars. H-71 to H-83). If the boiler is to be operated at a working pressure above 30 lb., the rivets must be driven in holes drilled full size or in holes punched not to exceed $^1/_4$ in. less than full diameter and then drilled or reamed to full diameter; also, every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $^1/_8$ in.

H-17. A horizontal-return-tubular boiler used for steam or hot water shall not have lap-riveted longitudinal joints over 12 ft. in length.

H-18. With butt-and-double-strap construction, longitudinal joints of any length may be used.

H-19. The longitudinal joints of horizontal-return-tubular boilers shall be located above the fire line of the setting.

H-20. The ends of shell plates forming the longitudinal joints in either autogenously welded boilers or riveted boilers, and butt straps, shall be formed by pressure, not blows, to the proper curvature.

Braced and Stayed Surfaces

H-21. The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where P = maximum calculated allowable working pressure, lb. per sq. in. (not less than 30 lb.)

T = thickness of plate in *sixteenths* of an inch

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, in.

C = 112 for stays screwed through plates not over $^7/_{16}$ in. thick with ends riveted over or for stays welded into such plates

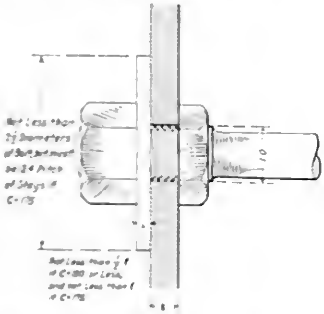


Fig. H-1 Acceptable Proportions for Ends of Through Stays

C = 120 for stays screwed through plates over $^7/_{16}$ in. thick with ends riveted over or for stays welded into such plates

C = 135 for stays screwed through plates and fitted with single nuts outside of plate

C = 150 for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate

C = 175 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than $0.4p$ and thickness not less than T.

If a flat boiler plate not less than $^3/_8$ in. thick is strengthened with a doubling plate covering the full area of the stayed surface and securely riveted thereto and having a thickness of not less than $^2/_3\,T$, then the value of T in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plate but not more than one and one-half times the thickness of the boiler plate, and the value of C given above may also be increased 15 per cent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

Acceptable proportions for the ends of through stays with washers are indicated in Fig. H-1.

H-22. Stays. The ends of stays fitted with nuts shall not be exposed to the direct radiant heat of the fire.

H-23. The diameter of a screw stay shall be taken at the bottom of the thread, provided this is the least diameter. No screwed stay or stay welded in by the autogenous process shall be made of stock less than $^3/_4$ in. diameter.

H-24. Area of Heads to be Stayed. The area of a segment of a flanged head to be stayed shall be the area enclosed by lines drawn 2 in. from the tubes and 3 in. from the shell.

H-25. When the portion of the head below the tubes in a horizontal-return-tubular boiler is provided with a manhole opening, the flange of which is formed from the solid plate and turned inward to a depth of not less than three times the required thickness of the head, measured from the outside, the area to be stayed as indicated in Fig. H-2, may be reduced by 100 sq. in. The surface around the manhole shall be supported by through stays with nuts inside and outside at the front head.

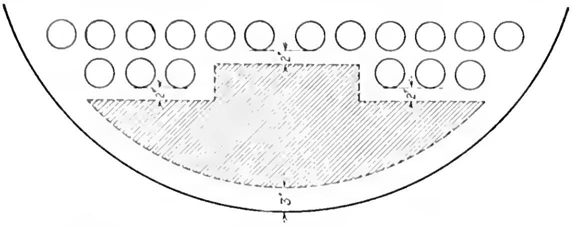


Fig. H-2 Method of Determining Net Area of Irregular Segment of a Head

The distance in the clear between the bodies of the braces, or of the inside braces where more than two are used, shall not be less than 10 in. at any point.

H-26. The maximum allowable stress per square inch at point of least net cross-sectional area of stays and staybolts shall be as given in Table H-4. In determining the net cross-sectional area of drilled or hollow staybolts, the cross-sectional area of the hole shall be deducted.

TABLE H-4 MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

Description of Stays	Stresses, Lb. per Sq. In. For lengths between supports not exceeding 120 diameters	For lengths between supports exceeding 120 diameters
a Unwelded or flexible stays less than 20 diameters long, screwed through plates with ends riveted over, or such stays welded in by the autogenous process	7,500	....
b Hollow steel stays less than 20 diameters long, screwed through plates with ends riveted over, or such stays welded in by the autogenous process	8,000	....
c Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and *b*	9,500	8,500
d Steel through stays exceeding $1^1/_2$ in. diameter	10,400	9,000
e Welded portions of stays	6,000	6,000

Boiler Openings

H-27. All boilers shall be provided with suitable manhole openings and handhole or washout-plug openings to permit inspection and to permit removal of any sediment which may accumulate. Where the size of construction is such that entrance is inpractical, manhole openings may be omitted.

H-28. A manhole shall be placed in the front head below the tubes of a horizontal-return-tubular boiler 48 in. or over in diameter. There shall be a manhole in the upper part of shell or head of a fire-tube boiler over 48 in. in diameter, except a vertical fire-tube boiler, or except a boiler used exclusively for hot-water heating where there is no steam space.

A boiler of the locomotive or firebox type shall have one handhole

or washout plug near each corner in the lower part of the water leg and at least one opening near the line of the crown sheet.

Vertical fire-tube or similar-type boilers shall have at least three handholes or washout plugs in the lower part of the water leg and at least two handholes or washout plugs near the line of the lower tube sheet.

H-29. Washout plugs shall have threads of non-ferrous material and shall not be less than $1^1/_2$ in. pipe size.

Washout openings may be used for return pipe connections and the washout plug placed in a tee so that the plug is directly opposite and as close as possible to the opening in the boiler.

H-30. Threaded Openings. All threaded openings in a boiler shall be tapped into material having a minimum thickness as specified for the various standard pipe sizes in Table H-5.

TABLE H-5 MINIMUM THICKNESS OF MATERIAL FOR TAPPINGS

Pipe Size, In	Minimum Thickness of Material or Length of Thread Required, In.
1 and under	$^1/_4$
$1^1/_4$ to 2 inclusive	$^5/_{16}$
$2^1/_2$	$^7/_{16}$
3 to $3^1/_2$ inclusive	$^5/_8$
4 to 5 inclusive	$^7/_8$
6 to 8 inclusive	1
9 to 12 inclusive	$1^1/_4$

H-31. Flanged Connections. Openings in boilers having flanged connections shall have the flanges conform to the American Standard given in Tables 16 or 17 of the Appendix, for the corresponding pipe size, and shall have the corresponding drilling for bolts or studs.

Supports

H-32. A horizontal-return-tubular boiler over 78 in. in diameter shall be supported from steel lugs by the outside suspension type of setting, independent of the boiler side walls. The lugs shall be so designed that the load is properly distributed between the rivets attaching them to the shell and so that no more than two of these rivets come in the same longitudinal line on each lug. The distance girthwise of the boiler from the centers of the bottom rivets to the centers of the top rivets attaching the lugs shall be not less than 12 in. The other rivets used shall be spaced evenly between these points. If more than four lugs are used they shall be set in four pairs.

H-33. A horizontal-return-tubular boiler over 54 in. and up to and including 78 in. in diameter, shall be supported by the outside suspension type of setting, or at four points by not less than eight steel or cast-iron brackets, set in pairs. A horizontal-return-tubular boiler up to and including 54 in. in diameter shall be supported by the outside suspension type of setting, or by not less than two steel or cast-iron brackets on each side.

H-34. Lugs or brackets, when used to support a boiler of any type shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. H-9 and H-10. Where it is impractical to use rivets, studs with not less than ten threads per inch may be used. In computing the shearing stress, the area at the bottom of the thread shall be used.

Setting and Installation

H-35. Wet-bottom steel-plate boilers shall have a space of not less than 12 in. between the bottom of the boiler and the floor line with access for inspection.

H-36. The minimum size of access door used in boiler setting shall be 12 in. by 16 in. or equivalent area, the least dimensions being 11 in.

H-37. Provisions shall be made for the expansion and contraction of steam mains connected to boilers, by providing substantial anchorage at suitable points, so that there shall be no undue strain transmitted to the boiler.

H-38. Feed or make-up water shall not be discharged directly into any part of a boiler exposed to the direct radiant heat from the fire.

H-39. All hot-water heating systems shall be so installed that there will be no opportunity for the fluid-relief column to freeze or to be accidentally shut off.

H-40. If valves are used in the supply and return mains they shall be locked and sealed open and bear tags stating that provision must be made to prevent pressure from building up in the boiler whenever the valves are closed. It is recommended that no valves be placed in the supply and return mains of single boiler installations.

H-41. When a valve is placed in the top connection from a hot-water supply boiler to a storage tank, an additional connection without valve shall be made between the boiler and top of storage tank.

Fittings and Appliances

H-42. Connections for Safety and Water-Relief Valves. Every boiler shall have proper outlet connections for the required safety or water-relief valves, independent of any other connection outside of the boiler. A steam equalizing pipe between boilers is not to be considered as a connection outside of the boiler in applying the requirements of this paragraph. The area of the opening is to be at least equal to the aggregate area based on the nominal diameters of all of the safety valves with which it connects. A screwed connection may be used for attaching a safety valve.

H-43. Safety Valves. Each steam boiler shall be provided with one or more safety valves of the spring pop type adjusted and sealed to discharge at a pressure not to exceed 15 lb. per sq. in. No safety valve for a steam boiler shall be smaller than $^3/_4$ in., except in case the boiler and radiating surfaces are self-contained. No safety valve shall be larger than $4^1/_2$ in.

H-44. Water-Relief Valves. Water-relief valves shall be connected to all hot-water boilers. The valve shall be of the diaphragm-operating type set to open at or below the maximum allowable working pressure. No water-relief valve shall be smaller than $^1/_2$ in. nor greater than 2 in. standard pipe size. The outlets of water-relief valves shall have open discharges in plain sight.

H-45. When two or more safety or water-relief valves are used on a boiler, they may be single, twin, or duplex valves.

H-46. Safety or water-relief valves shall be connected to the boilers independent of other connections and be attached directly or as close as possible to the boiler without any unnecessary intervening pipe or fitting except the Y-base forming a part of the twin valve or a steam equalizing pipe between boilers. A safety valve or water-relief valve shall not be connected to an internal pipe in the boiler. Safety valves or water-relief valves shall be connected so as to stand upright with the spindle vertical when possible.

H-47. No shut off of any description shall be placed between the safety or water-relief valve and boiler, nor on discharge pipes between such valves and the atmosphere.

H-48. When a discharge pipe is used its area shall be not less than the area of the valve or aggregate area based on the nominal diameters of the valves with which it connects, and the discharge pipe shall be fitted with an open drain to prevent water from lodging in the upper part of the valve or in the pipe. When an elbow is placed on a safety or water-relief valve discharge pipe, it shall be located close to the valve outlet or the pipe shall be securely anchored and supported. The safety or water-relief valves shall be so located and piped that there will be no danger of scalding attendants.

H-49. Each safety valve, $^3/_4$ in. or over, used on a steam-heating boiler, shall have a substantial lifting device by which the valve may be raised from its seat at least $^1/_{16}$ in. when there is no pressure on the boiler.

H-50. A relief valve used on a hot-water boiler need not have a lifting device.

H-51. Every safety valve or water-relief valve shall have plainly stamped on the body or cast thereon the letters A.S.M.E. STD., in such a way that the markings cannot be obliterated in service, the manufacturer's name or trademark and the pressure at which it is set to blow, and in addition, the safety valve shall be marked with the pounds of steam discharged per hour while blowing at $33^1/_3$ per cent overpressure when set to relieve at 15 lb. per sq. in. The seats and disks of safety or water-relief valves shall be made of non-ferrous material.

H-52. The diameter of seat shall determine the nominal diameter of safety or water-relief valve as given in Tables H-6 or H-7. The pipe thread at the inlet shall not be less than the nominal valve size.

H-53. The minimum size of safety or water-relief valve or valves

for each boiler shall be governed by the rated capacity of the boiler as shown by Tables H-6 or H-7.

The safety-valve capacity for each steam boiler shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 5 lb. above the maximum allowable working pressure of the boiler.

When the size of boiler exceeds the values given in Tables H-6 or H-7, safety valves or water-relief valves whose combined capacities equal the rated capacity of the boiler shall be selected from the tables.

TABLE H-6 MINIMUM ALLOWABLE SIZES OF SAFETY VALVES FOR STEAM HEATING BOILERS

Safety Valve			Rated Capacity of Boiler	
Diameter In.	Area, Sq. in.	Discharge Capacity[1] Lb. per Hr.	Steam Radiation, Sq. ft.	Steam, Lb. per Hr.
1/4	0.0491	15	60	15
3/8	0.1104	30	120	30
1/2	0.1963	60	240	60
3/4	0.4418	130	520	130
1	0.7854	230	920	230
1 1/4	1.2272	360	1440	360
1 1/2	1.7671	515	2065	515
2	3.1416	920	3680	920
2 1/2	4.9087	1435	5740	1435
3	7.0686	2070	8280	2070
3 1/2	9.6211	2810	11250	2810
4	12.5660	3675	14700	3675
4 1/2	15.9040	4650	18600	4650

---

[1] Capacity of safety valve based on 33 1/3 per cent overpressure, valve set to relieve at 15 lb. per sq. in.

Note. For the purpose of these computations 240 heat units or 0.25 lb. of steam per hour shall be considered as the equivalent of a square foot of steam radiation.

TABLE H-7 MINIMUM ALLOWABLE SIZES OF WATER RELIEF VALVES FOR WATER HEATING BOILERS AND FOR WATER-SUPPLY BOILERS

Diameter of Valve In.	Rated Capacity in Sq. ft. Water Radiation	Rated Capacity in Gallons per Hour		
		25° rise	50° rise	100° rise
1/2	750	540	270	135
3/4	2000	1410	720	360
1	3500	2520	1260	630
1 1/4	7500	5400	2700	1350
1 1/2	15000	10800	5400	2700
2	30000	21600	10800	5400

Note. For the purpose of these computations 150 heat units per hour shall be considered as the equivalent of a square foot of water radiation.

H-54. When a hot-water supply is heated indirectly, by steam in a coil or pipe, the pressure of the steam used shall not exceed the safe working pressure of the hot-water tank, and a water-relief valve of at least 1 in. in diameter, set to relieve at or below the maximum allowable working pressure of the tank, shall be used.

H-55. Steam Gages. Each steam boiler shall have a steam gage connected to the steam space or to the water column, or its steam connection, by means of a siphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle arranged to be parallel with the pipe in which it is located when the cock is open. Pipe connections to steam gages smaller than 1 in. pipe size shall be of brass, copper, or bronze composition when the distance between the gage and point of attachment of pipe is over 5 ft. If less than 5 ft., the connections shall be of brass, copper, or bronze composition if smaller than 1/2 in. pipe size. The dial of a steam gage for a steam heating boiler shall be graduated to not less than 30 lb., and shall be provided with a stop pin at the zero and maximum points and the graduations shall not occupy more than 325 degrees of the dial circumference.

H-56. Pressure or Altitude Gages. Each hot-water boiler shall have a gage connected in such a manner that it cannot be shut off from the boiler except by a cock with tee or lever handle, placed on the pipe near the gage. The handle of the cock shall be parallel to the pipe in which it is located when the cock is open. Pipe connections to gages smaller than 1 in. pipe size shall be made of brass, copper, or bronze composition when the distance between the gage and point of attachment of pipe is over 5 ft. If less than 5 ft., the connections shall be of brass, copper, or bronze composition if smaller than 1/2 in. pipe size. The dial of the pressure or altitude gage shall be graduated to not less than 1 1/2 times the maximum allowable working pressure, and shall be provided with a stop pin at the zero and maximum points and the graduations shall not occupy more than 325 degrees of the dial circumference.

H-57. Thermometers. Each hot-water boiler shall have a thermometer so located and connected that it shall be easily readable when observing the water pressure or altitude. The thermometer shall be so located that it shall at all times indicate the temperature in degrees fahrenheit of the water in the boiler at or near the outlet.

H-58. Temperature Combustion Regulators. A temperature combustion regulator which will control the rate of combustion to prevent the temperature of the water from rising above 250 deg. fahr. at or near the outlet or an equivalent thermostatic relieving device, shall be used on all hot-water boilers.

H-59. Pressure Combustion Regulators. When a pressure combustion regulator is used, it shall operate to prevent the steam pressure from rising above 15 lb.

H-60. Bottom Blow-Off. Each boiler shall have a blow-off pipe connection fitted with a valve or cock not less than 3/4-in. pipe size connected with the lowest water space practicable.

H-61. Water-Gage Glasses. Each steam boiler shall have at least one water-gage glass.

H-62. Gage Cocks. Each steam boiler shall have two or more gage cocks located within the range of the visible length of the water glass.

H-63. Water-Column Pipes. The minimum size of pipes connecting the water column of a steam boiler shall be 1 in. Water-glass fittings or gage cocks may be connected direct to the boiler. The steam connection to the water column of a horizontal-return-tubular boiler shall be taken from the top of the shell or the upper part of the head; the water connection shall be taken from a point not less than 6 in. below the center line of the shell. No connections, except for combustion regulator, drains or steam gages, shall be placed on the pipes connecting a water column to a boiler. If the water column or gage glass is connected to the boiler by pipe and fittings, crosses or tees shall be used on the water connection to facilitate cleaning.

H-64. Fusible Plugs. A fusible plug, if used, shall be placed at the lowest safe water line and in contact with the products of combustion.

HYDROSTATIC TEST

H-65. All hot-water boilers, the maximum allowable working pressure of which is not in excess of 30 lb. per sq. in., and steam-heating boilers, shall be subjected to a hydrostatic test of 60 lb. per sq. in., both at the shop where constructed and in the field when erected and ready for service. Hot-water boilers, the maximum allowable working pressure of which exceeds 30 lb. per sq. in., shall be subjected to a hydrostatic test of 1 1/2 times the maximum allowable working pressure both at the shop where constructed and in the field when erected and ready for service.

Any hydrostatic pressure test to be made on either a steam-heating boiler or hot-water boiler, after the boiler has been in service, shall be at a pressure 1 1/2 times the maximum allowable working pressure.

In making hydrostatic pressure tests the pressure shall be under such control that in no case shall the required test pressure be exceeded by more than 6 per cent.

H-66. Individual shop inspection shall not be required for boilers which come under the rules of this section, except for boilers constructed by autogenous welding (see Par. H-81).

H-67. Each plate of a completed boiler shall bear the plate maker's name with brand and tensile strength, except that these marks need not appear on the butt straps after completion of boiler.

H-68. All boilers built according to these rules and no other boilers shall be marked A.S.M.E. Std.-Heat., and with the manufacturer's name and maximum allowable working pressure. These markings shall be stamped with letters and figures at least 5/16 in. high on some conspicuous portion of the boiler proper, preferably over or near the fire door. Boilers suitable for use for both steam and water shall have the stamps arranged substantially as follows:

A.S.M.E. STD.-HEAT

. . . .
(Manufacturer's Name)

Max. W. P., Steam 15 lb.
Water. . . lb.

Boilers suitable for use for water only shall have the stamps arranged substantially as follows:

A.S.M.E. STD.-HEAT

. . . .
(Manufacturer's Name)

Max. W. P., Water lb.

These stamps shall not be covered with insulating or other material. The symbol authorized for use on power boilers shall not be used on heating boilers.

Autogenously Welded Boilers

H-69. Autogenous Welds. The autogenous welding process consists of welding by means of either the oxy-acetylene process or the electric arc process, using a metallic electrode, either bare, coated, or covered.

H-70. Steel-plate boilers constructed by autogenous welding under the rules prescribed for steel-plate heating boilers may be used for steam heating at pressures not exceeding 15 lb. per sq. in., or for hot-water heating at pressures not exceeding 160 lb. per sq. in. For pressures in excess of 30 lb. per sq. in. for hot-water boilers, the factor of safety for autogenously welded steel-plate boilers shall be not less than 5, assuming the strength of the welded seams at 50 per cent of the full strength of the plate at the welds.

H-71. Design and Construction. The design, construction, and stamping of autogenously welded boilers shall in all cases conform to the formulas, specifications and data which are given in the Rules prescribed for steel-plate heating boilers, unless some special requirement is necessary because of welding, in which case the requirements will be hereinafter detailed.

H-72. Base Metal. The term base metal when used, shall mean the metal or metals of which the boiler is constructed and which are joined together by the welded seam.

H-73. Filling Material. The term filling material shall mean the weld rod, filling rod, electrode or other metal which is used to join two sections of the base metal or metals. Either of the filling metals given in Table H-8 shall be used for oxy-acetylene or electric arc welding, respectively.

TABLE H-8 FILLING METAL FOR OXY-ACETYLENE OR ELECTRIC ARC WELDING

	Oxy-Acetylene Welding	Electric Arc Welding
Carbon	Not over 0.06 per cent	Not over 0.06 per cent
Silicon	Not over 0.08 per cent	Not over 0.08 per cent
Manganese	Not over 0.15 per cent	Not over 0.15 per cent
Phosphorus	Not over 0.04 per cent	Not over 0.04 per cent
Sulphur	Not over 0.04 per cent	Not over 0.04 per cent
Carbon	0.18 to 0.22 per cent	0.12 to 0.18 per cent
Manganese	0.40 to 0.50 per cent	Not over 0.06 per cent
Phosphorus	Not over 0.04 per cent	Not over 0.40 to 0.60 per cent
Sulphur	Not over 0.04 per cent	Not over 0.04 per cent
Nickel	3.0 to 3.5 per cent	Not over 0.04 per cent

The filling metal must be clean, flow freely, and shall neither "spit nor spark" appreciably during welding. Its fusing temperature shall be such as to correspond relatively with that of the sheet, or base metal. The size of the wire and the size of the tip shall be such as to enable the welder to meet the conditions required by the work he is doing with oxy-acetylene welding, and the size of the electrode and current characteristics should meet the same conditions for electric arc welding.

H-74. Material for Base Metal. The base metal composing the plates of autogenously welded steel-plate heating boilers shall be made by the open-hearth process of soft and good weldable quality and shall conform to the following requirements:

Chemical Composition by Ladle Test:

Carbon by combustion test	not over 0.15 per cent
Manganese	not over 0.60 per cent
Phosphorus	not over 0.05 per cent
Sulphur	not over 0.04 per cent

H-75. Analysis. A ladle analysis of each melt shall be made by the manufacturer to determine the percentage of the important elements, carbon, manganese, phosphorus, and sulphur. This analysis shall be made from a test ingot taken during the pour of the melt. The chemical composition thus determined shall be furnished the purchaser, or his representative, and shall conform to the requirements as specified.

H-76. Tension Tests. The base metal of autogenously welded steel-plate boilers shall conform to the following requirements:

Tensile strength in lb. per sq. in.	42,000-55,000
Yield point, lb. per sq. in. minimum	0.5 Ten. Str.
Elongation in 8 in., min., per cent	$\frac{1,500,000}{\text{Ten. Str.}}$

H-77. Test Specimens, Bend Tests, Finish, Etc. The test specimens, bend test, homogeneity test, number of test, permissible variation in gage, finish, marking, inspection, and rejection for material used in autogenously welded steel-plate boilers shall conform with the requirement of Par. H-5.

H-78. Method of Welding. Seams or joints on autogenously welded steel-plate boilers may be welded on both sides by the double-V method, socalled, or on one side only with a single-V or by using such methods as will assure a joint of sound metal thoroughly fused and to a thickness in excess of the maximum thickness of plate.

There shall be no valley either on the edge or in the center of the joint and the weld shall be so built up that the welded metal shall present a gradual increase in thickness from the surface of the sheet to the center of the weld. At no point shall the sheet on one side of the joint be offset with the sheet on the other side of the joint in excess of one quarter of the minimum thickness of the sheets or plates except where stayed plates are lap joined.

H-79. Longitudinal Joints. Where autogenously welded steel-plate heating boilers are made up of two or more courses, the welded longitudinal joints of adjacent courses shall be not less than 90 deg. apart.

H-80. Before welding longitudinal seams of cylindrical drums the plate shall be preheated along the full length of the edge to be welded to a substantially uniform temperature so as to show red in daylight for a width of about 3 in. on each side of the weld, and this temperature shall be maintained during the welding.

H-81. Every boiler, the unsupported joints of which are welded by the autogenous process, shall be inspected during its construction at the shop where manufactured, by a duly authorized inspector. The inspector shall examine the boiler at least three times during its construction; first, examining the material and the preparation for joining the parts if prepared before the parts are set up; second, the boiler shall be examined after the parts are set up and ready for welding; third, the completed boiler shall be examined and the final hydrostatic test witnessed. The inspector shall be a state inspector, municipal inspector or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, if known.

H-82. Steel-plate boilers having cylindrical shells and constructed by autogenous welding shall have their shell length limited to four diameters and in no case to exceed 20 ft. in length.

H-83. Where staybolts are to be welded into stayed plates by the autogenous process the staybolt holes shall be countersunk to within at least $^1/_{16}$ in. of the full thickness of the plate. The base metal of the plate and staybolt shall be welded to the full thickness of the plate. The staybolts shall be of such length that they will project at least $^1/_8$ in. above the surface of the plate in which they are welded.

SECTION 2—CAST-IRON BOILERS

H-84. These Rules for cast-iron boilers shall apply:

a To all steam boilers for operation at pressures not exceeding 15 lb. per sq. in.

b To hot-water boilers to be operated at pressures not exceeding 160 lb. per sq. in., or temperatures not exceeding 250 deg. fahr.

c For conditions exceeding those specified above, cast-iron construction is not permitted.

H-85. Wherever the term maximum allowable working pressure is used herein, it refers to gage pressure or the pressure above the atmosphere in pounds per square inch.

H-86. The maximum allowable working pressure shall not ex-

ceed 15 lb. per sq. in. on a cast-iron boiler built under these rules to be used exclusively for low-pressure steam heating.

The maximum allowable working temperature at or near the outlet of a hot-water cast-iron boiler shall not exceed 250 deg. fahr.

Boiler Openings

H-87. Washout Openings. All cast-iron steam and hot-water boilers shall be provided with suitable washout openings to permit the removal of any sediment that may accumulate therein. Washout openings may be used for return pipe connections and the washout plug placed in a tee so that the plug is directly opposite and as close as possible to the opening in the boiler.

H-88. Flanged Connections. Flanged openings in boilers shall conform to the American Standard given in Tables 16 or 17 of the Appendix, for the corresponding pipe size, and shall have the corresponding drilling for bolts or studs.

H-89. Threaded Openings. Pipe connections if threaded shall be tapped into material having a minimum thickness as specified in Table H-9.

TABLE H-9 MINIMUM THICKNESS OF MATERIAL FOR THREADED CONNECTIONS TO BOILERS

Size of Pipe Connection, In.	Minimum Thickness of Material Required, In.
3/4 and under	5/16
1 to 2 1/2 inclusive	7/16
3 to 3 1/2 inclusive	5/8
4 to 5 inclusive	7/8
6 to 8 inclusive	1
9 to 12 inclusive	1 1/4

Installation

H-90. Provisions shall be made for the expansion and contraction of steam mains connected to boilers by providing substantial anchorage at suitable points, so that there shall be no undue strain transmitted to the boiler.

H-91. When feed or make-up water is introduced from a pressure line, it shall be connected to the piping system and not directly to the boiler.

H-92. All hot-water heating systems shall be so installed that there will be no opportunity for the fluid-relief column to freeze or to be accidentally shut off.

H-93. If valves are used in the supply and return mains, they shall be locked and sealed open and bear tags stating that provision must be made to prevent pressure from building up in boiler whenever the valves are closed. It is recommended that no valves be placed in the supply and return mains of a single boiler installation. Provision shall be made for cleaning the interior of the return main at or near the boiler.

H-94. When a valve is placed in the top connection from a hot-water supply boiler to a storage tank, an additional connection without valve shall be made between the boiler and top of storage tank.

H-95. Connections for Safety and Water-Relief Valves. Every boiler shall have proper outlet connections for the required safety or water-relief valves, independent of any other connection outside the boiler. A steam equalizing pipe between boilers is not to be considered as a connection outside of the boiler in applying the requirements of this paragraph. The area of the opening is to be at least equal to the aggregate area based on the nominal diameters of all of the safety valves with which it connects. A screwed connection may be used for attaching a safety valve.

Fittings and Appliances

H-96. Safety Valves. Each steam boiler shall be provided with one or more safety valves of the spring pop type adjusted and sealed to discharge at a pressure not to exceed 15 lb. per sq. in. No safety valve for a steam boiler shall be smaller than 3/4 in., except in case the boiler and radiating surfaces are assembled in a self-contained unit. No safety valve shall be larger than 4 1/2 in.

H-97. Water-Relief Valves. Water-relief valves shall be connected to all hot-water boilers. The valve shall be of the diaphragm-operating type set to open at or below the maximum allowable working pressure. No water-relief valve shall be smaller than 1/2 in. nor greater than 2 in. standard pipe size. The outlets of water-relief valves shall have open discharges in plain sight.

H-98. When two or more safety or water-relief valves are used on a boiler, they may be single, twin, or duplex valves.

H-99. Safety or water-relief valves shall be connected to the boilers independent of other connections and be attached directly or as close as possible to the boiler without any unnecessary intervening pipe or fitting except the Y-base forming a part of the twin valve or a steam equalizing pipe between boilers. A safety valve or water-relief valve shall not be connected to an internal pipe in the boiler. Safety valves or water-relief valves shall be connected so as to stand upright with the spindle vertical when possible.

H-100. No shut-off of any description shall be placed between the safety or water-relief valve and boiler nor on discharge pipes between such valves and the atmosphere.

H-101. When a discharge pipe is used its area shall be not less than the area of the valve or aggregate area based on the nominal diameters of the valves with which it connects, and the discharge pipe shall be fitted with an open drain to prevent water from lodging in the upper part of the valve or in the pipe. When an elbow is placed on a safety or water-relief valve discharge pipe, it shall be located close to the valve outlet or the pipe shall be securely anchored and supported. The safety or water-relief valves shall be so located and piped that there will be no danger of scalding attendants.

H-102. Each safety valve, 3/4 in. or over, used on a steam-heating boiler, shall have a substantial lifting device by which the valve may be raised from its seat at least 1/16 in. when there is no pressure on the boiler.

H-103. A relief valve used on a hot-water boiler need not have a lifting device.

H-104. Every safety valve or water-relief valve shall have plainly stamped on the body or cast thereon, the letters A.S.M.E. STD., in such a way that the marking will not be obliterated in service, the manufacturer's name or trade mark and the pressure at which it is set to blow; and in addition, the safety valve shall be marked with the pounds of steam discharged per hour while blowing at 33 1/3 per cent overpressure when set to relieve at 15 lb. per sq. in. The seats and disks of safety or water-relief valves shall be made of non-ferrous material.

H-105. The diameter of seat shall determine the nominal diameter of safety or water-relief valve as given in Tables H-10 or H-11. The pipe thread at the inlet shall not be less than the nominal valve size.

H-106. The minimum size of safety or water-relief valve or valves for each boiler shall be goverened by the rated capacity of the boiler as shown by Tables H-10 or H-11.

The safety valve capacity for each steam boiler shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 5 lb. above the maximum allowable working pressure of the boiler.

When the size of boiler exceeds the values given in Tables H-10 or H-11, safety valves or water-relief valves whose combined capacities equal the rated capacity of the boiler shall be selected from the tables.

TABLE H-10 MINIMUM ALLOWABLE SIZES OF SAFETY VALVES FOR STEAM-HEATING BOILERS

Safety Valve			Rated Capacity of Boiler	
Diameter, In.	Area, Sq. in.	Discharge Capacity, Lb. per Hr.[1]	Steam Radiation, Sq. ft.	Steam, Lb. per Hr.
1/4	0.0491	15	60	15
3/8	0.1104	30	120	30
1/2	0.1963	60	240	60
3/4	0.4418	130	520	130
1	0.7854	230	920	230
1 1/4	1.2272	360	1440	360
1 1/2	1.7671	515	2065	515
2	3.1416	920	3680	920
2 1/2	4.9087	1435	5740	1435
3	7.0686	2070	8280	2070
3 1/2	9.6211	2810	11250	2810
4	12.5660	3675	14700	3675
4 1/2	15.9040	4650	18600	4650

[1] Capacity of safety valve based on 33 1/3 per cent over-pressure, valve set to relieve at 5 lb. per sq. in.

NOTE: For the purpose of these computations 240 heat units or 0.25 lb. of steam per hour shall be considered as the equivalent of a square foot of steam radiation.

H-107. When a hot-water supply is heated indirectly by steam in a coil or pipe, the pressure of the steam used shall not exceed the safe working pressure of the hot-water tank, and a water-relief

TABLE H-11 MINIMUM ALLOWABLE SIZES OF WATER-RELIEF VALVES FOR WATER-HEATING BOILERS AND FOR WATER-SUPPLY BOILERS

Diameter of Valve, In	Rated capacity in Sq. ft Water Radiation	Rated Capacity in Gallons per Hour 25° rise	50° rise	100° rise
1/2	750	540	270	135
3/4	2000	1440	720	360
1	3500	2520	1260	630
1 1/4	7500	5400	2700	1350
1 1/2	15000	10800	5400	2700
2	30000	21600	10800	5400

Note: For the purpose of these computations 150 heat units per hour shall be considered as the equivalent of a square foot of water radiation.

valve of at least 1 in. in diameter, set to relieve at or below the maximum allowable working pressure of the tank, shall be used.

H-108. Steam Gages. Each steam boiler shall have a steam gage connected to the steam space or to the water column, or its steam connection, by means of a siphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle arranged to be parallel with the pipe in which it is located when the cock is open. Pipe connections to steam gages smaller than 1 in. pipe size, shall be of brass, copper, or bronze composition when the distance between the gage and point of attachment of pipe is over 5 ft. If less than 5 ft., the connections shall be of brass, copper, or bronze composition if smaller than 1/2 in. pipe size. The dial of a steam gage for a steam-heating boiler shall be graduated to not less than 30 lb. and shall be provided with a stop pin at the zero and maximum points and the graduations shall not occupy more than 325 degrees of the dial circumference.

H-109. Pressure or Altitude Gages. Each hot-water boiler shall have a gage connected in such a manner that it cannot be shut off from the boiler except by a cock with tee or lever handle, placed on the pipe near the gage. The handle of the cock shall be parallel to the pipe in which it is located when the cock is open. Pipe connections to gages smaller than 1 in. pipe size, shall be made of brass, copper, or bronze composition when the distance between the gage and point of attachment of pipe is over 5 ft. If less than 5 ft., the connections shall be of brass, copper, or bronze composition if smaller than 1/2 in. pipe size. The dial of the pressure or altitude gage shall be graduated to not less than 1 1/2 times the maximum allowable working pressure, and shall be provided with a stop pin at the zero and maximum points and the graduations shall not occupy more than 325 degrees of the dial circumference.

H-110. Thermometers. Each hot-water boiler shall have a thermometer so located and connected that it shall be easily readable when observing the water pressure or altitude. The thermometer shall be so located that it shall at all times indicate the temperature in degrees fahrenheit of the water in the boiler, at or near the outlet.

H-111. Temperature Combustion Regulators. A temperature combustion regulator which will control the rate of combustion to prevent the temperature of the water from rising above 250 deg. fahr., at or near the outlet, or an equivalent thermostatic relieving device shall be used on all hot-water boilers.

H-112. Pressure Combustion Regulators. When a pressure combustion regulator is used, it shall operate to prevent the steam pressure from rising above 15 lb.

H-113. Bottom Blow-Off. Each boiler shall have a blow-off pipe connection fitted with a valve or cock not less than 3/4 in. pipe size connected with the lowest water space practicable.

H-114. Water-Gage Glasses. Each steam boiler shall have at least one water-gage glass.

H-115. Gage Cocks. Each steam boiler shall have two or more gage cocks located within the range of the visible length of the water glass.

H-116. Water-Column Pipes. The minimum size pipes connecting the water column of a steam boiler shall be 1 in. Water-glass fittings or gage cocks may be connected direct to the boiler. No connections, except for combustion regulator, drains or steam gages, shall be placed on the pipes connecting a water column to a boiler. If the water column or gage glass is connected to the boiler by pipe and fittings, crosses or tees shall be used on the water connection to facilitate cleaning.

H-117. Fusible Plugs. A fusible plug, if used, shall be placed at an accessible point in the combustion chamber.

Hydrostatic Tests

H-118. All hot-water boilers, the maximum allowable working pressure of which is not in excess of 30 lb. per sq. in., and steam-heating boilers, shall be subjected to a hydrostatic test of 60 lb. per sq. in. both at the shop where made, on each individual section and in the field when erected and ready for service. Hot-water boilers, the maximum allowable working pressure of which exceeds 30 lb. per sq. in., shall be subjected to a hydrostatic test of 2 1/2 times the maximum allowable working pressure both at the shop where made, on each individual section, and in the field when erected and ready for service.

Any hydrostatic pressure test to be made on either a steam-heating boiler or hot-water boiler, after the boiler has been in service, shall be at a pressure of 1 1/2 times the maximum allowable working pressure.

In making hydrostatic pressure tests the pressure shall be under such control that in no case shall the required test pressure be exceeded by more than 6 per cent.

H-119. Individual shop inspection shall not be required for boilers which come under the rules of this section.

H-120. All boilers shall be plainly and permanently marked with the manufacturer's name and the maximum allowable working pressure. All letters and figures shall be at least 5/16 in. high.

The maximum allowable working pressure shall be stamped, cast, or irremovably attached to the front and rear cored sections of vertical sectional cast-iron boilers and on the dome section of horizontal sectional cast-iron boilers. The marking of maximum allowable working pressure on cast-iron boilers suitable for use for steam or water shall be as follows:

MAX. W.P......... LB.
STEAM............ 15
WATER...........

Boilers suitable for use as water boilers only shall be marked as follows:

MAX. W.P........ LB.
WATER..........

All boilers built according to these rules, and no other boilers, shall be marked A.S.M.E. Standard-Heat as follows:

A.S.M.E. STD.-HEAT.

The symbol authorized for use on power boilers shall not be used on heating boilers.

When an insulating or other form of covering is used that portion of the front cored section of vertical sectional cast-iron boilers, and the dome cored section of horizontal sectional cast-iron boilers bearing the foregoing marking, shall either be provided with a removable cover plate or be left uncovered.

APPENDIX

A.S.M.E. Code in Hawaiian Islands

Mr. W. E. Smith, Chief Inspector of the Hawaiian Sugar Planters' Association, reports that the Association controls 42 sugar plantations in the Hawaiian Islands and that a Bureau of Boiler Inspection has been established to control the inspection of new boilers as well as to cover the construction of all new boilers. It was decided when the work of inspection was started in 1919, to adopt the A.S.M.E. Boiler Code which has been followed throughout in the control of the 378 mill and pump boilers of the Association. These comprise 90 per cent of all boilers in the Hawaiian Islands.

The pressure is being reduced on all h.r.t. boilers with double-riveted lap longitudinal seams according to the Code and it is the intention of the Association to eliminate these boilers just as soon as possible.

The Code is being carried out to the letter and they are at the same time obtaining the latest operation data from the states that all of their plants may be brought up to the standard. All steam plows and locomotives are being inspected and all new locomotives furnished the Association are being built according to the A.S.M.E. Code. All rules contain the words, "the latest edition of the A.S.M.E. Boiler Code," thus taking care of the issue of all new editions of the Code.

Test Code for Feedwater Heaters

Preliminary Draft of the Seventh in the Series of Nineteen Test Codes Being Formulated by the A.S.M.E. Committee on Power Test Codes

In 1918 the Power Test Committee of the A.S.M.E. was reorganized to revise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, consisting of a Main Committee of 25 members under the chairmanship of Fred R. Low, and 19 Individual Committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the seventh of these codes to be completed, namely, the Test Code for Feedwater Heaters.

The Individual Committee which developed this Code is headed by Mr. George A. Orrok as Chairman, and consists of Philip E. Reynolds, Secretary, Charles H. Baker, Jr., Raymond N. Ehrhart, George J. Foran, J. J. Mullan and Milton C. Stuart. Mr. Foran was chairman of the Committee from the time of its organization in December, 1918 until his death in May, 1921.

The Committee and the Society will welcome suggestions for corrections or additions to this draft of its Code from those who are specially interested in the manufacture and use of Feedwater Heaters. These comments should be addressed to the Secretary of the Committee in care of The American Society of Mechanical Engineers.

INTRODUCTION

1 This code applies to open and closed boiler feedwater heaters, and with slight modifications to suit special conditions, it may apply to heaters for heating water for any purpose when the heating element is either live or exhaust steam. In the open-type heater the heating steam mixes directly with the water to be heated. In the usual arrangement of closed-type heater the water passes through tubes surrounded by the heating system, though this arrangement may be reversed.

A feedwater heater is designed to heat a certain quantity of water through a given temperature range with a certain steam temperature or pressure available, with a limited loss of friction head in water flowing through the heater, and with a limited loss of steam through vents or stack.

OBJECT

2 There may be several objects of the tests, as pointed out in the "General Instructions," but usually they are conducted:

- (*a*) To determine whether the heater meets the designed conditions
- (*b*) To determine the variation of temperature rise of water and friction drop in water with capacity. (Closed heaters.)
- (*c*) To determine the closeness with which the outlet-water temperature approaches the steam temperature corresponding to the pressure in the heater (open heater).

The heat-transfer coefficient proves to be a useful and interesting item in connection with the analysis of a test of a closed feed-water heater. The heat-transfer coefficient is not, however, the sole measure of the merit of a heater.

INSTRUMENTS AND APPARATUS

3 The instruments and apparatus required for a heater test consist of the following:

- (*a*) Barometer, preferably of the mercurial type
- (*b*) Mercury columns for measuring vacuums and low pressures having scale graduations of not greater than 0.1 inch with vernier attachment
- (*c*) Bourdon gages for measuring pressures when too high for mercury columns
- (*d*) Thermometers:
  - (1) For determining temperatures of feed water, condensate and vapors—graduated by half degrees and with scale readings from 32 to 300 or 350 deg. fahr.
  - (2) For determining steam temperature graduated by degrees with scale readings from 32 to 300 or 350 deg. fahr.
- (*e*) Tanks and platform scales for measuring water (or water meters calibrated in place under conditions of use)
- (*f*) Steam calorimeter, throttling or separating, depending upon amount of moisture present and pressure. (See Code on Instruments and Apparatus, Par. –
- (*g*) Apparatus for testing oxygen content of water.

It is desirable that wherever possible observation of rate of water flow, pressures and temperatures be obtained by continuous recording instruments, in addition to the observations made by the more precise instruments for instantaneous measurements.

General directions for the application, use and calibration of these instruments and apparatus, and information regarding their range and accuracy are given in the section of the code dealing with "Instruments and Apparatus."

Identically the same testing apparatus for measuring the quantity of steam condensed in the case of closed heaters may be employed as that used for testing the engine, turbine or other steam machinery supplying the feedwater heater. (See Codes for Steam Engines, Steam Turbines, etc.). For measuring feedwater the same kind of apparatus may be employed as that used in pumping-engine or water-wheel tests, such as weirs, nozzles, orifices, pitot tubes. (See Code on Instruments and Apparatus, Pars.——).

4 In preparing for the heater test, the "General Instructions" should be first carefully studied. The dimensions and physical conditions should then be ascertained. The starting, stopping and duration of the test should follow the same rules as those governing a steam engine test, and reference may be made to the Test Code on Reciprocating Steam Engines for the general directions to be followed.

OPEN HEATERS—INSTALLATION, TEST AND CALCULATION OF RESULTS

5 In the open heater, which is also sometimes referred to as the "direct-contact" heater, in which the steam mixes directly with the water, it is possible to so design the water-distributing system that, over a wide range of capacity, the water will be heated to within a few degrees of the steam temperature corresponding to the pressure in the heater. In most open feedwater heaters, the purpose is not only to heat the water, but to filter or treat the water as well, and in these cases arrangements must be made to obtain analyses of the water entering and leaving the heater. Open feedwater heaters are also frequently used for partial deaeration of the water, and in such cases means should be provided for sampling the water and determining its oxygen content.

6 Inasmuch as the open feedwater heater serves as a storage tank supplying the boiler-feed pumps, the time required to empty the heater during normal operating conditions in case of failure of the supply of water to the heater is very important in establishing the rated capacity and size of heater. Of equal importance in establishing heater capacity is the time lag between the occurrence of an insufficiency of steam for a desired outlet temperature and the appearance of this improper temperature at the water outlet. These times will depend upon heater arrangement as well as volume of storage, and the test should if possible determine these items in terms of definite rates and temperatures.

CLOSED HEATER—INSTALLATION, TEST AND CALCULATION OF RESULTS

7 In a closed feedwater heater there is a definite relation between the capacity and outlet-water temperature which is determined by the ability of the surface to transfer heat. This ability of the surface to transfer heat under any given set of conditions is measured by the Heat-Transfer Coefficient. The principal items affecting the value of the heat-transfer coefficient are, (*a*) tube type, length and

arrangement, (*b*) water velocity, (*c*) condition of tubes as regards the presence of a film of scale, oil or dirt, and (*d*) the presence of accumulated air in the steam space of the heater.

8 During the test of the closed heater, as well as during operation, provision should be made to keep the shell thoroughly drained of condensate and vented of air. Accessories necessary for good operation are pressure gage, thermometers, safety valve, vacuum breaker, water-gage glass and trap.

9 The location of thermometer in the steam space is of considerable importance. It must not be installed where there is liable to be an air pocket nor must it be near a cold water manifold. If near cold tubes it must be shielded for radiation.

Calculation of Results

10 The logarithmic heat transfer coefficient expressed in British Thermal Units per hour per sq. ft. of surface per degree of logarithmic mean temperature difference is computed from the following formula

$$K = \frac{W}{S} \log_e \frac{T_s - T_i}{T_s - T_0}$$

in which

K = heat transfer coefficient
W = pounds of water per hour
S = heating surface, measured on the outside of the tubes in sq. ft.
T_s = steam temperature in heater (if superheated steam is supplied, use temperature of saturated steam at the pressure in heater)
T_i = inlet water temperature
T_0 = outlet water temperature

11 After working up the items tabulated, it is desirable to plot the results on logarithmic paper. The heat-transfer coefficient when plotted against the velocity of water in tube, almost invariably gives a straight line on logarithmic paper. This curve then gives the data for determining constants in the equation

$$K = aV^n$$

in which

K = heat-transfer coefficient
V = velocity of water, ft. per sec.

12 Friction drop when plotted against velocity usually gives a straight line on log paper which serves to determine constants in friction drop formula,

$$H = bLV^m$$

in which

H = total friction drop, lb. per sq. in.
L = length of tube, ft. (if multipass, length of total path of travel of water in heater)
V = velocity of water, ft. per sec.

The constants obtained in these formulas may be used to compare the performance of the heater under test with the performance of other heaters.

Records

13 The directions given in the Code on General Instructions under this heading should be followed in taking and recording the readings of instruments and other data.

TABLE 1 DATA AND RESULTS OF TEST CODE FOR OPEN FEEDWATER HEATERS

General Information

(1) Date of test..........
(2) Location of plant..........
(3) Owner..........
(4) Builder..........
(5) Test conducted by..........
(6) Object of test..........

Descriptions and Dimensions, Etc.

(7) Type of heater..........
(8) External dimensions of heater..........
(9) Gross volume of heater..........cu. ft.
(10) Weight of heater, empty..........lb.
(11) Weight of heater when operating (including water)..........lb.
(12) Volume of steam space..........cu. ft.
(13) Shape and dimensions of steam inlet opening into heater......in.
(14) Size of water inlet..........in.
(15) Size of water outlet..........in.
(16) Material of shell..........
(17) Volume of water in heater at operating water level..........cu. ft.
(18) Volume of water between overflow level and level at which make-up valve will open..........
(19) Rated capacity of heater, water per hour..........lb.
(20) Location of thermometers..........
(21) Number and arrangements of baffles or trays..........
(22) Description of filtering or purifying arrangement..........
(23) Size and arrangement of venting connections..........
(24) Description of metering apparatus installed in heater..........
(25) Description of automatic steam and water control..........
(26) Description of water distributing boxes..........
(27) Nature and amount of insulation on heater..........

Observed Data

(28) Duration of test..........
(29) Barometer..........in. hg.
(30) Room temperature..........deg. fahr.
(31) Quantity of water admitted to heater..........lb. per Hr.
(32) Inlet-water temperature..........deg. fahr.
(33) Outlet-water temperature..........deg. fahr.
(34) Steam pressure in heater, gage..lb. per sq. in. or in. of mercury
(35) Steam temperature in heater, by thermometer..........deg. fahr.
(36) Steam temperature at inlet by thermometer..........
(37) Steam used per hour..........lb.
(38) Total water discharged from heater..........lb. per hr.
(39) Volume of water in mixing compartment of heater..........
(40) Volume of water in storage compartment of heater..........
(41) Pressure drop from steam end of heater to vent end..........
(42) Time lag between occurrence of steam deficiency and change of outlet temperature..........
(43) Analysis of water entering heater..........
Analysis of water leaving heater..........
(44) Oxygen content of water entering heater..........
(45) Oxygen content of water leaving heater..........

Computed and Deduced Results

(46) Steam temperature corresponding to absolute pressure..deg. fahr.
(47) Quality of steam supplied to heater, per cent moisture or degree superheat..........
(48) Temperature difference between steam temperature corresponding to heater pressure and outlet water temperature..........deg. fahr.
(49) Lb. steam theoretically required per lb. water..........
(50) Lb. steam used per lb. water, actual..........
(51) Time required to empty heater when operating at rated capacity.
(52) Steam lost up stack..........lb. per hr

TABLE 2 DATA AND RESULTS OF TEST CODE FOR CLOSED FEED WATER HEATERS

General Information

(1) Date of test..........
(2) Location of plant..........
(3) Owner..........
(4) Builder..........
(5) Test conducted by..........
(6) Object of test..........

Descriptions, Dimensions, Etc.

(7) Type of heater..........
(8) Position of heater, horizontal or vertical..........
(9) Condition of heating surface..........
(10) Number of tubes..........
(11) Number of passes..........
(12) Length of single tube..........ft., in.
(13) Distance of travel of water through heater..........ft., in.
(14) Special type of tube, description..........
(15) Outside diameter of tube..........in.
(16) Thickness of tube..........in.
(17) Heating surface, of tubes, outside of tube..........sq. ft.
(18) Diameter of heater over shell..........ft., in.
(19) Length of heater over shell..........ft., in.
(20) Thickness of shell..........in.
(21) Material of tubes..........
(22) Material of shell..........
(23) Weight of heater, empty..........lbs.
(24) Weight of water in heater..........lbs.
(25) Gross volume of heater..........cu. ft.
(26) Shape and dimensions of steam inlet opening into heater.....in.
(27) Arrangement of steam supply pipes into heater..........
(28) Size of water inlet and outlet..........in.
(29) Size of drain..........in.
(30) Type and size of drain trap..........
(31) Location and type of air vents..........
(32) Arrangement of baffles..........
(33) Nature and amount of insulation on heater..........
(34) Location of thermometers..........

Observed Data

(35) Duration of test..........

(*Continued on page 765*)

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Helium

THE story of helium is one of the romances of science. Probably nothing except perhaps radium, compares with it in human interest. Helium is one of the best examples of a discovery in pure science that has wide commercial application. In 1868 an eclipse of the sun was visible in India, and several scientific men who were in India making observations of the eclipse turned a spectroscope for the first time on the solar chromosphere—that part of the atmosphere of the sun, about 10,000 miles deeps, which merges into the corona. A bright yellow line was observed and was thought at first to be due to sodium. Janssen showed, however, that this line was not just the same as either the D_1 or D_2 line of sodium, although it was extremely close to these lines, hence he suggested that the new line have the designation D_3. Frankland and Lockyer decided that D_3 was due to an element in the sun not previously discovered on the earth, and suggested for it the name "helium" from the Greek word "helios," the sun.

Helium is found in the atmosphere, in the proportion of one part by volume in 185,000. From samples of air taken at an altitude of several miles and analyzed, the proportion of helium has proved to be about the same as at lower levels; at extremely high altitudes, such as 100 miles or more, the proportion may, however, be much increased. Helium is also found in very minute quantities in sea and river water; undoubtedly it exists in some of the fixed stars as well as in the sun, and its presence has been spectroscopically determined in many nevulae. Helium is found in the gases evolved from many mineral springs; some contain a high percentage of helium, notably the gas from mineral springs at Mazières, France, which has over 5 per cent of helium, and two springs at Santenay, France, with more than 8 per cent. But the total amount of these gases is relatively too small for the extraction of helium from them to be feasible for practical uses.

In 1907 Cady and McFarland of the University of Kansas published a report on the presence of helium in several natural gases, mainly Kansas gases. Some of the samples tested ran as high as $1^1/_2$ per cent of helium by volume. This work of Cady and McFarland disclosed the information necessary for the inauguration for the helium "project" during the war.

To date no one has succeeded in combining helium with any other element, or in inducing the gas to take part in any chemical reaction under any conditions. In this respect, it is similar to the other rare gases of the atmosphere—neon, argon, krypton, and xenon. Helium is only slightly soluble in water. Its thermal conductivity is fairly high, but it is less than that of hydrogen. A volume of helium weighs about twice as much as an equal volume of hydrogen under identical conditions of temperature and pressure. It is a good conductor of electricity, being next to neon in this respect. Under similar conditions it conducts a current 25 times as readily as air. After overcoming immense difficulties, Professor Kammerlingh Onnes, of the University of Leyden, in 1908, succeeded in liquefying helium. The liquid boils at —268.75 deg. cent. or 4.25 deg. absolute Solid helium has not yet been obtained.

As a gas to replace the inflammable hydrogen used in dirigibles, helium has many advantages. Besides being non-inflammable it is the only gas known to be light enough to replace hydrogen as a lifting force. The use of helium has still other advantages: It diffuses through a fabric at about three-quarters the rate of hydrogen; and its non-inflammability makes it possible to place the engines in the framework of the dirigible, thus getting a direct drive, giving greater control of the craft and much increased speed for any given horsepower.

Early in 1915 word came to an official of the Bureau of Mines that the British were interested in sources of helium for use in dirigibles. When the United States entered the war in 1917, helium for use in dirigibles was discussed among Bureau of Mines officials, and in June the matter was presented to the Army and Navy Air Services as a war project. These services enthusiastically approved the proposition, and allotments of money were made from the Army and Navy appropriations to carry it forward.

Three experimental plants were constructed in Texas under the direction of the Bureau of Mines, two at Fort Worth for economic reasons; one plant used the Linde system of liquefaction, the other the Claude system, and the supply of gas was piped to the plants from Petrolia, Texas. Analysis has shown that this gas contained 0.95 per cent helium. Another plant was later constructed at Petrolia, near the gas wells, and use was made of a new method of liquefaction called the Jefferies-Norton process.

All three plants produced helium, but the Linde plant proved the most efficient, and it was decided to construct, under the cognizance of the Navy, a much enlarged plant for obtaining helium in greater quantities. The construction of this plant was started in October, 1918; it was completed in December, 1920, and was operated during part of 1921. It produced altogether about 2,000,000 cu. ft. of helium, which, with the helium obtained at the smaller plants during the experimental period, makes available at the present time a total of about 2,400,000 cu. ft. of helium over 90 per cent in purity. Most of the gas is around the 95 per cent grade.

The method of operation in all of these plants is, in general, the same, although there is considerable difference in detail. The object is to liquefy all of the elements making up the natural gas except the helium, which does not liquefy at the temperature used. After liquefaction of all other constituents in the gas—such a nitrogen, methane, ethane, propane, and butane—the helium can be pumped off. Thus far helium has been obtained in two stages. One stage in operation gives about 70 per cent purity; this has been refined up to 95 per cent. In the second operation the nitrogen, representing practically all the impurity, is liquefied and the helium is once more pumped off.

Complete equipment for conducting research at low temperatures, the Cryogenic Laboratory of the Bureau of Mines, is located at Washington in the Interior Department building, representing the research department of the whole helium project, and employing a force of 12 men. Fundamental information is being obtained that is essential for the construction of any new plant designed to have greater efficiency than the large plant at Fort Worth. Helium can probably be produced in this plant for 10 cents a cubic foot, but it is believed that the cost can, ultimately, be reduced to 3 cents and perhaps to 2 cents. Necessary information is being gradually accumulated to this end.

R. B. Moore,
Chief Chemist, Bureau of Mines.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Aeronautics A2-22. RADIATORS FOR AIRCRAFT ENGINES. The purpose of this report is to show the relations between the conditions under which the radiator operates, its characteristics of form and construction, and the properties that describe its performance, together with a detailed description of the experimental work on which the conclusions are based. The limitations of such a treatise in its immediate application, without any intervening step, to certain problems of design is the obvious one imposed by the impossibility of predicting for each possible case in actual practice the conditions which will determine the air flow. All of the work discussed in this paper and the results of the measurements recorded can be applied, provided only that the air flow through the core be known.

The material compiled in this treatise is based upon the war work and postwar work of the Bureau of Standards on the subject of aircraft

radiators. Individual reports covering many phases of the subject have been published previously in the technical series of the National Advisory Committee for Aeronautics and in scientific and engineering journals. These reports, however, lack the systematic coördination, uniform terminology, and unified mathematical treatment which should characterize a handbook on the subject.

This report is known as Bureau of Standards Technologic Paper No. 211, by Messrs. S. R. Parsons and D. R. Harper, 3d. It may be obtained by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 50 cents.

Air A2-22. The Reheating of Compressed Air. University of Illinois Bulletin No. 130, by C. R. Richards and J. N. Vedder. This investigation of the reheating of compresssed air was undertaken to determine the ideal thermodynamic efficiencies resulting from the heat expended in the reheating process, the efficiency of external- and internal-combustion reheaters, the performance of an engine using air expansively under a wide variety of operating conditions, and the performance of the same engine operating with steam alone, and with mixtures of air and steam when steam is injected into the air pipe as a means of reheating the air.

The results of the investigation of reheaters show that in small external combustion reheaters maximum efficiencies of from 16.7 to 61.5 per cent may be secured, depending upon the type of reheater employed; and that in the internal-combustion reheater of the type tested the efficiency varied from 69.4 per cent when 326 lb. of air per hour was heated. to 83.0 per cent when 1240 lb. of air per hour was heated.

In the tests of the engine using a mixture of air and steam it was found that the work done per pound of mixture was considerably in excess of that attainable by the separate use of the same weight of each ingredient in the mixture. The interest in air-steam mixtures developed during this investigation has led to further studies of the subject, the results of which will be presented in a later bulletin.

This bulletin may be obtained by addressing the University of Illinois, Engineering Experiment Station, Urbana, Illinois. Price per copy, 50 cents.

Automotive Vehicles and Equipment A2-22. Sixth Semi-Annual Motor Gasoline Survey. See *Fuels, Gas, Tar and Coke A12-22.*

Cement and Other Building Materials A5-22. Action of Alkali on Concrete. This paper reports the results of inspection in 1919 and 1920 of experimental drain-tile and concrete-block installations at eight alkali-bearing projects in the West. The investigation has been carried on since 1913, and the conclusions to date are that the best quality of concrete will disintegrate when exposed to severe alkali attack, and that installations of concrete in soils containing more than 0.1 per cent of salts of the sulphate type should be preceded by an examination of surrounding conditions.

Mr. G. M. Williams, associate engineer of the Bureau of Standards, in coöperation with seven others prepared this report which is designated as Technologic Paper No. 214. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 10 cents.

Cement and Other Building Materials A5-22. Flexural Strength of Plain Concrete. For many years little attention has been given to the flexural strength of concrete, due to the practice of disregarding the tensile stresses in the concrete in the design of reinforced-concrete members and structures. With the advent of concrete roads and pavements, the flexural strength of concrete again became important; it may in fact prove the determining factor in working out a rational and economical design of slabs for this purpose. Concrete roads have presented many new engineering problems, one of which is the design of a comparatively thin slab to carry heavy rolling loads. Critical tensile stresses may occur in any direction, in either the top or bottom surface; the span length is uncertain on account of the indeterminate nature of the support. To provide adequate steel reinforcement would involve a prohibitive expense, consequently engineers have come to realize that primary dependence must be placed on the ability of the plain concrete to develop the flexural strength necessary for a proper distribution of the load over the subgrade. The exact thickness of slab necessary for this purpose cannot now be fixed by mathematical analysis, but must be determined as a result of experience. Considerable advance toward a rational design of road slabs may be expected to result from the studies of subgrade soils, the effect of moisture and temperature on the slab, and the effect of impact that are now being carried out by the U. S. Bureau of Public Roads and a number of the state highway departments.

The tests covered by this report were made as a part of a general investigation of concrete and concrete materials being carried out through the coöperation of Lewis Institute and the Portland Cement Association, at the Structural Materials Research Laboratory, Chicago. Address the author, Prof. Duff A. Abrams, Professor in Charge of Laboratory.

Corrosion A2-22. Corrosion under Oil Films. With Special Reference to the Cause and Prevention of the After-Corrosion of Firearms. This report, known as Technical Paper 188, was prepared by Wilbert J. Huff and was recently published by the Bureau of Mines.

Toward the end of the world war the Bureau of Mines was requested to investigate the causes of after-corrosion upon the bore surfaces of the infantry service rifle, with the ultimate purpose of developing some simple procedure for eliminating this serious menace. The Ordnance Department of the Army says that probably more rifles are ruined by improper preparation for storage than by any other cause; and the problem, though primarily military, touches the interest of every owner of a firearm.

The importance of this study is not, however, limited to the users of firearms. The fundamental problem proved to be corrosion under oil films; this differentiates after-corrosion sharply from the ordinary corrosion of clean iron and steel surfaces. It will be shown that this after-corrosion is closely allied to a number of other general problems, such as the corrosion under oil of bright steel parts after handling in manufacturing operations, and to the corrosion under oil experienced near the ocean.

This paper first reviews the numerous theories that have been advanced to account for this after-corrosion. It then describes certain experiments which were conducted and concludes with a number of practical suggestions. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 5 cents.

Corrosion A3-22. Action of Alkali on Concrete. See *Cement and Other Building Materials A-522.*

Ferrous Alloys A2-22. Experimental Production of Certain Alloy Steels. In 1917 the Bureau of Mines received information from a creditable source that Germany was using uranium steel in the liners of some high-power naval guns. It was stated that uranium stiffens steel at high temperatures, and raises the softening point some 200 deg. cent., so that gun erosion is reduced. The fact that the German guns retained accuracy of fire at the end of the Jutland naval engagement was ascribed to the uranium-steel gun liners. The report agreed with previous less circumstantial reports. Somewhat similar reports had been received as to the use of molybdenum steel.

About four years ago, therefore, the Bureau began a series of experiments with small heats of uranium steels produced with the electric-furnace equipment of Cornell University. The Michigan Steel Castings Company and the Halcomb Steel Company coöperated in the earlier experiments, and later the Vanadium Corporation of America and the Welsbach Company took a part. Before the work had progressed very far the need for an electric furnace adapted to this purpose was realized. Such a furnace was developed and then the experiments progressed more rapidly and were extended to many other alloy steels.

This Bulletin 199, written by Messrs. H. W. Gillett and E. L. Mack, records valuable data connected with the preparation and study of uranium, manganese, molybdenum, chromium, vanadium, nickel, aluminum, zirconium, cerium and boron steels. It closes with a summary of results, conclusions and a list of publications on ferrous metallurgy.

Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 15 cents.

Foundry Equipment, Materials and Methods A3-22. Inclusions in Aluminum-Alloy Sand Castings. See *Non-Ferrous Metals A1-22.*

Fuels, Gas, Tar and Coke A12-22. Sixth Semi-Annual Motor Gasoline Survey. For several years the Bureau of Mines has conducted surveys to determine the changes in motor gasoline being sold throughout the United States. The present survey shows that for the districts in which samples were collected, the average gasoline is becoming more volatile instead of less so, as is sometimes supposed. This year's gasoline is much more volatile than that sold two years ago, and it has a somewhat better distillation range than last summer's samples. A comparison of the average figures for several years, shows that motor gasoline is also becoming more uniform in character. The large seasonal change is disappearing, but "winter gasoline" still has a lower initial boiling point than "summer gasoline." This difference in volatility is made intentionally to facilitate starting the motor in cold weather. The end point shown in the present survey is slightly lower either than that of last winter or of the summer of 1921.

The report on this survey, known as Serial No. 2388, was written by Messrs. A. D. Bauer and N. F. LeJeune, both assistant chemists of the Bureau of Mines.

Instruments and Apparatus A3-22. The Redwood Viscometer. It is generally believed necessary to standardize viscosimeters or viscometers at more than one temperature. If this is correct, all instruments of a given type must be made of materials of approximately the same thermal coefficients of expansion, and the use of only one calibrating liquid at two different temperatures would be inadequate, even if the experimental error were assumed negligible.

The Redwood viscometer was selected for calibration because there appeared to be some doubt whether or not the instrumental constants varied with the temperature. By the use of oils whose viscosity had been determined in a capillary-tube instrument the following equation was obtained:

$$\text{Kinematic viscosity} = 0.00260t - \frac{1.88}{t}$$

where t is the time of flow in seconds.

Two common errors in viscosimetry were investigated, with the following conclusions:

1 That the error due to inaccuracy in the Meissner formula for average head is negligible in ordinary work.

2 That the error due to cooling of the oil after leaving the outlet tube may be neglected at low temperatures, but should be corrected

at temperatures near the boiling point of water. Thus, any observed variation in instrumental constants at different temperatures is probably due to the last-mentioned error, so that viscosimeters may be calibrated at any convenient temperature, and outlet tubes may be made of any suitably durable and non-corrosive material without regard to its coefficient of expansion.

Mr. W. H. Herschel, associate physicist of the Bureau of Standards, prepared this report, a copy of which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. by asking for Technologic Paper No. 210. Price per copy, 10 cents.

Iron and Steel A3-22. Experimental Production of Certain Alloy Steels. See *Ferrous Alloys A2-22.*

Lubricants A1-22. The Redwood Viscometer. See *Instruments and Apparatus A3-22.*

Non-Ferrous Metals A1-22. Inclusions in Aluminum-Alloy Sand Castings. Although many representative aluminum-alloy founders by care in practice have been able practically to eliminate hard spots and resulting trouble when aluminum-alloy castings are machined, others still have periodic difficulties because of this defect. A number of foundrymen have suggested at various times that the Bureau of Mines investigate hard spots, put the available information on record, and suggest preventive methods. Such an investigation was undertaken and carried out in connection with the Bureau's work on casting losses in aluminum-alloy foundry practice. The present paper is published as a contribution to the literature of aluminum-foundry practice and as a guide to founders in preventing scrap losses from hard spots in castings.

In conducting the present investigation a number of aluminum-alloy founders were requested to outline their experience with hard spots and to submit typical samples of castings containing this defect. The information thus gathered was analyzed, and the samples submitted were examined microscopically. In this way the experience of representative foundrymen has been made available, and practically all possible kinds of hard spots have been examined. Furthermore, an investigation was made of the actual conditions in a foundry which was in the throes of an epidemic of hard spots for six or eight weeks. In addition, hard spots were produced purposely in sand castings.

Mr. R. J. Anderson is the author of this Technical Paper 290 and concludes the report of his investigation with a number of helpful suggestions. Address the Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 10 cents.

Steam Power A4-22. The Reheating of Compressed Air. See *Air A2-22.*

Ventilation A1-22. Effects of Breathing Carbon Dioxide. Experiments on the effects of breathing carbon dioxide have been conducted at the Pittsburgh, Pa., station of the U. S. Bureau of Mines under the direction of Dr. R. R. Sayers, chief surgeon of the Bureau, and A. C. Fieldner, supervising chemist. About 2 per cent of carbon dioxide in oxygen produced a slight increase in lung ventilation but no subjective symptoms; 5 per cent in oxygen caused an increase in lung ventilation of about 100 per cent, but no other signs or symptoms; 7.2 per cent produced about 200 per cent increase in lung ventilation and moderate perspiration and a slight fullness in the head were experienced after breathing the mixture for 10 minutes; 9 to 10 per cent produced about 300 per cent increase in lung ventilation, and the subject complained of frontal headache and was dizzy and perspiring at the end of 10 minutes. About 9 per cent of carbon dioxide in oxygen was breathed by some of the subjects for as long as 15 minutes, but the breathing was very laborious, and dizziness, headache, and perspiration were marked. In fact, to have done any work while breathing this mixture would have been extremely difficult.

Wood Products A4-22. Wood-Preserving Terms. Predominantly wood preservation is an engineering subject. Messrs. E. F. Hartman and E. F. Paddock have therefore rendered a great service in the preparation of this complete and full glossary of the terms employed in this industry. This pamphlet comprises 85 pages and was published by the Protexol Corporation, 34 Barclay Street, New York.

In their introduction the authors state that they have endeavored specially to help those unfamiliar with the language of the wood preserver. In many cases, what were originally simple definitions have been expanded and amplified until in its present form, what was intended merely as a glossary of terms has assumed proportions more nearly approaching those of a textbook. Terms of a technical nature have been included, as well as the strictly industrial terms.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Vapor Engines and Turbines F1-22. Mercury-Vapor Boiler and Turbine. A bibliography has just been completed on this subject and may be obtained by referring to Search No. S 3618, which consists of one page. Address the A.S.M.E. Research Department.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on activities and policies of the Society in Research and Standardization.

German Standards

To the Editor:

In the September issue of Mechanical Engineering, Mr. Wikander says on page 615, apropos of German industrial standards:

> To give a concrete illustration of this point, I may mention that at the time of my visit, a syndicate of nineteen German and one Swedish manufacturer was executing an order for seven hundred locomotives for Russia, all of the same design, and every part in every one of them was being made interchangeable with the corresponding part in all the others, all parts having been manufactured to the same fits and tolerances. This feature will have the great advantage of permitting the Russian railroads to use any disabled locomotive as a store of spare parts for all the others. In case of future orders, the Russians will no doubt specify that all new locomotives of this class be built not only of the same design as above, but so that every part is interchangeable with the above.

Mr. Wikander refers evidently to the order of the Russian Soviet Government for 700 locomotives to be made in Germany. The contract of the purchaser with the manufacturers *does* specify in Par. 5 that the parts are to be interchangeable, no matter at which of the works they are made, but the same contract also has a clause in the same paragraph stating that it is permissible to make these interchangeable parts fit one another by applying hand operations (filing, scraping, etc.). It can be readily seen that this latter clause kills entirely the preceding one and the whole idea of interchangeability.

This letter is, of course, in no way a criticism of the interchangeability idea in itself.

R. Poliakoff.

New York, N. Y.

[A copy of Mr. Poliakoff's letter was submitted to Mr. Wikander whose comment thereon is printed below.—Editor.]

To the Editor:

I beg to acknowledge receipt of a copy of a letter from Mr. R. Poliakoff referring to the order of 700 locomotives for the Russian Soviet Government placed with a syndicate of German manufacturers and which was mentioned in my article on German standards in the September issue of Mechanical Engineering.

The article in question was based on verbal information from the leading manufacturer of the locomotives, but the writer did not read the contract, a copy of which seems to be in the hands of Mr. Poliakoff.

It is to be seen from Mr. Poliakoff's letter that, in addition to the paragraph which *does* specify that all parts of the above locomotives are to be interchangeable, there is also a clause stating that it is permissible to make these interchangeable parts fit one another by applying hand operations (filing, scraping, etc.). The writer was not aware of this latter clause and in his opinion it is a kind of a joker which the Germans have placed in the contract so as to defend themselves in case it should not be found possible for them to fulfil the requirement of interchangeability beyond any

question. As a matter of fact, however, the syndicate was able to meet the said requirements to an extent exceeding their own expectations.

New York, N. Y. Oscar R. Wikander.

The Surge Tank Problem

To the Editor:

I have read Mr. R. D. Johnson's letter in Mechanical Engineering for August, 1922, page 541, in which he discusses an article on surge tanks by Professor Durand. He says, on page 542:

> Furthermore, it is difficult for the writer to find any excuse for omitting the differential principle when its use, without exception, produces a cheaper surge tank which will fulfill the same conditions.

In this connection I wish to call attention to the closing discussion of my article on surge tanks, which discussion will be printed in Vol. 85 of the Transactions of the American Society of Civil Engineers. Due to the fact that assertions similar to those made by Mr. Johnson and quoted above were made in discussing my paper, it became necessary to discuss the differential surge tank, and I have shown in this discussion that in case of sudden load demand the differential surge tank is at a distinct disadvantage. It produces faster acceleration by decreasing the head on the plant, which is very undesirable for low- or medium-high-head plants because it lowers the output of the plant at the critical moment when the greatest possible output is desired. The differential surge tank is therefore not generally the best solution of the surge-tank problem. The discussion referred to gives detailed information and curves.

Professor Durand has applied a valuable method of investigating surge-tank problems experimentally and at a nominal cost. This enables the designer to obtain a much better understanding, not alone of the best surge tank for any given condition, but of the action of the surge tank for various load changes, and this should assist materially in deciding the conditions for which the surge tank should be designed. This is perhaps the most difficult part of the whole design.

The article on surge tanks which appears in the April, 1922, Proceedings of the A.S.C.E., pp. 853–69, gives particular regarding tests on a surge tank for a 50,000-hp. plant, and shows the very rapid damping of the oscillations in the cone-shaped surge tank, in spite of the fact that no provisions whatever were made to damp the surges.

Fresno, Cal. B. F. Jakobsen.

Discharge through Orifices in Series

To the Editor:

An investigation was recently made at the Mechanical Engineering Laboratory of The Rice Institute, Houston, Tex., to determine the rate of flow of fluids through sets of orifices in series, so placed that the fluid must pass through each of the orifices in succession.

Various sizes and combinations of sizes of small orifices were tested under different pressure heads in order that a formula for the discharge through orifices in series could be derived, and also to find the effect of the distance between the orifices on the discharge. In order to carry out this test a search tube (Fig. 1) was constructed consisting of two tubes, A and B, the smaller one fitting in the larger, places for inserting orifices for testing being provided at C and D. Small glass tubes inserted in the search tube made it possible to read the pressures on orifices by the height of the water column in the glass tubes. The distance between the orifices was varied by moving the small tube B in or out, while the pressure head thereon was varied by varying the height of a supply tank containing three openings: one for the supply line to the search tube, another for the water inlet, and a third to take care of the surplus water whereby the water level was kept at a constant level. The orifices used were made of copper and were 0.037 in. thick, with the inner edge of the hole square and sharp.

The discharge was determined by weighing the water flow from the orifices on a balance weighing to one-thousandth of a pound and timed by means of a stop watch; also, all readings were checked after an interval of several days.

Fig. 2 shows the weight of water discharged in five minutes for two different sizes of orifices placed in series and discharging under a constant pressure head as the distance between them is varied. The maximum discharge was obtained when the two orifices were separated by a distance of approximately 70 per cent of their diameters; the pressure head on the orifice also changed this value to a certain extent.

Referring to curve No. 1 of Fig. 2, it is seen that the highest value for the discharge of two orifices in series is at the point E. When the two orifices are in contact and form one orifice (distance apart = 0), it will be observed that the discharge is less than when the distance between them is 0.063 in., which separation gives the maximum discharge. Under certain conditions this maximum discharge through two orifices was found to be greater than the discharge through a single orifice under the same conditions. These conditions were found to be: a correct alignment of the two orifices; a pressure head sufficient to give a good contracted jet through the first orifice; and the location of the opening of the second orifice at the point where the cross-sectional area of the jet from the first orifice is a minimum. For two orifices each 0.088 in. in diameter under a pressure head of 12 in. this maximum discharge was found when the orifices were separated a distance of 0.063 in.; when the pressure head was lowered to 3.9 in., however, the maximum discharge was less than that from one orifice of the same diameter (see Fig. 4).

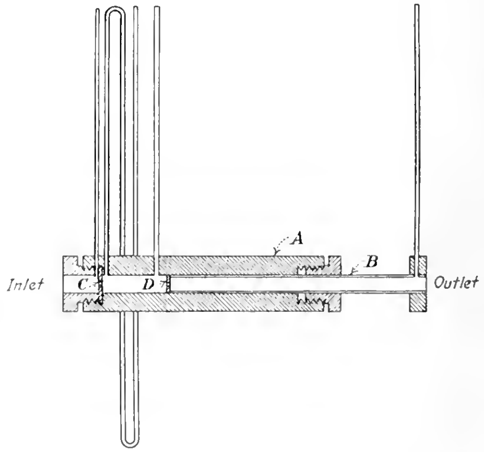


Fig. 1 Cross-Section of Search Tube Used in Testing Orifices in Series

The reason why two orifices will discharge more than one under the conditions named, may be determined by reference to the curves of Fig. 3. These curves show the pressure between the orifices of different sizes with varying distances between the orifices and with the first orifice a constant pressure head. Consider curve No. 4 for two orifices each 0.088 in. in diameter under a head of 12 in. When these orifices are 0.063 in. apart the pressure drops far below atmospheric, causing a pressure drop of 17.5 in. through the first orifice under an external head of 12 in.; while under similar conditions the reading of this pressure drop for a single orifice of the same size was only 14.93 in. of water. This may be explained by the fact that the second orifice not only exhausted the water of the first orifice easily—due to the diminished area of the jet at its high velocity—but it acted also as an air ejector, creating a partial vacuum between the two orifices and causing the greater pressure drop through the first orifice.

A change of distance between the two orifices does not affect their discharge after a certain point is reached, as is shown by the horizontal parts of the various curves in Fig. 2 and the constant pressure drop through the orifices as in Fig. 3 after a distance of 1 in. or more is reached, depending on the areas of the orifices and the pressure head. When the distance between two orifices is such that the velocity of flow is uniform throughout the cross

section of the pipe and the velocity of approach is negligible, then, according to the experimental results obtained, the formula for the discharge through orifices in series is:

$$Q = \frac{(K_1 \times K_2)(A_1 + A_2)\sqrt{2gh}}{2}$$

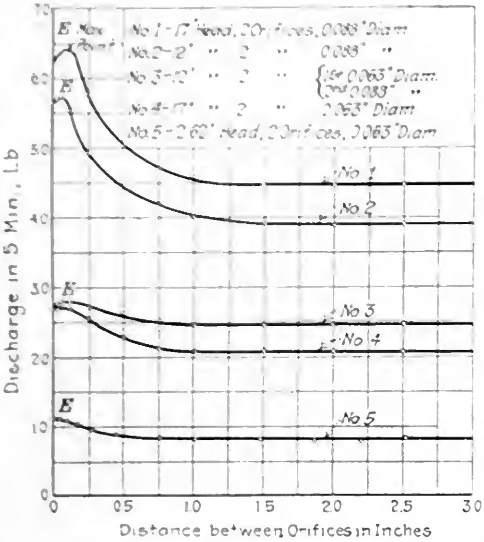


Fig. 2 Curves Showing Effect of Varying Distance between Two Orifices in Series on Discharge under a Constant Pressure Head

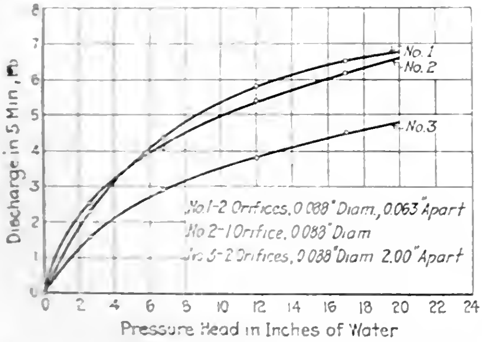


Fig. 4 Discharge Curves of a Single Orifice and of Two Orifices in Series, All Orifices Being of the Same Size

where Q = discharge in cu. ft. per sec.
K_1 = efflux coefficient of first orifice
K_2 = efflux coefficient of second orifice
A_1 = area of first orifice
A_2 = area of second orifice
$2gh$ = velocity corresponding to the pressure head.

Curve No. 3 in Fig. 4 is the discharge curve of two orifices each having a diameter of 0.088 in. and separated 2.00 in., which distance places them on the straight-line portion of the discharge-distance curves of Fig. 2 or of the pressure-distance curves of Fig. 3. Curve No. 1 in Fig. 1 is for the same two orifices, but they are placed so as to give maximum discharge corresponding to points under the letter E in Fig. 2; while curve No. 3 is plotted for a single orifice 0.088 in. in diameter. Curves Nos. 1 and 2 intersect when the value of the pressure head is 3.9 in., at which head these orifices will discharge the same amount in series as if discharging singly. Below 3.90 in. pressure head a good contracted jet is not formed and the two orifices will always discharge less than one will by itself, regardless of the placing of the two orifices in series. This does not hold true, however, when the pressure head is greater; for example, the tests show that above 3.90 in. head the two orifices in series can be so spaced that their discharge will be larger than the discharge from one orifice alone. The distance between the two orifices giving the maximum discharge is, according to test results, 70 per cent of the orifice diameter. The ratio of the discharge from two 0.088-in.-diameter orifices in series so spaced as to give maximum discharge and under a sufficient pressure head, to the discharge from a single orifice of the same diameter is 1.04.

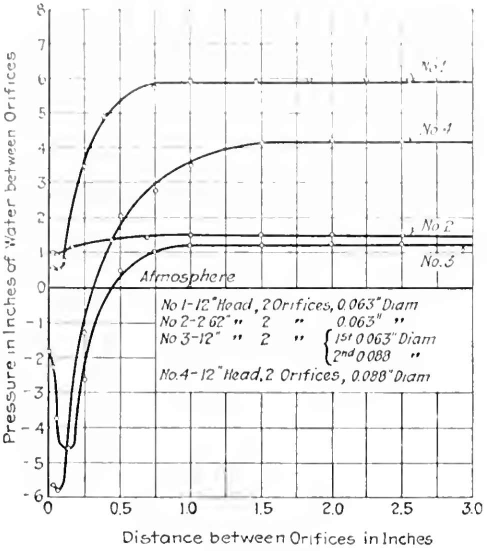


Fig. 3 Curves Showing Pressure between Two Orifices in Series Plotted against Distance between Orifices, Pressure Head Constant

H. W. Dietart.

Houston, Tex.

TEST CODE FOR FEEDWATER HEATERS

(Continued from page 760)

(36) Barometer reading .... **in. Hg.**
(37) Room temperature .... **deg. fahr.**
(38) Quantity of water through heater .... **lb. per hr.**
(39) Steam pressure in heater, gage ...... **lb. per sq. in. or in. of mercury**
(40) Steam temperature in heater by thermometer .... **deg. fahr.**
(41) Drain temperature .... **deg. fahr.**
(42) Vent temperatures by thermometer ....
(43) Steam temperature at inlet by thermometer ....
(44) Inlet water temperature .... **deg. fahr.**
(45) Outlet water temperature .... **deg. fahr.**
(46) Weight of steam used .... **lb. per hr.**
(47) Inlet water pressure, gage .... **lb. per sq. in.**
(48) Outlet water pressure, gage .... **lb. per sq. in.**
(49) Water-pressure drop by differential mercury column ....

Computed and Deduced Results

(50) Velocity of water in tube .... **ft. per sec.**
(51) Steam temperature in heater corresponding to absolute steam pressure .... **deg. fahr.**
(52) Quality of steam supplied to heater, per cent moisture or degrees of superheat ....
(53) Temperature rise .... **deg. fahr.**
(54) Logarithmic heat transfer coefficient, B.t.u. per hour per sq. ft. of surface, per degree of logarithmic mean temperature difference (Par. 10) ....
(55) Weight of steam theoretically required per lb. of water, computed from heat balance .... **lb.**
(56) Weight of steam used per lb. of water .... **lb.**
(57) Water-pressure drop in heater .... **lb. per sq. in.**
(58) Steam lost up stack .... **lb. per hr.**

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

DEXTER S. KIMBALL, *President*

WILLIAM H. WILEY, *Treasurer* CALVIN W. RICE, *Secretary*

PUBLICATION COMMITTEE:

GEORGE A. ORROK, *Chairman* ALEX. G. CHRISTIE

RALPH E. FLANDERS JOHN T. WILKIN

O. G. DALE

PUBLICATION STAFF:

C. E. DAVIES, *Managing Editor*

FREDERICK LASK, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Sailplaning

THE extraordinary flights carried out during the past summer by Hentzen and other German pilots, together with the success obtained by certain French experimenters during the summer's competitions and more especially after their close, have naturally and properly aroused great interest in America. There is direct and inherent interest in a motorless flight lasting two hours or more, but there has been manifest also a hope that these developments will prove of immediate practical utility in decreasing the power required for flight and in making commercial air transport safer and more certain than it has been in the past. Some enthusiasts have already gone so far as to predict that engines will be altogether dispensed with and that sailplanes will cruise across deserts and oceans without the expenditure of any power, an achievement which is theoretically possible but which would be much closer to perpetual motion than most engineers have ever expected to get.

EDWARD P. WARNER

Having been a witness of both the French and German soaring meets, the writer has no hesitation in declaring his own belief that the day when engines can be dispensed with is far away, and, indeed, that there is no real indication of its approach. The records of the past summer are important, but they do not herald the advent of motorless cross-country flights carried out on regular schedule. They were not accomplished by magic, and they involve no violation of the familiar laws of mechanics.

The real significance of the flights carried out from the Wasserkuppe and La Taupe lies in other directions, and it seems to lie first of all in the field of aerological research. For many years the structure of the atmosphere has been debated, and in particular there has been great argument as to the magnitude of the vertical motions of the air and as to the localities where such motions were likely to occur. Now, for the first time, ascending currents are being used for the support of aircraft and the pilots are of necessity gathering information concerning them by the slow but certain process of trial. The information is all useful, however, whatever the purpose for which it was gathered or the method employed. If airplanes are to fly safely with much less reserve power than they now possess it will be necessary greatly to increase our knowledge of the structure of the atmosphere and of the nature of the conditions which may have to be met when flying over unfavorable country such as the mountainous regions where the gliding experiments have been carried out. The continuance of the work with gliders furnishes an incentive and to some extent a means for the acquisition of such knowledge.

The second element of importance in the tests has to do with the training of pilots. They furnish a means of keeping in practice at moderate expense, and they lead to the development of a delicacy of control perhaps even superior to that required for the satisfactory handling of a powered airplane. It is for advanced training only, however, that the glider should be counted on. Despite the fact that a few German students have learned to fly gliders without ever having been in an airplane, such procedure cannot be recommended as either economical or safe for the ordinary individual. Except for landing, which is facilitated by the low ground speed of the gliders, a glider is harder to fly successfully than an ordinary airplane, and the sport is not one to be undertaken lightly by schoolboys. Conducted with due precautions it forms a useful element in the training of a pilot, and Lieutenant Thoret, one of the oldest and best known of French Army fliers, has gone so far as to recommend that every military pilot should undergo a course of instruction in gliders before his studies are considered complete.

Third, and most interesting to engineers, there arises the question of the effect of the glider experiments on the design and construction of airplanes of the future. That effect will probably be small. The designs of the most successful gliders incorporate little that differs from the standard airplane practice, at least so far as externals are concerned. The details of construction show some changes from what is conventional in powered machines because of the necessity of building very lightly. In the airplane, carrying a loading of six pounds or more for every square foot of wing surface, the materials can naturally be heavier and the assembly more solid than in the gliders which are loaded about two pounds per square foot. The constructional practice developed for use in the gliders will of course be available for light airplanes if, as seems probable, there arises in the future a demand for sporting machines with very low power and light wing loading.

Finally, the glider must be considered as an instrument of aeronautical research. Its potentialities in that capacity have often been overestimated, and there is no probability that it will supersede the wind tunnel, as some overenthusiastic writers have suggested, but it has a field of its own, particularly in connection with experiments on new forms of control. A new type of aileron, for example, can be tried out on a glider more quickly and cheaply than on an airplane, and experiments can be conducted with comparative safety on the glider of due precautions are taken and no attempts made to break records. One of the most interesting features of the German meet this summer was the originality displayed in the means provided for controlling some of the competing machines. While the majority employed the full complement of airplane controls, there were a few who dispensed with the rudder, securing directional as well as lateral control through the ailerons or through tilting the wing tips, and several others had no movable elevator, the longitudinal control being cared for by tilting the wings as a whole to a different angle of attack. Any such radical change of course requires that the pilot learn to fly all over again, and self-instruction, which must be the rule with a wholly original type of machine because no teachers are available, is no more difficult on a glider than on an airplane.

In summary, it may be said that, great as is the interest of the glider competitions, it is doubtful if they bring results of sufficient importance to justify the diversion of any considerable part of our energies from engine-driven aircraft to the motorless type. The glider should be used for the purposes which it is best fitted to serve, but it should be used with a clear understanding of its limitations and without imagining that its development will make it possible to slacken the effort applied to the improvement of the present-day airplane.

EDWARD P. WARNER.[1]

---

[1] Professor of Aeronautical Engineering, Massachusetts Institute of Technology.

Industrial Development in the Orient

[To gain a better understanding of hydroelectric power developments in Japan, Mr. W. M. White, manager and chief engineer of the hydraulic department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., spent the latter half of 1921 in the Orient, visiting Formosa, China, Korea and Manchuria, as well as Japan. In the following article Mr. White has set forth some of his impressions of industrial possibilities in these countries.—Editor.]


W. M. White

JAPAN is advance agent of our civilization to the peoples of the Orient; she has made greater progress in the arts and sciences of our western civilization than all of the other oriental peoples put together. Her interpretation of our arts and sciences is being impressed upon Korea and Formosa and her influence is extending into Manchuria and China. Observations, inquiries, and studies made in Korea and Formosa, convinced the writer that Japan is doing a good and needed work along certain lines.

Formosa, particularly, has made great advancement in the ways of civilized peoples since 1895, at which time the island was ceded to Japan at the termination of Chino-Japanese War. The Japanese have destroyed the feudal walls surrounding the ancient capital Taihoku and put city street railways in their stead. Taihoku has spread far beyond the confines of the old walls, and instead of the ancient, dreary, shut-in, congested town, there has arisen, under Japanese domination, a city of 100,000 population, with many of our modern conveniences. Railways have been built along the western side of the island from Keelung on the north to Takao at the south.

The Japanese support and maintain a large army, which is engaged in the subjugation, pacification, reclamation, education and civilization of the savage aboriginal head-hunting tribes which infest the camphor-wooded sides of the high mountains. Only about one-third of the island yet remains savage territory. The writer visited the border line of the recently subjugated territory where work was in progress upon a water-power plant near the outlet of Lake Jitsugetsatu. The waters of the Jitsugetsatu River are to be diverted into Lake Jitsugetsatu by means of a tunnel fifteen feet in diameter and about ten miles long. A dam which is to be located at the outlet of the lake will impound the waters to an additional height of 85 ft. Another tunnel leads from the lake three miles to a bluff above the Suirikei, affording a head of 1000 ft. The jungle has been cleared away for the pipe lines. The power house is to contain five units each of 30,000 hp. Transmission lines run to both the north and south ends of Formosa, forming trunk lines which will feed every important city on the island. When one considers that there is now utilized in Formosa less than 15,000 electrical horsepower, one realizes that this is a venturesome and bold stroke toward industrial development.

From the windows of a splendidly equipped railway train running from one end of Korea to the other, could be seen well-built highways—work done under Japanese direction—and mountain sides, which five years ago were bare, now covered with trees, thousands of which were planted by Koreans in lieu of the payment of taxes.

The coal deposit at Fushun is twenty miles in length, one mile in width and, at one place, 476 ft. in thickness. American-made electric locomotives handle the cars going about the mines, on railway tracks of American standard gage. The writer saw coal being mined in an open pit with the aid of American steam shovels, the excavated coal being dumped into gondola cars. At Ashan there were two blast furnaces, one of which was in operation at part capacity, producing 250 tons of pig iron per day. There is, however, lack of sufficient high-grade ore to make this project successful, although the deposits of low-grade ore are enormous in this vicinity.

Japan is mountainous, there being a possible tillable area of only seventeen per cent, so that she must look to the field of mechanical arts for the occupation of her rapidly growing population. The Japanese are apparently realizing that cheap power is vital to the development of their country, for within the last decade one million and a quarter of her possible eight million water horse-power has been developed. High-tension transmission lines radiate from Tokyo in nearly every direction to hydroelectric plants located within a radius of about one hundred miles. One notable development just being undertaken is that on the Shanano River, the waters of which are to be diverted, carried through a tunnel of 28 ft., finished diameter for a distance of fifteen miles to a forebay, the elevation of which will be 450 ft. above the river level. Hydraulic turbines will utilize the available water and will produce about 300,000 hp.

W. M. White.

A.S.M.E. Annual Meeting to be Supplemented by Power Exposition

THE combination of a strong technical program and an exposition of engineering apparatus will undoubtedly prove to be the attraction that will bring members of the A.S.M.E. to New York during the first week of December in greater numbers than ever before. The Forty-third Annual Meeting of The American Society of Mechanical Engineers, which will open on December 4, will comprise twenty-two sessions dealing with both theory and practice in the various branches of mechanical engineering. This meeting will last four days and will be followed by the National Exposition of Power and Mechanical Engineering, to be held at the Grand Central Palace, at which apparatus and materials of interest to mechanical engineers will be exhibited. Fundamentally the great underlying idea of both the A.S.M.E. Annual Meeting and the Exposition is that of disseminating information which will contribute to the development of the art and science of mechanical engineering. The discussion of the technical papers presented at the Annual Meeting forms a factor of very real importance in this development; and the addition this year of the educational effect of an exposition in which machines and apparatus may be carefully studied, will undoubtedly result in an increased interest being taken in its furtherance.

Members of the A.S.M.E. will be admitted to the Exposition upon display of their badges or membership cards.

The program for the Annual Meeting will not only treat of technical subjects, but will emphasize a number of broad considerations in which engineers will be vitally interested. A joint session will be held on December 6 in the evening with the American Economic Association, at which Dr. W. C. Mitchell, of the National Bureau of Economic Research, will deliver an address on the subject, Making Money and Making Goods. He will be followed by E. M. Herr, President of the Westinghouse Electric and Manufacturing Company, who will talk on The Human Problem in Industry. The broad economic phases of engineering which these two addresses will broach will be discussed under the leadership of Prof. H. R. Seager, President of the American Economic Association; Dean Dexter S. Kimball, President of the A.S.M.E.; and H. F. Loree, President of the Delaware and Hudson Railroad Company.

Further joint sessions with the American Society of Safety Engineers and the American Society of Refrigerating Engineers are under consideration.

The Standing Committee on Training for the Industries will present a Committee Report on Industrial Training which will speak authoritatively in the matter of correspondence work in extension schools, industrial training in schools, and industrial training within the works. The Committee in charge of this Report consists of W. W. Nichols, Chairman, Dr. Ira N. Hollis, D. C. Jackson, Dean R. L. Sackett, Prof. C. R. Richards and J. C. Spence; J. A. Moyer is coöperating in its preparation. The Standing Committees on Research and Standardization are also preparing programs, and the Professional Divisions on Aeronautics, Forest Products, Fuels, Gas Power, Machine Shop Practice, Management, Materials Handling, Power, Ordnance, Railroads and Textiles, will be represented at appropriate sessions. A detailed statement regarding the program will be made in the November 7 issue of *A.S.M.E. News*.

"Opportunity"

THE wireless apparatus which was supposed to carry President Kimball's words from East Springfield to the dining room at the top of Mt. Tom was not working very well. The toastmaster said, however, that he got one word out of it very distinctly—"opportunity."

And that is the most important and significant word in President Kimball's address.[1] No man can be sure about the degree of success he will attain in his chosen calling, but he can be absolutely sure that his attainments will not be very great if he denies himself opportunities for development; and such opportunities for the engineer are to be found in Professional Society membership.

True there are many who find that to be listed as a member of the A.S.M.E., to wear its insignia and to receive its publications are sufficient for them, but when these are not considered sufficient and the question is asked, "What else does (or can) the Society do for me?" then the answer must be, "Nothing except as you participate in its activities."

It is in these activities that self-development is stimulated and prompted, and from no other source can these super-added benefits be derived. A great number of qualities and conditions must contribute to success in life. One of the essential things is "opportunity." Real success cannot be bestowed, it must be attained by proper use of opportunities, and this applies to the engineering fields as well as to all other departments of human activity.

F. J. Miller.[2]

Dr. Giolitti Favors World Union of Engineers

AN APPEAL for coördination of the iron and steel industries of the United States and Italy was made by Dr. Federico Giolitti at a luncheon given in his honor at the Bankers' Club, New York City, on September 26, by the Iron and Steel Committee of the American Institute of Mining and Metallurgical Engineers.

Dr. Giolitti, head of the Ansaldo works at Genoa and a leading Italian metallurgist, has recently toured America speaking for the internationalization of industrial effort through the engineering profession and the world union of engineers to promote peace.

Dr. Giolitti pictured Italy as a rising industrial power which is making great progress in the manufacture of steel and iron, especially in electric steel and iron. High-grade pig iron, he stated, is being turned out cheaper than elsewhere, steel plants are being constructed, and lakes are being built for purposes of irrigation, with power as a by-product. He felt that Italy and the United States could work together in the iron and steel industry to good advantage, the former supplying labor and the latter fuel and raw materials.

Other speakers at the luncheon were M. Gaston Liebert, consul general of France; Edward D. Adams, vice-chairman of the Engineering Foundation, and Charles F. Rand, chairman of the Foundation, who presided; John W. Lieb, past-president of the A.S.M.E.; Bradley Stoughton, formerly secretary of the A.I.M.E.; Dr. Rossi, Italian consul; and Dr. A. R. Ledoux, past-president of the A.I.M.E.

International Engineering Congress in Brazil

Representatives of Leading Engineering Societies, Convened at Rio de Janeiro, September 17 to 30, Study Common Problems of Conservation and Utilization of Natural Resources

SEVEN years ago the mecca for engineers was San Francisco, where they might attend not only the International Engineering Congress but also the Panama-Pacific International Exposition at San Francisco and the Panama-California Exposition at San Diego. This year, again, the profession has been afforded a unique opportunity, that of attending another international engineering congress, held in Rio de Janeiro in conjunction with the Brazilian Centennial Exposition. The magnitude of industrial and particularly engineering developments during these past seven years, coupled with the growing recognition of the similarity of the engineering problems in South and North America, makes both events important to engineers.

Until recently Latin-America, being more familiar with the French than with the English language, has naturally turned to French engineering text-books and magazines and has followed the engineering methods and standards of France. But with the increasing realization that Latin-America faced engineering problems more like those of the United States than those of the smaller and more fully developed France, our text-books and periodicals have been in greater demand and the United States is coming to be used more generally as an engineering model.

It is fitting, therefore, that this country should contribute in every possible manner to the success of what promises to be the largest exposition ever held south of the equator, and particularly to that of an exposition celebrating the independence of Brazil, a country which has already participated in eight expositions in the United States. The appropriation of $1,000,000 for the exposition made by Congress provides for many official exhibits showing the progress made in science, industry, and commerce. These and a large number of private exhibits will acquaint the people of South America with practically every phase of our industries, while the South American exhibits, in turn, will express the economical and social progress of that continent during the last century.

The International Engineering Congress, which opened on September 17 and closed September 30, was conceived to "study and discuss the solution of certain problems interesting various countries." The following list of sections into which the work of the congress was divided show more definitely just what problems were considered:

1 Overland, maritime, fluvial, and aerial transportation: the Pan-American railway, practical means of its construction
2 Iron metallurgy
3 Fuels
4 Hydraulic power, its utilization as motive power
5 Sanitation, dams, and irrigation
5 Maritime and fluvial ports, their regime and relations with international navigation
7 Machinery for agricultural and industrial purposes
8 Standardizing of statistical methods in ports and railways.

Organization of the Congress

The organization of the Congress was the work of the Club de Engenharia of Rio de Janeiro, which for forty-two years has devoted its energies exclusively to the studies and development of engineering and industrial problems in its own country. The officers of the Executive Committee of the Congress were: Dr. Ozorio de Almeida, president; Dr. Daniel Herninger, vice president; Dr. Alvaro Niemayer, secretary; and Commander Saturnino Gomes, treasurer. Official invitations were sent out through the Brazilian government to engineering societies in mechanical, electrical, mining, and civil engineering fields. In the United States a joint committee of the four national societies was appointed to arrange for their participation in the Congress. The members of this committee were:

A.S.C.E., I. W. McConnell, Fred Lavis, V. L. Havens, P. W Henry, M. H. Freeman, and J. H. Dunlap
A.I.M.E., T. T. Read, G. W. Tower, and F. F. Sharpless
A.S.M.E., P. H. Thomas, Maurice Coster, C. W. Rice, and D. P. Robinson
A.I.E.E., Maurice Coster, F. L. Hutchinson, and P. H Thomas

A similar committee was appointed in South America, the personnel of which was:

A.S.C.E., H. B. Pond, W. T. Webb, Walter Charnley, C. H. Crawford, A. W. Billings, and W. G. McConnell
A.I.M.E., M. A. R. Lisboa, E. P. DeLiveira, A. S. Barboza, and H. W. Williams
A.S.M.E., A. S. Barboza, A. W. Billings, and W. A. Haile
A.I.E.E., C. M. Mauseau, E. A. Sturgis, C. P. Braconnot, W. V. B Vandyck, and A. W. Billings

Mr. Arrojado, Mr. D. Chisholm and Mr. Ernest Havens also served with this committee. The full list of Engineering societies

---

[1] This address appears in full on page 724 of this issue.

[2] Acting Secretary of the A.S.M.E.

and organizations of the United States represented and their delegates follows:

A.S.C.E., A. W. K. Billings, Walter Charnley, C. W. Comstock, P. B. Easterbrooks, Verne L. Havens, L. C. Heilbronner, Fred Lavis, W. G. McConnell, A. A. Northrop, C. W. Rice, A. A. Fereira, Geo. Ribeiro, Geo. Schobinger, Victor da Silva Freire, T. P. Stevenson, A. Y. Sundstrom, and B. S. Thayer

A.I.M.E., T. T. Read, C. W. Rice and D. Chisholm

A.S.M.E., C. W. Rice, C. H. Crawford, Percy J. Allen, A. S. Barbosa, J. H. Bowden, A. H. Dick, A. P. da Silva, Herman Greenwood, W. A. Haile, A. A. Locasette, S. M. Lambert, E. B. Linton, E. G. Muller, A. Pachon, José de Assis Ribeiro, Arthur Rouband, and C. E. B. Sylvain

A.I.E.E., A. W. K. Billings, F. J. W. Luck, C. M. Mauseau, J. H. Payne, C. W. Rice, F. H. Shepard, Edwin A. Sturgis, and William V. Van Dyck

F.A.E.S., *Engineering Foundation*, and *United Engineering Societies*, V. L. Havens, T. T. Read and C. W. Rice

American Railway Engineering Association, C. H. Crawford, and R. C. Crocker

American Society for Testing Materials, W. E. Emley

American Association of State Highway Officials, Clifford Schoemaker

Engineering Institute of Canada, Prof. E. O. Temple Piers and C. W. Rice

American Engineering Standards Committee, *American Water Works Association*, *John Fritz Medal Board of Award*, *and National Research Council*, C. W. Rice

Mr. Rice, honorary vice-president and secretary of the A.S.M.E. was also appointed personal representative of the engineers in this country to continue from Rio de Janerio with messages to the various engineering societies in other cities of South America.

The Technical Program

As shown by the list of sections into which the work of the Congress was divided, the technical program was confined to practical problems of conservation and utilization of natural resources. The accompanying list gives the titles and authors of the papers presented, by the four national engineering societies of the United States, many of which were illustrated with slides and photographs.

High-Tonnage Blasting, Dr. W. O. Snelling, Trojan Powder Co., Allentown, Pa.

Utilization of Low-Grade Fuels with Seymour Pulverizers, with film, Erie City Iron Works, Erie, Pa

Electrical Apparatus for High-Tension Power Transmission, Stephen Q Hayes

Economic Possibilities in the Use of the Low-Grade Fuels of South and Central America with Special Reference to Locomotive Requirements, Howard P. Quick, New York, N. Y.

Some of the Engineering and Construction Problems of the Panama Canal, with slides, S. B. Williamson, construction civil engineer, Guggenheim Bros., New York, N. Y

Mammouth Coffer Dam for Pier Construction in New York Harbor, with slides, Charles W. Staniford, New York, N. Y

The Design of Masonry Dams, with slides, Edward Wegmann, New York, N. Y

Technique of Radio Broadcasting, with slides, S. M. Kintner, Westinghouse Elec. & Mfg. Co.

High-Head Hydroelectric Development in the Mountains of California, with film, A. A. Northrop, Stone & Webster, Inc., Boston, Mass

Long-Distance Telephony in the United States of America, with slides and photographs, Bancroft Gherardi, vice-president and chief engineer, and H. S. Osborne, transmission engineer, American Telephone and Telegraph Co

Developments of Electric Drives for Cotton Mills in the United States, with slides, C. N. Johnson, general engineer, Westinghouse Elec. & Mfg. Co

Some Service Records of Electric Locomotives and Motor Cars in American Heavy-Traction Service, with slides and photographs, Homer K. Smith, railway engineer, Westinghouse Elec. & Mfg. Co.

Static Transformers for Pressures of 150,000 Volts or Higher, Walter S. Moody

A New Electric Furnace for Brass, Bronze and Copper, J. Murray Weed, power and mining engineering department, General Electric Co.

Factors Limiting the Voltage of Long-Distance Transmission Lines, F. W. Peek, Jr., General Electric Co

Development in Hydroelectric Practice, T. A. E. Belt, General Electric Co.

Large High-Voltage Oil-Circuit Breakers, E. M. Hewlett, engineer, switchboard department, General Electric Co.

High-Voltage Long-Distance Transmission of Power, B. Nikiforoff, lighting engineering department, General Electric Co.

Impressions of the Cotton Textile Mills in the United States, R. L. Pamplona, General Electric Co.

The Present Status of the Electric Furnace for the Iron and Steel Industry, John A. Seede, General Electric Co.

Concrete Piles and Concrete Piling Construction, with slides, Maxwell M. Upson, Raymond Concrete Pile Co., New York, N. Y.

Report on the Development of the Cachoeria Paulo Affonso, Brazil, Charles O. Lenz, New York, N. Y.

An Outline of the Development of Excavating Machinery, with slides, Bucyrus Company, New York, N. Y

Two other films, in addition to those shown illustrating papers, were also run, one entitled Coal is King, by the Diamond Power Specialty Co., New York, N. Y. and one entitled Pit River Development, by the Pacific Gas & Elec. Co., San Francisco, Cal.

In view of the need for all engineers to work together for the solution of the principal economic problems of the day the importance of this congress cannot be overestimated. The direct interchanging of information, the discussion of mutual problems and the establishment of personal contacts are essential factors in establishing a world union of engineers for "organizing and directing men and controlling the forces and materials of nature for the benefit of the human race."

Dr. Stratton Elected President of Massachusetts Institute of Technology

THE Massachusetts Institute of Technology is to be congratulated on having secured for president Dr. Samuel Wesley Stratton, for twenty-one years director of the Bureau of Standards at Washington. Dr. Ernest Fox Nichols, elected president in 1921 to succeed Dr. Richard C. MacLaurin, who died in January, 1920, was forced by ill health to resign without having served in office. A committee of faculty and corporation members has carried on the administrative work.

Dr. Stratton was born in Litchfield, Ill., in 1861, and was graduated in 1884 from the University of Illinois, where he later became professor of physics and electrical engineering. From 1892 to 1901 he was with the physics department of the University of Chicago.

As head of the Bureau of Standards he has built up from a small office of weights and measures employing three or four persons a bureau which occupies a dozen buildings and has a staff of more than 900 employes. The Bureau is closely aligned with the industries of the country, aiding them in research work and development of precision of method.

Dr. Stratton has received the honorary degree of Doctor of Engineering from the University of Illinois and that of Doctor of Science from the Western University of Pennsylvania, the University of Cambridge and from Yale. He was made a Chevalier of the Legion of Honor in 1909.

In the war with Spain he served as a Lieutenant in the Navy. During the World War he was a member of the Interdepartmental Board of the Council of National Defense and of the National Advisory Committee for Aeronautics.

Herbert Hoover, commenting on the resignation of Dr. Stratton, said:

> The loss of Dr. Stratton as head of the Bureau of Standards is a real national loss. He has built up that service from a bureau devoted to scientific determination of weights and measurements to a great physical laboratory coöperating with American industry and commerce in the solution of many problems of enormous value in industry which the commercial laboratories of the country, from lack of equipment and personnel, have been unable to undertake.

Dr. Stratton will take up his duties at M.I.T. on January 1, 1923.

An Index to Technical Bibliographies

In assisting the extension of the services of the Engineering Societies Library MECHANICAL ENGINEERING during recent years has recognized both a duty and an opportunity. The publication of book reviews and of THE ENGINEERING INDEX has been in accord with the general policy of putting the unequalled facilities of this great technical library at the disposal of the entire profession.

The question now arises as to the extent to which an index of bibliographies, such as is printed on page 774 of this issue, would be used. Owing to the fact that there are in print comparatively few bibliographies on technical subjects the Library is frequently asked to compile them, for which service a charge of two dollars an hour is made. An index to bibliographies to be found in current technical literature ought, therefore, to be of real value and if the demand warrants it, such items will be printed in MECHANICAL ENGINEERING as frequently as available.

Engineering and Industrial Standardization

Automotive-Engine Crankcase Oils

One of the most important subjects before the Standards Committee of the Society of Automotive Engineers is the establishing of definite specifications for different grades of engine-crankcase oil used by the several groups of the automotive industry.

The S.A.E. Lubricants Division was reorganized on an active basis in 1921 and work started on formulating practical specifications for crankcase oils, cup greases, transmission greases and other classes of lubricant. The work of the Federal Government, conducted by the Bureau of Mines in the Interdepartmental Committee on the Standardization of Petroleum Specifications, and the standard methods of testing adopted by the American Society for Testing Materials, have been considered carefully by the Division.

AUTOMOTIVE-ENGINE CRANKCASE OILS

(Tentative specifications, June 20, 1922)

General.—These specifications cover grades of petroleum oil for the lubrication of internal combustion engines, except aircraft, and are not recommended for the lubrication of turbines.

Only refined petroleum oils without admixture of fatty oils, resins, soaps or other compounds not derived from crude petroleum will be considered.

Specification No.[1]	Flash point, min.	Fire point, min.	Viscosity, Saybolt Sec. 100 Deg. Fahr. Min.	Viscosity, Saybolt Sec. 100 Deg. Fahr. Max.	Viscosity, Saybolt Sec. 210 Deg. Fahr. Min	Viscosity, Saybolt Sec. 210 Deg. Fahr. Max.	Color (NPA): darkest color allowed on mixture of oil and 50 per cent kerosene	Pour test, max.	Acidity, Mg KOH per gram max	Conradson carbon residue, per cent. max.	Corrosion test
20	325	365	180	220	42	–	5	35	0.15	0.20	Required for all grades
020	325	365	180	220	42	–	5	0	0.15	0.20	
30	335	380	270	330	44	–	5	40	0.15	0.30	
030	335	380	270	330	44	–	5	0	0.15	0.30	
40	345	390	360	440	46	–	5	45	0.15	0.40	
50	355	400	450	575	50	–	6	50	0.15	0.60	
60	360	–	–	–	55	65	–	55	0.15	0.80	
80	380	–	–	–	75	85	–	55	0.15	1.50	
95	390	–	–	–	90	100	–	55	0.15	1.75	
115	400	–	–	–	110	120	–	60	0.15	2.00	

---

[1] For Specifications Nos. 20 to 50, inclusive, the numbers indicate the first two figures of the average Saybolt viscosity in seconds at 100 deg. fahr. of the grades indicated. The first cipher in Specifications Nos. 020 and 030 indicates that the pour-test value of these two grades is zero. Nos. 60 to 115, inclusive, indicate the average Saybolt viscosity in seconds for these four grades at 210 deg. fahr

Corrosion Test.—The following corrosion test shall not cause discoloration of copper strip: Place a clean piece of mechanically polished pure strip copper about $^1/_2$ in. wide and 3 in. long, and 10 cc. of the oil to be tested, in a clean test-tube. Close the tube with a vented stopper and hold for 3 hr. at 212 deg. fahr Rinse the copper strip with sulphur-free acetone and compare it with a similar strip of freshly polished copper.

The accompanying table is the last revised specification proposed by the Lubricants Division as the result of the discussion at the Summer Meeting of the Society at White Sulphur Springs. The specifications are still open to revision and the Lubricants Division will appreciate constructive criticism, especially in regard to the identification of the different grades of oil by number instead of by name such as Light, Medium and Heavy.

A.S.M.E. Procedure Connected with the Approval and Adoption of Standards and Codes Prepared by the Society's Special Committees

Since its organization forty years ago The American Society of Mechanical Engineers has, through the activity of its technical committees, developed a large number of standards and codes of various kinds. The procedure followed in bringing about the coöperation of interested organizations and in informing all organizations and individuals of these activities has grown and developed through the years.

The present activities of the Constitution and By-Laws Committee together with the need which the Standing Committees on Research, Standardization, and Power Test Codes have felt for an exact, up-to-date statement of this procedure has prompted its preparation at this time. A draft approved by the Constitution and By-Laws Committee was presented to the A.S.M.E. Council at its September meeting and that body accepted and adopted it in the form which appears below.

Procedure Leading to Adoption of Special Reports, Standards or Codes

1 Preliminary Report, Standard or Code submitted to Secretary in duplicate, one copy signed by the members of the Committees with or without reservations (letter ballot equivalent to signature).

2 Preliminary Report, Standard or Code manifolded and distributed to a selected list including the Council for criticism and suggestion.

3 Preliminary Report referred back to Special Committee for revision in light of the criticisms and suggestions which are received.

4 Revised preliminary Report, Standard or Code submitted to the members of the Executive Committee of the Council.

5 Executive Committee of the Council votes: (*a*) to approve the printing of the Report; (*b*) to receive it without printing; (*c*) to refer back to special committee.

6 Printed in Mechanical Engineering for criticism and suggestion.

7 Presented for discussion at a regular Business Session of the Society or at a Public Hearing which may be held as part of the Spring or Annual Meetings. This open discussion must be fully advertised and all those within reason known to be interested or affected must be invited to attend, particularly the recognized national organizations of such persons. It will be conceded that when the outstanding national organizations of any industry or branch of engineering have been notified, such notice must be regarded as an adequate notice to all its members and companies, etc.

8 All written discussions and all records of the discussion at the Business Session or Public Hearing must be carefully considered by the Special Committee and the Report again revised where necessary.

9 Copies of the final draft of the Report are then submitted to the members of the Standing Committee concerned for review, to enable it to draft suitable recommendations to the Council.

10 Report submitted to the Council for final approval and adoption as to form and substance.

11 Report submitted to Publication Committee for consideration relative to printing in Transactions or publication as a separate pamphlet for general distribution.

A slightly modified procedure necessary when the standards and codes are developed by Sectional Committees for which the Society is sponsor or joint sponsor is now in the course of preparation through the combined action of the A.S.M.E. Standing Committees on Standardization, Safety Codes, Publication and Papers, Finance, Professional Divisions, Meetings and Program, Constitution and By-Laws, and Local Sections.

Functions and Method of Work of the A.S.M.E. Standardization Committee

One of the standing committees advisory to the Council of The American Society of Mechanical Engineers is that known as the A.S.M.E. Standardization Committee. Mr. E. C. Peck, of the Cleveland Twist Drill Company, Cleveland, Ohio, has been Chairman of this Committee for the past two years and it was through his initiative that a revised statement of the functions of his Committee was drafted and has now been approved by the A.S.M.E. Council.

Preliminary drafts of this statement were discussed informally during the Annual Meeting last December. It was then further revised and a copy mailed to each of the four hundred and more members of the Society serving on its Standards and Technical Committees. The comments and suggestions received from these members were carefully studied and a final revised draft prepared for transmittal to the Council. On September 25 this body voted to approve the statement as submitted and referred it to the Constitution and By-Laws Committee for inclusion in the Rules of the Society.

The following are the revised statements of duties of this Committee:

1 It shall be the duty of the Committee to collect and keep on file copies of all A.S.M.E. and other engineering, mechanical, and industrial standards and other data relating to standards which have been adopted in the United States and such foreign standards as can be obtained by exchange or otherwise.

2 It shall be the duty of the Committee to receive all proposals for the

development of standards, give the same consideration, and recommend a procedure to the Council.

3 It shall be the duty of the Committee to take the proper steps to initiate projects for standardization in the Society's field and communicate them to the Council.

4 It shall be the duty of the Committee, upon the acceptance of sponsorship by the Society for a given project under the rules of the American Engineering Standards Committee, to make sure that the scope of the work is clearly and accurately defined and that the name is suitable.

5 It shall be the duty of the Committee to assist the President and the Secretary in the organization of Sectional and Special Standards Committees by recommending A.S.M.E. members and others who are qualified to represent the A.S.M.E. on such committees.

6 It shall be the duty of the Committee to supply all Committees organized to develop dimensional standards copies of the procedure for such work approved by the Society and information regarding the facilities which are available for committee work. The Committee shall express its desire to assist these Committees in their work in so far as that is possible.

7 It shall be the duty of the Committee to secure periodically, for the information of the Council, a report of the status of the work on which each Special or Sectional Committee dealing with dimensional standards, is engaged.

8 It shall be the duty of the Committee to examine the reports of all Special or Sectional Committees dealing with dimensional standards and to make recommendations to the Council concerning them.

9 It shall be the duty of the Committee to expedite action on all matters pending between the A.E.S.C. and the A.S.M.E.

Two More Standard Specifications Submitted to A.E.S.C. under Rule R-4

During September the American Society for Testing Materials submitted to the American Engineering Standards Committee in due form its specification on the Methods of Testing Cotton Fabrics (D39-20) for approval as a Tentative American Standard. In its letter of transmittal it requested that it be designated as the Sponsor Body for the preparation of all specifications and methods of test for textile materials.

At about the same time this Society transmitted also its standard Methods of Test for Flash Point of Volatile Flammable Liquids (D56-21) for approval as Tentative American Standard under this same rule.

These two proposals are now before the members of the American Engineering Standards Committee, so that Dr. P. G. Agnew, Secretary of the Committee, will be glad to receive as much information as possible concerning the use and general approval of these two standards.

NEWS OF THE F.A.E.S.

F.A.E.S. Committee to Study Muscle Shoals Project

At a recent meeting of the Executive Board a resolution was passed authorizing the president to appoint a committee of engineers to make a thorough study of the Muscle Shoals project from an engineering standpoint, placing the facts in a clear and comprehensive manner before the public. The work of raising necessary funds has already been started and organizations which have studied the project have offered to place their data and statistical information in the hands of the committee. It is believed that the report of such a committee of disinterested engineers will be of great and possibly determinative value to the nation.

Secretary Wallace Makes Trip to Coast

Beginning with an address at the College of Engineering, Lincoln, Neb. on September 18, L. W. Wallace, executive secretary of the F.A.E.S., during the past month, has spoken in many of the important centers of the Pacific Coast and the Northwest. At Denver, on September 20, he addressed a joint meeting of constituent societies of the Federation held under the auspices of the Colorado Society of Engineers; he also spoke before the faculty and student bodies of the State School of Mines at Golden, and the University of Colorado at Boulder.

Mr. Wallace attended fall meetings of the A.I.M.E. and A.S.C.E. in San Francisco, discussing the aims and activities of the F.A.E.S. While in California he addressed the Joint Technical Societies of Los Angeles and the engineering students of the University of California. His itinerary for the return trip from the Coast included addresses before the Oregon Technical Council and Oregon Agricultural College, Portland, Ore., Associated Engineers of Spokane, the State College at Pullman, the University of Idaho, faculty and engineering students of State School of Mines, Butte, Mont., Chamber of Commerce, Columbus, Ohio, and industrial engineering students at Ohio State University.

Annual Meeting of American Engineering Council

The annual meeting of the American Engineering Council will be held Thursday and Friday, January 11 and 12, 1923. It will be preceded by a meeting of the Executive Board. The meetings will be held at the new headquarters of the F.A.E.S., 24 Jackson Place, Washington, D. C.

Report of Membership and Representation Committee

With the election of the Engineers' and Architects' Club of Louisville to membership in the F.A.E.S., the state and local societies in the Federation will be entitled to a total of twenty-two representatives on the American Engineering Council. As the national societies are now entitled to forty-four representatives, the ratio between the national and state will be two to one and their representation on the Executive Board will be sixteen for the national and eight for the state and local societies. The respective quotas of the national societies are as follows: A.I.E.E., five; A.I.M.E., three; A.S.M.E., five; and distributed among American Society of Safety Engineers, American Society of Agricultural Engineers, Society of Industrial Engineers, and American Institute of Chemical Engineers, three.

The division of districts for the year 1923 is as follows:

1 New York
2 Michigan, Minnesota, Wisconsin, Illinois, Indiana and Ohio
3 New England States
4 Maryland, Delaware, New Jersey, Pennsylvania, Virginia and West Virginia
5 North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee and Kentucky
6 Iowa, Missouri, Kansas, Nebraska, North and South Dakota, Wyoming, Colorado and Utah
7 Arkansas, Texas, Oklahoma, New Mexico and Arizona
8 Montana, Idaho, Washington, Oregon, Nevada and California

Special Meeting of Jurisdictional Board

The National Board for Jurisdictional Awards in the Building Industry held a special meeting in Cleveland on September 26 to consider the situation in that city and in Cincinnati, Pittsburgh, and other cities where difficulties have arisen because of independent agreements of contractors with the outlaw carpenter's union. All parties locally interested were invited to send delegates, and a general discussion took place on means for securing united and effective action toward the elimination of strikes.

British Engineering Joint Council

An important step in the movement toward international coöperation among engineers is the formation in England of an Engineering Joint Council of representatives of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institution of Electrical Engineers. Proposals for this union of British engineering bodies have been under consideration for some time, and particularly since the visit of American engineers to England last year, when great interest in the Federated American Engineering Societies was evidenced.

Among other objects, the joint council, as stated in the announcement of its formation, proposes to improve the status of engineers, to secure the better utilization of their services in the country's interests and the appointment of properly qualified individuals to responsible engineering positions, and to prevent the unnecessary duplication of activities.

The Engineering Joint Council will coöperate with the F.A.E.S. Committee on Affiliation with Engineering Societies outside of the United States in establishing direct contact between American and British engineers. This committee of the F.A.E.S. has already established contact with the engineering bodies of France, Italy, and Czechoslovakia.

NEWS OF OTHER SOCIETIES

American Chemical Society

Beginning on September 4 and extending through the week, the 64th annual convention of the American Chemical Society held at Pittsburgh included the presentation of a large number of papers under the auspices of various divisions and sections of the society and an all-day excursion to the Clairton by-product coke plant of the Carnegie Steel Co. and to the Monongahela, Pa., plant of the American Window Glass Co.

At the council meeting of the society announcement was made of an annual prize of $25,000 to be given by the Allied Chemical & Dye Corpn. to the chemist in the United States who, in the opinion of a proper committee, shall have done the most to advance the science of chemistry in the world. It is to be initiated in 1923.

Further announcement was made that the Chemical Foundation would annually donate $10,000 for defraying the publication expenses of the *Journal of Physical Chemistry* which will be published jointly by the Chemical Society (London) and the American Chemical Society.

Among the papers presented, one having a broad appeal both to the scientist and the industrialist was that by Thomas Midgley and T. A. Boyd on the Chemical Control of Gaseous Detonation, with Particular Reference to the Internal-Combustion Engine. Mr. Midgley has for some time been investigating the possibilities of eliminating "knocking" in engines by the addition of various chemical compounds to gasoline. He demonstrated, with a high-pressure gas engine, completely installed on the lecture platform, the detonating characteristics of various mixtures. Mr. Midgley stated however, that the full benefit of these compounds cannot be derived until gas engines have been redesigned to operate at higher compression. The increased knowledge of the theory of catalysis derived from these investigations is of great interest and importance from the scientific viewpoint.

A conference on world metric standardization was held at which some twenty-five organizations participating passed a resolution favoring the adoption of the metric system.

A symposium on automatic process control was held under the auspices of the Division of Industrial and Engineering Chemistry. Two papers were presented describing control devices employed in high-pressure testing of ammonia catalysts, a glass pressure gage consisting essentially of a glass diaphragm blown on the end of a tube and automatically recording pressure by means of a bent platinum wire contact, being an especially interesting device described by S. Karrer. The same division also presented several papers on corrosion, among which may be named one on the mechanism of the corrosion of iron and steel in natural waters and the calculation of specific rates of corrosion, by Robert E. Wilson, and one by F. N. Speller and V. V. Kendall on a new method of measuring corrosion under water and an investigation of the effect of velocity.

Two illustrated papers, one a consideration of the question, Do higher-sulphur fuels cause trouble in Diesel motors? and one on low-speed high-pressure friction tests with a Kingsbury machine were among the papers presented by the Section of Petroleum Chemistry.

Eleventh Annual Safety Congress

Following four days of "Safety First" campaigning by the Public Safety Bureau of the Detroit police department, the eleventh annual safety congress was held at Detroit, Mich., Aug. 28–Sept. 1, 1922. At the business meeting Marcus A. Dow, general safety agent of the New York Central lines, was elected president of the National Safety Council. W. H. Cameron was reappointed secretary.

There were several general sessions but in the main sectional meetings were held in order that each member might give his attention to that phase of safety engineering which was of particular interest to him. Among these were chemical, drop forge, education, engineering metals, mining, steam railroad, textile, and woodworking sections.

An industrial and public safety exhibit, an inspection trip to the Highland Park plant where 5000 Ford cars are made daily, and a mechanical safety exhibit were features of the meeting. Among the large number of papers presented were: Preventing Vapor and Gas explosions, F. J. Hoxie, engineer and special inspector, Associated Factory Mutual Fire Insurance Companies, Boston; Safety in Crane Repairing, E. E. Remington, assistant superintendent of maintenance, Ford Motor Co., Detroit; How to Lay Out a Woodworking Plant for Safety and Efficiency, B. A. Parks, Byron E. Parks & Son, Grand Rapids; Flywheel Explosions and Their Prevention, E. B. Tolstead, consulting engineer, Chicago; and Safe Practices in Acetylene and Oxygen Welding, H. S. Smith, Prest-O-Lite Company, New York.

Engineering Institute of Canada

Inspection trips to the hydroelectric works in the neighborhood of Winnipeg and the presentation of papers descriptive of the hydroelectrical development of the province of Manitoba were the chief features of the general professional meeting of the Engineering Institute of Canada held at Winnipeg, Sept. 5–7, 1922.

The Great Falls development of the Manitoba Power Company, which was described in a paper by F. H. Martin on the first day of the meeting, was visited by nearly 300 engineers on September 6. The initial development at Great Falls consists of two of the six units which provide for a total development of 168,000 hp. When operating under a head of 56 ft. and running at a speed of 138.5 r.p.m., the turbines, which are of the single-runner vertical-shaft diagonal or propeller type, will develop 28,000 hp. The generators, which will be of the vertical type, generating 3-phase 60-cycle alternating current at 11,000 volts, will have a capacity of 21,000 kva.

After leaving the Great Falls works, the engineers visited the civic plant of the city of Winnipeg at Point du Bois, about 78 miles from Winnipeg. This plant has a normal fall of 46 ft., a present capacity of 68,000 hp. and an ultimate capacity of 112,000 hp. This inspection trip was taken in connection with a paper on Extensions to the Hydroelectric System of the City of Winnipeg, presented by E. V. Caton on the previous day.

The sessions on the closing day of the convention included civil, geological and mechanical sections. Among the specific subjects discussed were turbines for the Great Falls development, disintegration of concrete by alkaline waters, fuel values of Alberta coal, and automatic grain-car unloaders.

Association of Iron and Steel Electrical Engineers

Iron and steel electrical engineers to the number of over 2000 came together at Cleveland, Ohio, September 11–14, 1922, for the sixteenth annual convention of the Association of Iron and Steel Electrical Engineers.

One of the features of the meeting was an exposition of mechanical and electrical apparatus of special interest to the iron and steel industry, trucks and tractors, handling equipment, and other steel-plant equipment contributed by over 85 companies.

At the business meeting, R. B. Gerhardt, electrical engineer for the Bethlehem Steel Co., Sparrows Point, Md., was elected president for the ensuing year. John F. Kelly, of Pittsburgh, will continue as secretary.

A report of electrical development showed that the electric drive is being adopted by a large number of rolling mills, with a tendency toward the use of direct-current motors supplied with power from motor-generators or rotary converters. Improvements in methods of production of electric energy and general power-station economies were also discussed in this report.

The motors and the control committees also submitted reports. Replies to a questionnaire on the use of anti-friction bearings sent out by the former committee to electrical engineers in 25 large steel plants, show that a high percentage of motor failures caused by oil could be eliminated by replacing ring oiler bearings by ball or roller bearings. The committee recommends standard anti-friction bearings. Control standardization was advocated in the report of the control committee.

Following his presentation of a paper on Generating Station Development, of which he was co-author with E. Pragst, David B. Rushmore was questioned as to the possibilities of the Ljungström steam turbine as an efficient prime mover. He believed it suitable for small-size units but on account of structural features, not practicable for large sizes.

Steam-boiler practice was the subject of several papers. Obtaining perfect combustion of gaseous fuel, the relative cost of large and small boilers per horsepower, the relation of heating surface to furnace width, types of stokers, the sectional-head boiler, amount of pressure, and the welding of pressure parts were among the points discussed.

D. M. Petty, electrical engineer for the Bethlehem Steel Co., So. Bethlehem, Pa., presented a paper entitled Internal-Combustion Engines for Power Generation in Steel Plants, in which he pointed out the advantages of the cast-steel cylinder over the cast-iron cylinder, and particularly the fact that cracks in the former can be welded. The use of blast-furnace gas was discussed by J. R. McDermott, chief engineer, Illinois Steel Co., and R. B. Gerhardt.

A paper by B. G. Lamme, chief engineer, Westinghouse Elec. & Mfg. Co., and W. Sykes, vice-president of the Canadian American Alloy Corpn., advocated steel-mill electrification as being highly efficient in that it is flexible, durable, economical, and easily maintained.

Charles P. Steinmetz, chief consulting engineer, General Electric Co., spoke on Improvement in Efficiency of Electric Power Supply, pointing out that the best economy requires the separation of power production from the industries it serves, although by-product energy should be conserved, preferably by interchanging power with the local section; i.e., the latter to take care of the by-product energy and supply the power needed by the industry.

A paper by Mr. Gerhardt on the Electrification of Steel-Plant Railroad Yards was well discussed. It was predicted that eventually all mill yards would be electrified.

American Electrochemical Society

The major part of the program of the annual convention of the American Electrochemical Society, held at Montreal September 21–23, 1922, was a symposium on electric industrial heating. Two full sessions were devoted to papers dealing largely with electric furnaces used in the ferrous and non-ferrous industries, with particular reference to the field of low-temperature work. The first session was introduced by a paper on the generation, propagation, and application to industrial processes of electric heat, by E. F. Collins, engineer for the General Electric Co., Schenectady, N. Y. Mr. Collins classified both the methods for the conversion of electric energy for industrial heating, and the industrial processes to which electric heat may be applied. He discussed the principles and laws governing various branches of his subject, illustrating his points with tables and charts, and closed with some remarks on the overall cost of electric heating.

An abstract of a paper on the principles of high-temperature furnace design, by E. L. Smalley, manager of the Electric Heating Apparatus Co., Newark, N. J., was presented by Wirt S. Scott, of the Westinghouse Elec. & Mfg. Co. The paper enumerated the attributes of electric furnaces which will give the highest quality of products at the lowest cost of operation and maintenance and with the greatest safety in operation at high temperatures.

The heat-treatment phase of the industry was presented in a paper entitled Some Electrical Properties of Alloys at High Temperatures, by M. A. Hunter and A. Jones, both of Rensselaer Polytechnic Institute.

Experiments being conducted at the Northwest Experiment Station of the Bureau of Mines, in coöperation with the University of Washington at Seattle, to determine the electrical resistivities of a number of granular-carbon resistor materials were discussed in an article prepared by Clyde E. Williams, metallurgist, U. S. Bureau of Mines, Seattle, Wash., and Gordon R. Shuck, professor of electrical engineering, University of Washington.

An illustrated lecture by Frank W. Brooke, engineer for Swindell & Co., Pittsburgh, discussed methods of economically handling materials in electric furnaces, describing recuperative furnaces involving the use of dummy furnaces, the counter-type of furnace, continuous furnaces, and the walking-beam type of heat-treating furnace.

The subject of heat-insulating materials for electric heating apparatus was treated in a paper by J. C. Woodson, and electric steam generators and their application by P. S. Gregory. A paper on Electric Annealing of Malleable Iron, by C. B. Gibson, of the Westinghouse Elec. & Mfg. Co. stated that few electric furnaces for the annealing of iron were in operation on a commercial scale. Two papers on electric melting furnaces were also presented at the industrial heating session.

Among the papers presented at other sessions of the convention were two on electrolytic iron, one considering the effect of heat treatment on the hardness and microstructure of electrolytically deposited iron and the other the preparation and the mechanical properties of vacuum-fused alloys of electrolytic iron with carbon and manganese, and two papers on the application of electric heat to the enameling and ceramic industries.

National Association of Stationary Engineers

With an attendance of some 1500, the National Association of Stationary Engineers held its fortieth annual convention at Des Moines, Ia., Sept. 11–15, 1922. A mechanical exposition was held in connection with this meeting, at which the latest developments in power-plant equipment were shown, over 100 firms contributing to the exhibition.

One of the principal discussions concerned a resolution of the Association's education committee proposing that the N.A.S.E. favor the passage of a national law requiring that all coal for delivery be accompanied by a certified copy of its proximate analysis and heat value, attached to the bill of lading. It was pointed out that the sale of inferior coal at top prices, particularly in times of shortage, would be prevented by such a law. The cost of making the analysis at the mine would be about two cents a ton.

One of the resolutions adopted at the business meeting called for the appointment of a committee of three to confer and coöperate with the A.S.M.E. in developing standard ammonia fittings.

Among the papers presented were those dealing with the causes of and remedies for dry rot in associations, by Charles H. Bromley, Richardson-Phenix Co., Fort Wayne, Ind., and with recent developments in feedwater treatment, by F. L. Dunham, of the Permutit Co. The latter outlines progress in water softening during the last twenty years, describing early intermittent softeners, the continuous softening process and the hot-process system employing the lime-soda treatment, and the zeolite process, the latest method.

Vice-President Frederick Felderman was elected president to succeed Richard W. Parry. Fred W. Raven, reappointed secretary, reported that membership in the association had passed the 22,000 mark.

New England Water Works Association

Among the phases of water-works problems considered at the 41st annual convention of the New England Water Works Association held at New Bedford, Mass., Sept. 12–15, 1922, were questions of pipe joints, service pipes, high-pressure fire systems, and water sanitation.

The New Bedford Water Department, in the spring of 1920, made tests of leadite and lead hydrotite joints on both 6-in. and 36-in. pipe, as the result of which leadite has been adopted and used in practically all the joints made since that time. Discussion on the paper in which Stephen H. Taylor, superintendent of the New Bedford works, described these tests, was also favorable to the use of leadite.

A paper by D. A. Heffernan, superintendent of the water department at Milton, Mass., and the discussion following condemned the use of relief and vacuum valves on domestic boilers because of corrosion, and considered other corrosion problems.

The water supplies of southeastern Massachussetts were described in three illustrated lectures given at the morning session on the second day of the convention, and the problems of several cities drawing upon the same source of supply outlined.

The effectiveness of the high-pressure fire system as shown in its use in New York during the last fourteen years was pointed out in a paper by G. W. Booth, of the National Board of Fire Underwriters, and the high-pressure system for Boston was described by F. A. McInnes, of the Public Works Department of that city.

In addition to the technical sessions there were excursions to various points of interest, including the Morse Twist Drill & Machine Co. and a manufacturers exhibit of water-works appliances and supplies.

Some Technical Bibliographies

THE following list of bibliographies on technical subjects has been compiled by Raymond N. Brown of the Engineering Societies Library, 29 West 39th St., New York, N. Y., where all of the publications named are to be found. The photostatic service as described in THE ENGINEERING INDEX may also be used in connection with this index. Attention is called to an editorial on page 769 in which mention is made of a further bibliographical service rendered by the Library.

Aeronautic Instruments. General Classification of Instruments and Problems, U. S. Natl. Advis. Comm. for Aeronautics, Report no. 125, Washington Gov't Ptg. Office, 1922, 22 pp.; bibliography, pp. 13–22. About 200 references beginning in 1892, arranged chronologically, more than half in German and French.

Carbon Black. Carbon Black, its Manufacture, Properties, and Uses, by R. O. Neal and G. St. J. Perrott, U. S. Bureau of Mines, Bull. no. 192; bibliography, pp. 80–91. About 220 references covering years 1844–1919 are grouped into periods and arranged by authors in each period. Most references are in English. Many patents included.

Carbon Steels. Hydrogen Decarburisation of Carbon Steels with Considerations on Related Phenomena, C. R. Austin, Iron & Steel Inst., Preprint of paper for Annual Meeting, May, 1922; bibliography, pp. 49–50. Thirty-nine references.

On Delayed Crystallisation in the Carbon Steels; the Formation of Pearlite, Troostite, and Martensite, A. F. Hallimond, Iron & Steel Inst., Preprint of paper for Annual Meeting, May, 1922; bibliography, pp. 19–20. Thirty-two references, for the most part in English.

Chromite. Deposits of Chromite in Eastern Oregon, L. G. Westgate, U. S. Geol. Survey, Bull. no. 725, pp. 37–65; bibliography, p. 38.

Dams. The Design and Construction of Dams, Edward Wegmann, John Wiley & Sons, Inc., New York, 1922, 7th ed.; bibliography pp. 529–546. Hundreds of references divided into sections for masonry dams, earth dams, movable dams, etc., and arranged chronologically in each section.

Directories. Trade and Class Directories Copyrighted in the U. S., Newark (N. J.), Public Library, Business Branch; Special Libraries, vol. 13, pp. 26–31, and 43–47. Lists under proper subject headings about 430 directories.

Distillation, Fractional. Elements of Fractional Distillation, C. S. Robinson, McGraw-Hill Book Co., Inc., New York, 1922; bibliography, pp. 198–200. Some 63 references covering years 1906–1920; one half of references are in German or French.

Electric Furnace. The Electric Furnace in the Iron Foundry, L. C. Judson and H. P. Martin, Amer. Electrochemical Soc., Preprint of paper no. 22, for Meeting, April, 1922, 10 pp. About 46 references to articles appearing during the last five years. Notes indicate the contents of each article.

Elevators, Electric. Electric Power Application to Passenger and Freight Elevators—Part IV, H. P. Reed, Jl. Amer. Inst. Elec. Engrs., vol. 41, pp. 152–164; bibliography, p. 164.

Engineering Education. A List of References on Engineering Education, Mrs. H. O. Norville, Bull. Univ. of Mo., School of Mines and Metallurgy, vol. 14, no. 1, pp. 89–100. About 160 references to periodicals, chiefly American, beginning with year 1912. Many items have descriptive notes.

Freight Terminals. Bibliography of Articles on Freight Terminals. Bull. Amer. Ry. Engrg. Assn., vol. 23, pp. 892–894. Lists 47 articles, most of which are in the Engrg. News-Rec. and Ry. Age.

Gears, Strength of. Gears, Jl. Soc. Automotive Engrs., vol. 11, p. 195–196; bibliography, p. 196. A selected list of 24 references.

Gelatin and Glue. The Evaluation of Gelatin and Glue, R. H. Bogue, Jl. of Ind. & Engrg. Chem., vol. 14, pp. 435–441; bibliography, pp. 440–441. About 25 references in German and 50 in English.

Heating and Ventilating Cost Data. Bibliography, Heat. & Vent. Mag., March, 1922, pp. 41–42. Fifteen references to the best books and articles.

House Organs. Bibliography and Selected References on House Organs, Nat. Elec. Light Assn., Bull. vol. 9, pp. 157–159. This is a list of some 130 articles about house organs.

Iron, Electrodeposition of. On the Electrodeposition of Iron, W. E. Hughes, Great Britian Dept. of Scientific & Industrial Research, Bull. no. 6, 1922, 50 pp.; bibliography, pp. 44–50. About 110 references in various languages, classified. Some descriptive notes.

Iron and Steel, Sulphur in. The Determination of Sulphur in Iron and Steel, H. B. Pulsifer, Chemical Publishing Co., Easton, Pa., 1922, 160 pp. Bibliography covering years 1797–1921. Some 300 references in many languages. Many items have long notes indicating contents of the articles. The arrangement is chronological but all authors cited are given in the index.

Iron and Steel Literature. Review of Iron and Steel Literature for 1921, E. H. McClelland, Blast Furnace and Steel Plant, vol. 10, pp. 4–8. "A classified list of the more important books, serials and trade publications."

Metals, Crystal Growth in. Crystal Growth in Metals, G. R. Fonda, Gen. Elec. Rev., vol. 25, pp. 305–315; bibliography, p. 315. Twenty-eight references, for the most part of recent date.

Metric System. The Metric System, H. H. B. Meyer. Special Libraries, vol. 13, pp. 1–16. About 350 references in many languages covering a long period of years. Most of the items are in the sections headed "Favorable" and "Opposed" to the metric system. Many entries have descriptive notes.

Mine Timber, Preservation of. Bibliography of Articles Relating to the Preservation of Mine Timber, R. R. Hornor. Reports of Investigations no. 2343, U. S. Bureau of Mines, April, 1922, 6 mimeographed pages. Sixty-four references from 1884 to 1921, mostly in American publications.

Motor Haulage. List of References on Motor-Truck Transportation, U.S. Library of Congress, Jan. 20, 1922, 19 mimeographed pp.

Nitrogen Fixation. Report on the Fixation and Utilization of Nitrogen, U. S. Ordnance Office, Nitrate Division, Washington Gov't Ptg. Office, 1922, 353 pp.; bibliography, pp. 343–353. About 125 references covering various methods of fixation of nitrogen. Includes articles in foreign publications. Most of the references fall in the period 1917–1921.

Oil Shale. Oil Shale Bibliography for 1921, Railroad Red Book, vol. 39, pp. 17–27.

Petroleum Refining. Petroleum Refining, Andrew Campbell, C. Griffin & Co., London, 1922, 297 pp.; bibliography, pp. 223–282. Many hundreds of references arranged alphabetically by subject. Includes translations of many foreign articles. The authors' names appear in the index of the volume.

Printing. Printing and Allied Industries, A List of Books and Periodicals, Newark (N. J.), Public Library, 1922, 17 pp.

Rails, Internal Fissures in. Bibliography, Bull. Amer. Ry. Engrg. Assn., vol. 23, pp. 658–667. About 75 references all in English, covering 1911 to 1920. Each reference is accompanied by a short abstract.

Railway Motors, Heating of. Heating of Railway Motors in Service and on Test-Floor Runs, G. E. Luke. Jl. Amer. Inst. Elec. Engrs., vol. 41, pp. 165–173; bibliography, p. 173. Ten references to articles in journals beginning with 1909.

Research. Research in Industry, A. P. M. Fleming and J. G. Pearce, Sir Isaac Pitman & Sons. Ltd., New York, 1922, 244 pp.; bibliography, pp. 221–236.

Safety Organization in Industry. Selected Bibliography, Safety, Bull. Safety Inst. of America, March, 1922, p. 75, 32 references.

Smoke Prevention. The Smoke Problem, O. P. Hood, Reports of Investigations no. 2323, U. S. Bureau of Mines, February, 1922, 5 mimeographed pages.

Sodium, Metallic. Metallic Sodium, H. E. Batsford, Chem. & Met. Engrg., vol. 26, pp. 888–894 and 932–935; bibliography pp. 933–935. Some 400 references in several languages arranged chronologically beginning with 1855.

Steel, Stainless. Bibliography in MECHANICAL ENGINEERING, vol. 44, p. 469, 22 references.

Train Control, Automatic Stop. Revised List of References on Automatic Train Control, U. S. Bureau of Railway Economics, 1922, 32 mimeographed pages. About 340 references. Part I consists of general discussions arranged chronologically beginning with 1903. Part II gives a list of descriptions of particular devices.

Trestles, Fireproofing. Bibliography, Bull. Amer. Ry. Engrg. Assn., vol, 23, pp. 725–726, 19 references.

Ventilation and Carbon Monoxide. The Physiological Principles Governing ventilation when the Air is Contaminated with Carbon Monoxide, Yandell Henderson and H. W. Haggard, Jl. of Indus. & Engrg. Chem., vol. 14, pp. 229–236; bibliography, p. 236. Sixteen references

Zinc Plating Solutions. A Study of the Throwing Power and Current Efficiency of Zinc Plating Solutions, W. G. Horsch and T. Fuwa, Amer. Electrochemical Soc., Preprint of paper no. 16 for Meeting, April, 1922, bibliography, p. 231. Thirty-five references beginning with 1894.

Zirconium. Zirconium and its Compounds, F. P. Venable. Chemical Catalog Co., New York, 1922; bibliography, pp. 149–169. Over 830 references to American and foreign publications covering half a century. Arranged alphabetically by author.

LIBRARY NOTES AND BOOK REVIEWS

American Fuels. By Raymond Foss Bacon and W. A. Hamor. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 2 vol. illus., diagrams, $12.

The editors of this volume have attempted to condense into a series of specially prepared chapters the fruits of the experience of specialists, and thus present an authoritative account of all American fuels of technical importance. It is intended to give informative summaries of sound practice and provide such information as will assist the engineer to decide upon the most suitable fuel to use or the changes to make in using fuel or heat in order to get the highest efficiency in plant operation.

Architectural Drawing. By Wooster Bard Field. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 10×12 in., 161 pp., illus., $4.

An effort has been made to provide those things which are of fundamental importance to the student in his initial study of the subject, together with a careful presentation of some of the important points that are usually left to be acquired during his office experience. The book should also be valuable to anyone who deals with architectural work.

Les Axiomes de la Mécanique. By Paul Painlevé. Gauthier-Villars et Cie., Paris, 1922. (Les Maitres de la Pensée Scientifique.) Paper, 5×7 in., 111 pp.

In this small book Professor Painlevé sets forth, with a minimum of mathematical terminology, the axioms of mechanics, as laid down by the founders of the science. From these he proceeds to a description of the modifications proposed by recent theories. His book is therefore not only a thorough study of the fundamental axioms of the subject but also an introduction to the theory of relativity.

Bearings and Bearing Metals. First edition. Industrial Press, New York, 1921. (Machinery's Dollar Books.) Paper, 6×9 in., 120 pp., illus., diagrams, $1.

A book of practical information upon plain bearings, in which the various types are shown and their suitability for various purposes explained. Information is also given on the composition and properties of bearing metals, the service to which they are adapted and proper methods of lubrication.

Beitrag zur Berechnung der Dampfturbinen auf Zeichenerischer Grundlage. By Erich Henne. Julius Springer, Berlin, 1922. (Forschungsarbeiten aud dem Gebiete des Ingenieurwesens. Heft 260.) Paper, 7×10 in., 58 pp., diagrams, chart, 20 marks.

Describes a simplified method of determining the dimensions of the stages of a turbine, for any given efficiency, by means of graphic charts. The charts are given in the book, with examples of their use. They are based upon the relation between the indicated efficiency, speed of revolution and the heat drop discovered by Loschge. By use of the charts, the author claims, much wearisome calculation can be avoided without any loss of accuracy.

Conservation of Natural Gas in Kentucky. By Willard Rouse Jillson. First edition. John P. Morton & Co., Louisville, Ky., 1922. Cloth, 5×8 in., 152 pp., illus., $2.

Dr. Jillson's little book is intended to call the attention of those interested in Kentucky to the urgent necessity of conserving the natural-gas reserves of the state, and to indicate the necessary steps to prevent waste. Incidentally, the book provides a good summary of the gas resources and industries of Kentucky. It should prove valuable both to producers and consumers of gas, both by calling attention to the consequences of waste and by its specific recommendations for conservation.

Dictionary of Applied Physics. Edited by Sir. Richard Glazebrook. Vol. 2. Electricity. Macmillan and Co., Ltd., London, 1922. Cloth, 6×9 in., 1104 pp., illus., $15.

The second volume of this important reference work contains many articles of importance to electrical engineers and physicists. Some of the longer articles are: Photoelectricity, by H. Stanley Allen; Technical Applications of Electrolysis, by A. J. Allmand; Arc Lamps, by R. E. Angold; Positive Rays, by F. W. Aston; Insulated Electric Cables, by C. J. Beaver; Switchgear, by R. A. R. Bolton; Capacity and Inductance, by Albert Campbell; Batteries, by W. R. Cooper; Electrons, by J. A. Crowther; Magnetic and Radio-Frequency Measurements, by D. W. Dye; Molecular Theories of Magnetism, by Kotaro Honda; Telephony, by F. B. Jewett; Magnet Design, by R. L. Jones; Stray-Current Electrolysis, by Burton McCollum; Thermionics, by O. W. Richardson and W. Wilson. Numerous bibliographies and a full index are provided.

Die-Casting. First edition. Industrial Press, New York, 1921. (Machinery's Dollar Books.) Paper 6×9 in., 108 pp., illus., diagrams, $1.

Describes briefly the development of die-casting machines, their commerical applications and the alloys used for die-casting. Based upon contributions to *Machinery*, and intended for those engaged in die casting.

Die Warme-Ein Gas. By Lothar Fischer. H. A. Ludwig Degener, Leipzig, 1922. Paper, 6×9 in., 61 pp., 38 marks.

This pamphlet is an attack on current opinion concerning the nature of heat. Heat is, according to this author, a gas. This gas he conceives as having an atomic weight far below that of hydrogen, and molecules of such minuteness that they diffuse easily through all substances. His monograph presents reasons for this opinion.

Engines and Boilers. By Thomas T. Eyrie. The Macmillan Co., New York, 1922. Cloth, 6×9 in., 231 pp., diagrams, $3.50.

An elementary course in heat engines for students of engineering, based on the author's experience in teaching engines and boilers and allied subjects at Purdue University.

Factory Storeskeeping. By Henry H. Farquhar. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 182 pp., illus., $2.50.

The materials considered in this book are the stores of raw materials and factory supplies, and worked materials or work in process and partly or completely finished parts. The book deals with the replenishment, storage and disbursement of these two classes of materials, but excludes the administration of work in process. The book outlines the principles and methods by which this problem may be solved and a system may be developed to suit local conditions, but does not outline a system for any specific type of factory.

Graduating, Engraving and Etching. First edition. Industrial Press, New York, 1921. (Machinery's blue books.) Paper, 6×9 in., 60 pp., illus., diagrams, $0.50.

The methods presented in this pamphlet are those commonly used by manufacturers of tools and instruments to graduate straight and circular scales and to engrave or etch name plates, etc. The dividing engines and engraving machines available are described and their use explained.

Graphic Charts in Business. By Allen C. Haskell. First edition. Codex Book Co., New York, 1922. Cloth, 6×9 in., 250 pp., charts, $4.

A companion volume to the author's earlier book, How to Make and Use Graphic Charts. The present work is confined to the charts most used for business purposes, line, bar, circular percentage, organization, trilinear and probability charts. Methods of making these are explained, their adaptability for various purposes is set forth and their application in various departments of business organizations illustrated. The ratio chart is explained fully. A bibliography is included.

The book is intended to help the man of business see when and how graphic charts can serve his purposes in controlling business operations.

Hydraulic Diagrams for the Discharge of Conduits and Canals. By Theodore Horton and C. H. Swan. Third edition. McGraw-Hill Book Co., Inc., New York, 1922. Paper, 6×9 in., 53 pp., diagrams, $1.

This set of diagrams is intended for use in the study of those sections of conduits and canals which are commonly used in sewerage, water supply, water power and drainage. The set includes conduits of ten different types of cross-section and canals of rectangular and trapezoidal cross-section. In this edition one diagram previously used has been replaced by three new diagrams of more useful types, and the text has been revised and extended.

Hydraulics. By Horace W. King and C. O. Wisler. John Wiley & Sons, New York, 1922. Cloth, 6×9 in., 237 pp., diagrams, $2.75.

This book deals with the fundamental principles of hydraulics and their application in engineering practice. Though many formulas applicable to different types of problems are given, it has been the aim to bring out clearly and logically the underlying principles that form the basis of such formulas rather than to emphasize the importance of the formulas themselves. The book is intended as a text for beginners and a reference book for engineers interested in the fundamental principles.

Liquid Fuel and Its Apparatus. By Wm. H. Booth. Second edition. E. P. Dutton and Co., New York, 1922. Cloth, 6×9 in., 308 pp., illus., diagrams, $4.

The object of this book is to present in a handy form the more practical points of the author's larger book, Fuel and Its Combustion. The present book is fairly closely confined to the use of liquid fuel under boilers and in internal-combustion engines. It discusses the principles of liquid fuel and the properties of fuel oils, gives examples of practice in using oil fuel for stationary boilers, locomotives and oil engines, and discusses burners and the storage, distribution and atomizing of oil.

Machine-Tool Operation. By Henry D Burghardt. Part 2. Drilling machine, shaper and planer, milling and grinding machines. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 5×8 in., 438 pp., illus., diagrams, $2.75.

A textbook for trade schools and apprentices. The present volume, which follows one on lathe, bench and forge work, treats of drilling, shaping, planing, milling and grinding machines. Emphasis is laid on the fundamental principles of their construction and operation. These are discussed thoroughly as a foundation for rapid production.

Mastering Power Production. By Walter N. Polakov. Engineering Magazine Co., New York, 1921. Cloth, 6×9 in., 455 pp., plates, diagrams, $5.

Contents: The descent of the principle of production for use; power industry as an economic factor; location of plants; equipment of plants; mastering materials; mastering maintenance; mastering labor problems; mastering processes; mastering records; analysis of expenses; power as a commodity.

The subject of this volume is the technology of a method of mastering power production so that the best use of our resources will be made under present social, economic and political conditions. Mr. Polakov avoids discussion of the technical subjects already available in books on power engineering, and confines himself to the broader economic, psychological and engineering features. Special attention is given to management problems.

Modern Workshop Practice. By Ernest Pull. Sixth edition. D. Van Nostrand Co., New York, 1922. Cloth, 6×8 in., 671 pp., plates, illus., diagrams, tables, $5.

A textbook for students and machinists' apprentices. Deals with the common bench and machine tools, gages, lathes, lathe tools and fixtures, milling machines, planers, boring and slotting machines, and grinding machines. Describes methods of bench work, heat treatment, soldering and brazing, twining, screw cutting, gear cutting, planing, shaping, drilling and forging.

New Building Estimators' Handbook. By William Arthur. 1922 edition. U. P. C. Book Co., New York, 1922. Fabrikoid, 5×7 in., 1002 pp., illus., tables, $6.

This well-known handbook has been revised, and reset in a smaller, though legible type, so that its size has not been increased. It is intended to assist architects, builders, contractors and engineers in estimating the cost of new construction and repairs in all lines of building work, excavating and municipal work.

L'Union D'Electricité et la Centrale de Gennevilliers. By Ernest Mercier. La Revue Industrielle, Paris, 1922. Paper, 9×12 in., 48 pp., illus., plates.

The Union Francaise d'Electricité, formed in 1919, is a combination of the principal central stations serving Paris and its environs, organized to unify the system of distribution in existence, to eliminate competition between its organizers and to provide for the future in a rational way. This monograph describes the distributing system adopted and the generating stations acquired. The principal portion of the book is devoted to the new power plant under construction at Gennevilliers, planned for a present output of 200,000 kw., with future enlargement to 320,000 kw. This station is described in detail. Many plans and illustrations are given.

Production Milling. By Edward K. Hammond. First edition. Industrial Press, New York; Machinery Publishing Co., Ltd., London, 1921. Cloth, 6×9 in., 278 pp., illus., $3.

The purpose of this book is to explain the application of some of the more efficient methods of operating milling machines in the production of duplicate parts in quantities. The methods discussed have been collected from many sources and have all been successfully used under shop conditions. A knowledge of milling machines is assumed.

Well-Boring for Water, Brine and Oil. By C. Isler. Third edition Spon & Chamberlain, New York, 1921. Cloth, 6×9 in., 259 pp., illus., diagrams, $4.80.

Describes various methods of boring and drilling in search of water, brine, oil or minerals, including driven and bored tube wells; the Kind-Chaudron, Dru, and Mather and Platt deep-boring systems; the American rope-boring system, and diamond drilling. Methods of raising water are dealt with. This edition is not only revised but also includes the methods which have been developed during recent years.

World Metric Standardization. Compiled by Aubrey Drury. World Metric Standardization Council, San Francisco, 1922. Cloth, 6×9 in., 524 pp., portraits, $5.

A comprehensive survey of the arguments advanced in favor of the adoption of the metric system in commerce. The testimony of proponents of the system has been collected from a wide range of sources and summarized in convenient form for consultation. A bibliography of over fifty pages is included.

PRECISION, STANDARDIZATION AND PRODUCTION

(Continued from page 730)

in hand. Before any product can be manufactured on an interchangeable basis, standards must be originated for all the interchangeable parts and surfaces. At first such standards were peculiar to each individual plant, but later many of them became common to all plants. As examples of such standards we have the conventional screw threads, bolts, nuts, etc.

The fear is sometimes expressed that standardization will tend to monotony. This comes from an imperfect knowledge of the nature and purpose of standardization. Again, many machine designers seem to fear that the extensive adoption and use of standards will limit their initiative and curtail their originality. Yet no one ever hears architects complaining that the adoption of standard sizes and forms for bricks, structural-steel members and joints, pipes, plumbing fixtures, electrical fixtures, etc., has limited their originality in designing new buildings. As a matter of fact, the adoption of these standards has relieved them of a large amount of drudgery on all minor details and left their minds clear for the important creative work. It is not so much the details themselves, but rather the effective arrangement and use of these details that is important.

At the present time the subject of standardization is receiving world-wide attention. It is becoming more and more apparent that standardization is one of the most effective means of promoting efficient production. Until quite recently, however, the development of standards has been a desultory process. Various engineering societies, trade associations, etc., have from time to time promulgated standards for the use of their own members. As no definite channels for coöperation existed, many matters which were equally important to several of the different associations were either left untouched, or handled in a limited way. To provide a definite means of coöperation, the American Engineering Standards Committee was formed. The nature of this committee and its method of operation is clearly stated in its report of its activities for 1921, as follows:

> The American Engineering Standards Committee essays to serve as a national clearing house for engineering and industrial standardization, to act as the official channel of coöperation in international standardization, and to provide an information service on engineering and industrial standardization matters. The ultimate responsibility for and control of the work rests with the organizations whose representatives constitute the American Engineering Standards Committee. At present these include five departments of the Federal Government, nine national engineering societies, and fourteen national industrial associations.
>
> Each industry, or branch of industry, is wholly autonomous in its standardization work, the function of the Main Committee being merely to assure that each body or group concerned in a standard shall have opportunity to participate in its formulation, which is in the hands of a working committee, technically called a "sectional committee," made up of representatives designated by the various bodies interested.
>
> In the work the sectional committee is the form in which agreements are worked out between the various organizations which speak for those branches of industry concerned in the particular standard for the formulation of which the sectional committee is responsible. Hence the sectional committee is necessarily made up primarily of accredited representatives of such organizations. A sectional committee also usually contains one or more outstanding specialists, not representing any particular organization. One of the most important duties of the Main Committee is the approval of the personnel and composition of each sectional committee, as being authoritative and adequately representative of the various interests concerned in the standard or group of standards, for the formulation of which the sectional committee is responsible.

The American Engineering Standards Committee has already started an extensive program. Its various sectional committees require much assistance from industry. Part of this is information in regard to current practice on different manufacturing and constructional subjects. So far this information has been hard to get. Several times, definite questionnaires have been sent out to several hundred factories; the number of replies seldom amounts to fifty. The only possible reason for this lack of response must be that the great importance of the subject of standardization is not fully realized.

The formulation of a standard is merely the first step. These standards must be put in extensive use before their full benefits become apparent. Engineers, designers, and draftsmen should keep themselves fully acquainted with the progress of the work of standardization and employ such standards wherever possible.

One word of caution, however, should be said at the outset. A standard does not necessarily meet every condition. The most it can do is to meet the majority of conditions. Exceptional cases will always require special consideration.

The mere publishing of a standard does not establish it. It can only become established by its common use. In order to remain in common use it must meet the majority of usual conditions as well as, or better than, any other construction would meet them. Thus a standard will become established or will be rejected entirely upon its intrinsic merits. The wide trial of proposed standards, however, will do much to show up any inherent defects in them, and thus enable them to be corrected. A wider response of manufacturers to requests for information from the various sectional committees will do much to prevent defective standards from being promulgated.

The subject of standardization is not limited to standard parts alone. It includes both assembled units and various types of machined surfaces—such as shaft and bearing diameters, keyways and key seats, etc. The extensive use of such standards leads to larger production of similar parts with resulting economy, and the larger production and stocking of standard tools for producing standardized surfaces.

The production of parts in larger quantities enables much more time and thought to be given to the methods for producing them. This in turn enables the part to be made with greater precision. Thus we have practically a complete circle. The increased accuracy of manufacturing equipment has made interchangeable manufacturing possible, and this again has made extensive standardization both desirable and possible. The extensive use of standards makes it economical to utilize the accuracy of the manufacturing equipment to the fullest extent.

The advantage of precision and standardization as regards production might be summed up as follows: It is cheaper to make a thing once and make it right than it is to make it wrong several times.

STANDARDIZATION OF SMALL TOOLS

(Continued from page 723)

This does not include the approximately 140 sizes of millimeter drills under $^1/_2$ in. diameter, nor the various odd styles of straight-shank drills such as tell-tale drills, dowel bits, etc. We are here dealing only with the kinds of drills in general use.

The establishment of sizes, particularly in Tables 1 and 2 appears to have been entirely empiric, as there are many duplications or near duplications with the fractional size drills, Tables 3 and 4. One is unable to find any uniform variation in diameter between consecutive sizes.

Table 5, which appears on page 723, is an attempt to establish uniformity of variation in diameter, and to eliminate sizes which are thought unnecessary. This will mean a reduction from 166 to 73 sizes.

It will be noted that the old symbols have been retained, but that the amount of variation in consecutive sizes has been arranged roughly in a geometrical progression. Thus we have:

From No. 80 to No. 78, diameter increases approximately 0.001 in.
From No. 77 to No. 57, diameter increases approximately 0.002 in.
From $^3/_{64}$ in. to $^1/_8$ in. diameter increases approximately 0.004 in.
From No. 29 to $^1/_4$ in., diameter increases approximately 0.008 in.
From $^{17}/_{64}$ in. to $^1/_2$ in., diameter increases approximately 0.016 in.

Reamers and milling cutters can be made subject to similar methods of standardization and with equally profitable results. No specific proposals are made, because it is realized that such standards must be created through suggestions from a wide field, and through careful consideration and discussion of the suggestions offered.

Tolerances and Nomenclature

The British Engineering Standards Association in 1920 published their Bulletin No. 122, entitled British Standards for Milling Cutters and Reamers. From the introduction to this publication the following is quoted:

> The standards herein contained have been arrived at as a result of conferences, research, and direct coöperation between the small-tool makers machine-tool makers, and users of this country, at whose instance the work was undertaken. . . . . .

An examination of the work done by the British engineers reflects their desire for uniformity in both design, tolerance, and nomenclature. Much of the material could probably be bodily adopted for use in this country, while some of it would necessarily have to be changed to suit our own conditions.

We all recognize the desirability of having definite limits established. It seems that as far as reamers are concerned there would be an excellent field for coördination with the existing standards of tolerances on shafts and holes.

Uniformity of nomenclature is particularly desirable for the sake of avoiding confusion and loss of time. We have frequently had cases where a customer will order some sort of tool we never heard of before. When we of necessity ask for further particulars, it is found that a standard tool is wanted, but that a local term is used for designating the same.

On the whole it is believed that the engineering societies in taking up this question of standardization of small tools will perform a service to the manufacturers of tools; but more particularly to the users.

In the end it is of course the consumer who pays the bill, and if through standardization this bill can be reduced, we shall have made a step forward in the march toward the goal of economical manufacturing.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Breakage, Causes of. Grinding Wheel Breakage and Its Causes, Harold E. Jenks Am. Mach., vol. 57, nos 3 and 4, July 20 and 27, 1922, pp. 98 100 and 144–146, 6 figs. What produces stresses resulting in wheel breakage; effect of overspeeding. Details of correctly mounted wheel, necessity for balance; why wheels are weakened by balancing weights.

Grinding Tests. Factors Affecting Wheel Action H. W. Wagner. Abrasive Industry, vol. 3, no. 8, Aug. 1922, pp. 244–246, 2 figs. Account of tests conducted to determine grinding performance of wheels with various materials.

AERODYNAMICS

Curvilinear Motion. Notes on Aerodynamic Forces—II, Max M. Munk. Nat. Advisory Committee for Aeronautics Tech. Notes, no. 105, July 1922, 10 pp. Laws of curvilinear motion are established and transverse forces on elongated airship hulls moving along a curved path are investigated.

AERONAUTICAL INSTRUMENTS

Direction Instruments. Direction Instruments. Nat. Advisory Committee for Aeronautics. Aeronautic Instruments, section 4, report no 128, 1922. 67 pp., 71 figs. Part I: Inclinometers and banking indicators. Part II Testing and use of magnetic compasses for airplanes. Part III: Aircraft compasses. Part IV: Turn indicators.

Types. Instruments for Use on Aircraft Engineering, vol. 114, no. 2954, Aug 11, 1922, pp. 174–175, 9 figs Describes altimeter dial, and aneroid barometer provided with scale which may be adjusted to suit any variations in pressure and temperature, air-speed recorder for speeds up to 80 m.p h.; and an instrument for exploring radiator temperatures.

AERONAUTICS

Standardization. Aeronautical Standardization. Aviation, vol. 12, nos. 20 and 21, May 15 and 22, 1922, pp. 564 566 and 596 598, 2 figs. Standardization of materials, parts and tools desirable for mass production in emergencies suggested by two engineers experienced in factory as well as theoretical knowledge.

AIR COMPRESSORS

Rotary. New Rotary Air Compressor, E Loewenstein. Mech. Eng., vol. 44, no 9, Sept. 1922, p. 598, 2 figs. Describes new type with springless abutment blades. Results of tests undertaken at Goettingen Inst., Germany. Translated from Deutsche Optische Wochenschrift, vol. 8, no. 22, May 28, 1922, pp. 413–414.

Planche Rotary Compressor Lucien Fournier Mech. Eng., vol 44, no 6, June 1922, pp. 385 386, 8 figs. Describes rotary compressor, designed by French engineer, with disk piston moving in a conchoid. Translated from Génie Civil, vol 80, no 12, Mar. 25, 1922, pp. 275 277

AIR PUMPS

Condensation. Investigations of Condensation Air Pumps (Untersuchungen an Kondensations-Luftpumpen), K Hoefer Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no 253, 1922, 92 pp., 48 figs. Investigations to determine relative efficiency of piston, steam-jet and water-jet air pumps with regard to economy, safety in operation, weight and space requirement Results demonstrate advantages of steam-jet air pumps.

Radojet Dry-Air. The "Radojet" Air-Pump. Mech World, vol. 72, no. 1860, Aug. 25, 1922, pp. 130–131, 4 figs. Describes dry-air pump which can be used in place of any other type of air pump. It is an ejector combination comprising tubular ejector in first stage and radial-flow ejector in second stage.

AIRCRAFT

Employment and Tactics. Employment and Tactics of Aircraft in Naval Warfare, John P. Jackson U. S. Naval Inst. Proc., vol. 48, no. 8, Aug. 1922, pp. 1263–1297. Place of aircraft in military system; capabilities of aircraft; types; and methods of employment, such as: scouting, reconnaissance, and patrol; fire control, observation and spotting; protection of fleet; attack on enemy surface and subsurface craft, transportation; etc.

AIRPLANE CONSTRUCTION MATERIALS

Rubber. Rubber Materials in Airplane Construction, C. J Cleary. India Rubber World, vol 66, no. 6, Sept. 1, 1922, pp. 801 802, 3 figs. Deals with clincher and straight-side tires, inner tubes, wheels and rims.

AIRPLANE ENGINES

Aeromarine U8D. Aeromarine Engine Passes 300 hr. Navy Test Aviation, vol 13, no. 6, Aug 7, 1922, pp. 153 155, 3 figs Characteristics of model U8D engine: no. of cylinders, 8, rated power 200 hp.; bore, 4 25 in.; stroke, 6.50 in.; displacement 737 cu in.; dry weight of engine, 577 lb.

Fuel-Consumption Test. Fuel Consumption Test of DH-4B with Liberty "12" Engine. Air Service Information Circular, vol. 4, no. 346, May 15, 1922, 5 pp., 4 figs. Test to determine fuel consumption of engine at various speeds and altitude, and value of Schroeder econometer as means of measuring fuel consumption.

Performance. Comparative Performance Test of X.B.I.-A. Equipped with High Compression Wright Model "H" and Packard 1237 Engines. Air Service Information Circular, vol 4, no. 327, Mar 15, 1922, 8 pp., 5 figs. Description of airplane and engines and summary of results.

Valve Lift. Variation in Volumetric Efficiency of an Engine with Valve Lift T. E Tillinghast Air Service Information Circular, vol 4 no 356, June 15, 1922, 11 pp., 7 figs Experiments to determine (a) effect of changes in valve lift on volumetric efficiency, (b) effect of changes in compression ratio on volumetric efficiency, and (c) effect of changes in valve lift on engine performance

AIRPLANE PROPELLERS

Design. Notes on Propeller Design, Max M Munk Aerial Age, vol. 15, nos 8, 10, 12 and 13, May 1, 15, 29 and June 5, 1922, pp 178 179, 225 226, 274 275 and 298 299, 1 fig May 1 Energy losses of propeller May 15: Distribution of thrust over propeller blade. May 29 Aerodynamical equations of propeller blade elements. June 5 Summary.

Stresses. Stresses in Airscrews due to Varying Engine Torque, John Case Aeronautical Jl, vol. 26, no 140, Aug. 1922, pp 321 324 General analysis; values of constants, approximate calculations, bending moment due to acceleration, example.

AIRPLANES

Altitude Adjustments, Automatic. The Use of Multiplied Pressures for Automatic Altitude Adjustments, Stanwood W Sparrow. Nat Advisory Committee for Aeronautics Technical Notes, no. 108, Aug. 1922, 8 pp, 2 figs. Describes method of automatic compensation which deserves consideration in design of devices for making adjustments automatically.

Commercial. A Czecho-Slovak Commercial Aeroplane. Aeroplane, vol. 23, no. 6, Aug. 9, 1922, p. 106, 2 figs. Describes Ae.10, 5-seater cabin biplane for service on civil transport lines between Prague and Austria and Germany; 260 hp. Maybach engine.

Control Indicator. The Reid Aeroplane Control Indicator. Engineering, vol 114, no. 2955, Aug. 18, 1922, pp. 216–218, 18 figs. Describes instrument comprising an air speed indicator, clinometer and turn indicator, all of which can be observed at a glance.

Design, Economical. Aerodynamical Efficiency and the Reduction of Air Transport Costs, Breguet. Aeronautical Jl, vol. 26, no. 140, Aug. 1922, pp. 307–313 and (discussion) 313–318. How to design airplanes which should reduce present rates of aerial freight by more than one-half.

Fuselage. Report of Static Test of XB-1-A Fuselage. Air Service Information Circular, vol. 4, no. 338, May 1, 1922, 9 pp., 9 figs. Test to determine strength of fuselage which had seen over 83 hours' service in air and been subjected to weather conditions for 1 year 4 months and 4 days.

Gliders. Description of the Hannover Glider. Aviation, vol. 13, no. 6, Aug. 7, 1922, pp. 156–157, 2 figs. Details of glider which made $4^1/_2$ mi. cross-country flight in 15 min. 40 sec. on second Rhön meeting.

Landing-Gear Shock Absorbers. Designing Landing Gear Shock Absorbers, Orrin E. Ross. Aviation, vol. 13, no. 8, Aug. 21, 1922, pp. 215–218, 8 figs. Practical method for determining size of cord, number of loops, tension, etc., for given service.

Navy Vought. Performance Test of Navy Vought Type XV Equipped with Wright Model E-2 Engine. Air Service Information Circular, vol. 4, no. 352, June 1, 1922, 6 pp., 6 figs. Summary of results; pilot's observations; distribution of weights; description of airplane and power plant.

Pressure Distribution. The Pressure Distribution over the Horizontal Tail Surfaces of an Airplane, III, F. H Nurton and W. G. Brown. Nat. Advisory Committee for Aeronautics, report no. 148, 1922, 26 pp., 33 figs. Deals with distribution of pressure during accelerated flight of full-sized airplane, for purpose of determining magnitude of tail and fuselage stresses in stunting.

Soaring. The M. I. T. Soaring Machine, Frank M. Gentry. Aerial Age, vol. 15, no 18, Sept. 1922, pp. 451 452, 4 figs. Soaring plane developed by Aeronautical Eng. Soc. of Mass. Inst. Technology is of cantilever construction, with 120 sq. ft. of supporting surface and weighs 73 lb.; wing has spread of 24 ft., chord of 4 ft. 9 in. and aspect ratio of 5.

Structural Safety. Structural Safety During Curved Flight, Adolph Rohrbach. Nat. Advisory Committee for Aeronautics Tech. Notes, no. 107, Aug. 1922, 18 pp., 9 figs Includes appendix with graphic determination of airplane speeds during rectilinear and curved flight, and propeller efficiency according to experiments with models. Translated from German.

Wings. The Twisted Wing With Elliptic Plan Form, Max M Munk. Nat. Advisory Committee for Aeronautics Technical Notes, no. 109, Aug. 1922, 7 pp Method for computing aerodynamic induction of wings with elliptic plan form if arbitrarily twisted.

AIRSHIPS

German. German Airships (Das deutsche Lufts-

Note.—The abbreviations used in indexing are as follows.
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

chiff). Werner v. Langsdorff. Schiffbau, vol. 23, nos. 39, 43 and 44, June 28, July 26 and Aug. 2, 1922, pp. 1137-1152, 1155-1159 and 1211-1217, 11 figs. June 28: The Schütte-Lanz rigid airship. July 26 and Aug. 2: The Zeppelin airship.

Rigid. The U. S. Navy Airship ZR1. Aviation, vol. 13, no. 9, Aug. 28, 1922, pp. 234-236, 3 figs. Detailed description of America's first rigid airship now under construction; length overall, 680 ft.; height, 93 ft.; diameter, 78.7 ft.; 1800 hp.; speed, 60 m.p.h.; gas volume, 2,115,174 cu. ft.

Semi-Rigid. The 18-Ton Parseval Semi-Rigid Airship PL27. Flight, vol. 14, no. 25, June 22, 1922, pp. 354-357, 10 figs. Description of airship built in 1916 of type somewhat similar to "Roma."

ALCOHOL

Internal-Combustion Engines. Alcohol for Internal-Combustion Engines. Engineer, vol. 133, no. 3463, May 12, 1922, p. 511. Account of experiments carried out with 95 volumes per cent alcohol by Empire Motor Fuels Committee.

ALLOY STEELS

Decomposition of Martensite. The Decomposition of Martensite into Troostite in Alloy Steel. Howard Scott. Blast Furnace & Steel Plant, vol. 10, no. 8, Aug. 1922, pp. 421-424, 3 figs. Effect of alloying elements on decomposition of martensite to troostite was determined by means of heating curves. Published by permission of Director of Bur. of Standards.

ALLOYS

Aluminum. See ALUMINUM ALLOYS, DURALUMIN.

Iron-Carbon. See IRON ALLOYS.

Nickel. See NICKEL ALLOYS, MONEL METAL.

ALUMINUM

Castings. Molds for Aluminum Castings. Am. Mach., vol. 56, no. 24, June 15, 1922, pp. 896-898. Brass foundry practice modified for light, brittle aluminum; advantages of green sand cores; die castings stronger; how to test aluminum castings.

ALUMINUM ALLOYS

Castings. Notes on Aluminum Alloys for Casting. Chem. & Met. Eng., vol. 27, no. 10, Sept. 6, 1922, pp. 501-503. Useful foundry alloys contain relatively low percentages of copper, zinc or both; tabulation of physical properties of aluminum alloys used in America and other common metals and alloys.

Copper-Silicon-Aluminum. Physical Properties of Some Copper-Silicon-Aluminum Alloys When Sand Cast. E. H. Dix and A. J. Lyon. Am. Soc. for Testing Matls., advance paper for meeting June 26-30, 1922, 17 pp., 15 figs. Results of investigation conducted by Engineering Division of Air Service, covering alloys of 3, 6 and 9 per cent silicon with 0, 2, 4 and 6 per cent copper, and with 2 per cent copper and 1 per cent manganese are summarized.

Molding. Molding Practice for Aluminum Alloys. Chem. & Met. Eng., vol. 27, no. 11, Sept. 13, 1922, pp. 555-557. Notes on what is considered best practice. From sales dept. condensed data prepared by Tech. Dept., Aluminum Co. of America.

AUTOMOBILE ENGINES

Camshafts, Machining. The Machining of Camshafts. Fred H. Colvin. Am. Mach., vol. 57, no. 3, July 20, 1922, pp. 95-97, 9 figs. Use of multiple tools in turning camshafts. Master cams and cam-grinding methods.

Cooling Systems. Advantages of Evaporating Type of Cooling System. A. Ludlow Clayden. Automotive Industries, vol. 47, no. 11, Sept. 14, 1922, pp. 509-511, 2 figs. Describes steam-cooling system. Promises to be lighter, simpler and more efficient than conventional types, less likely to permit overheating and loss of water, no thermostats required, smaller radiator can be used.

Neglect of Water Flow Cuts Cooling Efficiency. A. Ludlow Clayden. Automotive Industries, vol. 47, no. 7, Aug. 17, 1922, pp. 306-309, 3 figs. Consideration of rate of water flow at various points, and items such as pump design, arrangement of radiator, etc.

Heavy-Fuel. The Use of Crude Oil for Fuel in Automobile Engines (Verwendung von Rohöl als Betriebsstoff für Fahrzeugmotoren). Gustav Künzel. Motorwagen, vol. 25, no. 19-20, July 10-20, 1922, pp. 371-372, 2 figs. Describes carburetor which is recommended for use of heavy crude oils.

Ignition. See IGNITION.

Overhead Camshaft Efficiency. Do Overhead Camshafts Increase Efficiency in Engine Operation? P. M. Heldt. Automotive Industries, vol. 46, nos. 21 and 22, May 25 and June 1, 1922, pp. 1109-1111 and 1158-1161, 22 figs. Design leads to symmetrical engine of easy accessibility which need not be noisy. Used by four American makers and common in European practice. Read before Soc. Automotive Engrs.

Radiators. Air Flow in Relation to Water Cooling. A. Ludlow Clayden. Automotive Industries, vol. 47, no. 10, Sept. 7, 1922, pp. 462-466, 11 figs. Radiators compared; baffles increase efficiency, heat transfer, effects of water velocity.

Spark Plugs. See SPARK PLUGS.

Vauxhall. New Vauxhall Four Has Lanchester Harmonic Balancer. M. W. Bourdon. Automotive Industries, vol. 47, no. 10, Sept. 7, 1922, pp. 457-461, 7 figs. British passenger-car 23-60-hp. engine with overhead valves, designed to compete with 6-cylinder jobs in smooth-running qualities; duralumin tubing for push-rods.

AUTOMOBILE FUELS

See ALCOHOL, GASOLINE.

AUTOMOBILES

Camping Cars. Designing Camping Cars and Trailers. Harry W. Perry. Automotive Industries, vol. 47, no. 7, Aug. 17, 1922, pp. 324-327, 4 figs. Ideas about design of suitable trailer camping outfits.

German Chassis. Modern German Car Chassis Have Unique Details. Benno R. Dierfeld. Automotive Industries, vol. 47, no. 8, Aug. 24, 1922, pp. 359-362, 23 figs. Fan and water pump impeller on opposite ends of same shaft in some cases. Special facilities for ready adjustment of brakes on new Benz six. Mercedes has rigid central frame cross member. Unconventional rear springs.

Grand Prix 1922. Some Mechanical Details of French Grand Prix Racing Cars. W. F. Bradley. Automotive Industries, vol. 47, no. 5, Aug. 3, 1922, pp. 210-212, 9 figs. High engine speed and failure of lubricating systems said to have caused some eliminations. Features of winning Fiat car.

Light Car. The 10 Hp. B. S. A. Car. Auto Motor Jl., vol. 27, no. 32, Aug. 10, 1922, pp. 659-661, 8 figs. Example of air-cooled engined light car, capable of speed of 45 mi. per hr.

Marmon. The 34 Hp. Marmon Chassis. Automobile Engineer, vol. 12, no. 164, June 1922, pp. 162-170, 24 figs. Typical American design; rated horsepower, 33.75. Describes engine, induction system, lubrication, cooling system, electrical equipment, clutch, gearbox, brakes, suspension, etc.

Peerless. 1923 Peerless Carries Semi-Elliptic Springs. J. Edward Schipper. Automotive Industries, vol. 47, no. 8, Aug. 24, 1922, pp. 354-356, 5 figs. Platform type abandoned in new models, nearly every unit in car has been altered in some detail; frame design more rigid and easier to produce; wheels smaller.

Steam Cars. The Winslow Automotive Boiler. Charles B. Page. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 265-271 and (discussion) 271-272 and 274, 11 figs. Data and efficiency curves in support of claim that, per ton-mile or other work done, steam power and gas power are about at stand-off in weight of fuel consumed. History, construction and advantages of Winslow boiler.

Vauxhall. The 14 Hp. Vauxhall. Auto-Motor Jl., vol. 27, no. 35, Aug. 31, 1922, pp. 721-724, 11 figs. Built for economy in running costs; petrol consumption, 30 miles per gallon; maximum speed, 60 m.p.h.

B

BALANCING MACHINES

Dynamic. Dynamic Balancing Machine. Machy. (Lond.), vol. 20, no. 515, Aug. 10, 1922, pp. 574-577, 5 figs. Describes Lawaczeck & Heymann machine; attainment of balance at all speeds; first test of balance; plane of unbalance; sensitiveness of machine.

Martin. Balancing of High-Speed Machine Parts (Het uitbalanceeren van snel roteerende machinedeelen), W. Hamilton Martin. Ingenieur, vol. 37, no. 30, July 29, 1922, pp. 587-593, 7 figs. Static and dynamic balancing of rotating parts; Martin balancing machines.

BELTING

Dressings. German Formulae for Belt Dressings. Belting, vol. 21, no. 1, July 1922, pp. 17-18. Several formulas translated from German publication.

Leather. New Federal Specification for Leather Belting. Belting, vol. 21, no. 2, Aug. 1922, pp. 15-19, 1 fig. Adoption by Government intended to set first regular standards for users of products, manufacturers and distributors.

BEARINGS, BALL

Power Consumption. Tests on the Power Consumption of Ball and Journal Bearings for Driving Gear Shafts (Versuche über den Energiebedarf von Kugel- und Gleitlagern an Triebwerkswellen), M. Gohlke. Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 447-451, 7 figs. Results of tests show that ball bearings save about 50 per cent of work of friction of shaft, have longer life and lighter starting.

BLAST FURNACES

Reconstruction. Rebuilding Emporium Blast Furnace. Iron Trade Rev., vol. 71, no. 10, Sept. 7, 1922, pp. 651-653, 3 figs. Emporium Iron Co. discards hand-filling system and installs modern mechanical equipment. New construction includes storage bins, skip hoist, furnace top and pig-casting machine.

BLOWERS

Forced-Draft Furnaces. Tests on a Forced-Draft Furnace (Versuche an einer Unterwindfeuerung), E. Philipp. Feuerungstechnik, vol. 10, no. 20, July 15, 1922, pp. 224-226, 3 figs. Describes Schlotter blowers, built by Siemens-Schuckert Works, with air duct in axial direction; and installation in Wiesbaden electricity works equipped with these ventilators.

BOILER FEEDWATER

Softening. Softening Boiler-Feed Water with Zeolites. Power, vol. 56, no. 11, Sept. 12, 1922, pp. 412-414, 4 figs. How zeolites remove hardness; details of operation; data on typical installation; combination lime-zeolite treatment for water high in temporary hardness.

BOILER HOUSES

Sugar-Refining Co. The Boiler House of the American Sugar Refining Company at Baltimore, Maryland, E. B. Powell. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 509-512, 4 figs. General features of plant, boilers, feedwater system; instruments; combustion equipment. (Abridgment.) See also Steam, vol. 30, no. 3, Sept. 1922, pp. 63-67, 4 figs.

BOILER OPERATION

Heat Losses. The Control of Boiler Operation, E. A. Uehling. Mech. Eng., vol. 44, no. 7, July 1922, pp. 438-443, 4 figs. Simplified formulas for use in calculating chimney, combustion and absorption losses. Proposed fuel unit for bituminous coal, etc. (Abridgment.)

BOILER PLANTS

Performance Tests. Fuel Economy from Old Plant Equipment, A. R. Mumford. U. S. Bur. of Mines Reports of Investigations, no. 2373, July 1922, 4 pp. Gives results of tests of two Babcock & Wilcox boilers fired by means of overfeed stokers and equipped with fuel economizer in uptake.

Rebuilding. Rebuilding a Large Boiler Plant Without Interrupting the Service, Alfred Iddles and J. Walter May. Power, vol. 56, no. 11, Sept. 12, 1922, pp. 402-408, 11 figs. Modern boiler plant, containing five water-tube boilers, each of 4900 sq. ft. of water heating surface, was built on same location as old plant, without interfering with capacity of plant and without interrupting service supplied to large textile plant.

Stirling. The Stirling Boiler Plants of the Gennevilliers Central Station (Les chaufferies Stirling de la centrale de Gennevilliers), Jean Labadié. Revue Industrielle, vol. 52, nos. 8 and 9, June and July 1922, pp. 249-255 and 285-291, 14 figs. Notes on boilers, furnaces, economizers, stoking arrangements, etc., and their operation.

BOILERS

High-Pressure. High-Pressure Boilers for the Waukegan Power Station. Power, vol. 56, no. 11, Sept. 12, 1922, pp. 417-418, 1 fig. Boilers, each having 14,086 sq. ft. of water-heating surface, of new design for 400 lb. pressure, which allows use of metal thicknesses in pressure parts no greater than in boilers designed for ordinary pressures.

Locomotive. See LOCOMOTIVE BOILERS.

Practice in 1922. Boiler Practice. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 521-543, 3 figs. Symposium of following articles: The Trend of Boiler Development, J. B. Crane. Boiler Practices of 1922, R. E. Butler. The Modern Sectional Header Boiler, R. M. Rush. Heine Boiler Practice in 1922, E. R. Fish and Alfred Cotton.

Shovel-Stokered. Adler & Hentzen High-Capacity Boilers for Power Plants (Adler & Hentzen-Hochleistungsfeuerungen für den Kraftbetrieb), H. Pradel. Elektrotechnischer Anzeiger, vol. 39, nos. 129 and 130, Aug. 15 and 16, 1922, pp. 1009-1010 and 1015-1016, 7 figs. Describes double-ended vertical-tube boiler with shovel stokers.

Tests, Accuracy of. The Accuracy of Boiler Tests, Alfred Cotton. Mech. Eng., vol. 44, no. 7, July 1922, pp. 427-430 and (discussion) p. 437, 1 fig. Points out unavoidable inaccuracies involved in reports of boiler tests and absurdity of assigning values carried out to one-hundredth of one per cent to items which cannot possibly be measured so closely. Discusses factors entering into boiler-test computations. (Abridgment.)

BOILERS, WATER-TUBE

Improvements. Improved Water-tube Boilers. Engineer, vol. 134, no. 3477, Aug. 18, 1922, pp. 166-168, 6 figs. Details of and alterations in Nesdrum water-tube boilers built by Richardsons, Westgarth & Co., Middlesbrough.

Vertical. Calculation of a Vertical Water-Tube Boiler (Berechnung eines Steilrohrkessels), H. de Grahl. Glasers Annalen, vol. 9, no. 3, Aug. 1, 1922, pp. 43-47, 3 figs. Calculation of heat consumption for 1 kg. steam of 350 deg. cent. and 15 atmos.; weight and specific heat of combustion gases; temperature along heating surface.

BORING TOOLS

Pressure. Chart for Determining the Pressure Exerted by Boring Tools, J. B. Conway. Mech. World, vol. 72, no. 1860, Aug. 25, 1922, pp. 127-128, 1 fig. For purpose of determining end thrust and cutting pressure exerted by one- and two-lipped boring tools.

BRASS

Dezincification. The Dezincification of Brass, Ralph B. Abrams. Am. Electrochem. Soc. advance paper for meeting, Sept. 21-23, 1922, no. 1, 12 pp. Account and results of investigation.

High-Tenacity. The Development and Manufacture of High-Tenacity Brass and Bronze, O. Smalley. Foundry Trade Jl., vol. 26, nos. 309, 310, 311, 312 and 313, July 29, 27, Aug. 3, 10 and 17, 1922, pp. 47-49, 78-80, 99-101, 118-121 and 145-146, 14 figs. Treats synthetically development of complex high-strength brasses and considers principal problems of manufacture.

Properties. The Nature of Brass, A. E. White. Engrs.' Soc. of West. Pa. Proc., vol. 38, no. 1, Feb. 1922, pp. 7-25 and (discussion) 25-34, 24 figs. Properties of brasses and extent to which these properties are varied by cold working and by different degrees of annealing; fundamental laws under which grain growth in metals may occur.

Season Cracking. Season-Cracking, H. W. Brownsdon. British Non-Ferrous Metals Research Assn. Bul., no. 6, July 1922, pp. 11-18. Indicates chief factors giving rise to cracking of articles made of brass.

BRAZING

Dip. A Modern Method of Dip Brazing, C. A. Van Dusen. Am. Mach., vol. 57, no. 11, Sept. 13, 1922, pp. 408–410, 4 figs. Furnace and materials that produce best results; preparing and testing mixture for temperature, instructions for dipping parts.

BRONZES

Manganese. Manganese Bronze, F. A. Livermore. Foundry Trade Jl., vol. 26, no. 310, July 27, 1922, pp. 83–84. Practical suggestions as to manufacture and tests of physical properties.

C

CABLEWAYS

Suspended Cars. Suspended Elevators and Ferries (Schwebelift und Schwebefahre), Richard Petersen. Verkehrstechnik, vol. 39, no. 31, Aug. 4, 1922, pp. 401–405, 8 figs. Describes new German patents for conveyance of passengers and freight between two stations whose beeline connection is high over surface of earth. Suspended elevators connect station on cliff with one in valley, whereas suspended ferries connect two sides of a deep valley. Results of model tests.

CALCULATING MACHINES

Manufacture. Manufacturing Calculating Machine Side-Frames, Fred H. Colvin. Am. Mach., vol. 57, no. 7, Aug. 17, 1922, pp. 256–258, 8 figs. Methods and tools used by Monroe Calculating Machine Co. Gages and how they are used.

CAR WHEELS

Chilled-Iron. The Griffin Wheel (Das Griffinrad) Emil Rüker. Glasers Annalen, vol. 91, no. 3, Aug. 1, 1922, pp. 33–43. Statistics on fracture of tire and life of wheels. Investigation of speed limits, maintenance costs, influence of continuous braking of trains. Experiences in practice and workshop. Bibliography.

CARS

Dining. Steel Diners for the Atchison, Topeka & Santa Fe. Ry. Age, vol. 73, no. 11, Sept. 9, 1922, pp. 459–460, 4 figs. Cars are 86 ft. 6 in. long over end sills and weigh 171,000 lb.; tables seat 36 persons.

Self-Propelled. Self-Propelled Cars on Steam Railways. Can. Ry. & Mar. World, no. 294, Aug. 1922, pp. 417–419, 4 figs. Description of equipment on Can. Nat. Rys. This equipment is both of American and Canadian origin.

CARS, FREIGHT

Design. Some Factors to be Considered in Freight Car Design, H. W. Williams. Ry. Rev., vol. 71, no. 9, Aug. 26, 1922, pp. 269–271. Evolution of design leading toward standardization and reduction in weight.

Transformers, Transportation of. Trucks for the Railway Transportation of Large Transformers (Wagen für den Eisenbahntransport eines fertigen Grosstransformators), Erich Klein. Elektrotechnische Zeit., vol. 43, no. 28, July 22, 1922, pp. 939–941, 5 figs. New arrangement is described for transportation and loading of large transformers without use of special hoisting machines.

CARS, REFRIGERATOR

Design and Operation. Some Notes on Railway Refrigerator Cars, W. H. Winterrowd. Mech. Eng., vol. 44, no. 7, July 1922, pp. 419–426, 13 figs. Facts relating to principles of railway refrigerator-car operation and information about various types of cars and methods of design and construction. (Abridgment.)

Mechanical Refrigeration of. Mechanical Refrigeration of Railroad Cars, W. M. Baxter. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 570–574, 8 figs. Technical, economic and operating aspects of various attempts to employ mechanical refrigeration in railroad refrigerator cars, with details of proposed dense air system for that purpose. (Abridgment.)

Santa Fe Railway. New Designs of Refrigerator Cars for the Santa Fe. Ry. Age, vol. 73, no. 5, July 29, 1922, pp. 189–193, 10 figs. Include two similar types, one with movable, other with stationary bulkheads. See also Ry. Mech. Engr., vol. 96, no. 8, Aug. 1922, pp. 455–459, 10 figs.

CARS, TANK

Acid. Tank Cars for Transportation of Muriatic Acid, J. M. Rowland. Chem. Age, vol. 30, no. 7, July 1922, pp. 299–301, 3 figs. Description of construction of car and discussion of lining with particular reference to unvulcanized para rubber linings.

CASE-HARDENING

Localized. Problems in Localized Case Hardening, R. A. Millholland. Iron Age, vol. 110, no. 5, Aug. 3, 1922, pp. 265–266. Low carbon machine steel used; after carburization and annealing, material to be removed machinable and not distorted in subsequent hardening.

Prevention. Methods for Locally Preventing Case Hardening, Jean Gahbourg and Marcel Ballay. Iron Age, vol. 110, no. 3, July 20, 1922, pp. 136–137. Protective layers applied with brush and coating with copper compared by French authorities. Translated from Revue de Métallurgie, Apr. 1922.

CAST IRON

Chemical Composition. Cast Iron and Its Chemical Composition, O. Smalley. Engineering, vol. 114, no. 2957, Sept. 1, 1922, pp. 277–281, 22 figs. Notes on semi-steel, oxygen in cast iron, casting temperatures; solidity of cast iron; effect of composition on strength of cast-iron hot, etc. Paper read before British Foundrymen's Assn.

Electric-Furnace Production. Cast Iron as Produced in the Electric Furnace, and Some of Its Problems, George K. Elliott. Chem. & Met. Eng., vol. 27, no. 3, July 19, 1922, pp. 116–120. Basic electric furnace is useful to refine cupola-melted iron, reducing sulphur and gases to any extent desired, and producing easily machinable castings, very tough and strong, and with minimum of defectives from dirt or blowholes. Paper read before Am. Electrochem. Soc.

Ferrite-Graphite Eutectic. The Ferrite-Graphite Eutectic as a Frequent Phenomenon in Certain Kinds of Cast Iron (Das Ferrit-Graphit-Eutektikum als häufige Erscheinung in gewissen Gusseisensorten), Emil Schüz. Stahl u. Eisen, vol. 42, no. 35, Aug. 31, 1922, pp. 1345–1346, 4 figs. Details of structure; theory of origin; influence of composition.

Low Temperature, Influence of. Some Influences of Low Temperature on the Strength and Other Properties of Cast Iron, A. Campion. Foundry Trade Jl., vol. 26, no. 308, July 13, 1922, pp. 32–36, 2 figs. Results of tests made on irons of different qualities and compositions; on repeated heating and cooling, changes of weight were found.

Melting. Heat Factors Govern Melting, Y. A. Dyer. Foundry, vol. 50, no. 16, Aug. 15, 1922, pp. 661–662. Importance of thermophysics in melting, superheating, pouring and cooling iron illustrated by effects enumerated and study of results obtained from combustion of coke in cupola.

Nickel-Chromium, Effect of. Effect of Nickel-chromium on Cast Iron, Richard Moldenke. Am. Inst. Min. & Met. Engrs. Trans., no. 1187-S, Sept. 1922, 23 pp., 12 figs.; and (abstract) in Min. & Metallurgy, no. 189, Sept. 1922, pp. 54–55, 3 figs. Describes making of pig iron from Mayari iron ores of Cuba, and gives tables of results of tests, series of curves showing interrelation of elements involved, and summary of conclusions derived.

Specifications. Report of Committee A-3 on Cast Iron. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 14 pp., 2 figs. Proposed tentative specifications for chilled cast iron wheels, foundry pig iron and high-test gray-iron castings.

Steel Scrap in Cupola. Steel Scrap in Cupola Iron Mixtures, E. J. Lowry. Iron Age, vol. 110, no. 6, Aug. 10, 1922, pp. 337–338, 3 figs. Strength of product and percentages of scrap. Experiments and results. Effect on hardness.

CASTING

Centrifugal. Centrifugal Casting, Leon Cammen. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 500–504, 4 figs. Résumé of development and discussion of design and operating problems of centrifugal-casting processes and their field of application. Manufacture of plates by this process. (Abridgment.)

CENTRAL STATIONS

Superpower. The Gennevilliers Plant and the Distribution of Electric Energy in the Paris District (L'Usine de Gennevilliers et la distribution de l'énergie électrique dans la région Parisienne), F. Loppé. Industrie Électrique, vol. 31, no. 722, July 25, 1922, pp. 265–276, 10 figs. Describes buildings, boiler house, 50,000-hp. turbo-alternators, 50,000-hp. turbines, etc.

The New Superpower Plant Near Paris Approaching Completion. Elec. World, vol. 80, no. 6, Aug. 5, 1922, pp. 264–270, 14 figs. Details of Gennevilliers power plant on Seine River, ultimately to be rated at 320,000 kw. See also article by R. H. Andrews in Power, vol. 56, nos. 5 and 7, Aug. 1 and 15, 1922, pp. 156–162, 5 figs. and 232–236, 6 figs.

CHEMICAL PLANTS

Design. The Design of Chemical Plants, A. E. Marshall. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 439–441. Handling of materials through plant and influence of plant design on cost of pre-process and process labor.

The Modern Chemical Plant, Frank D. Chase. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 432–434. Factors to be taken into account in designing plant, viz., location, layout, design, construction and equipment.

Production Efficiency. Increased Production Efficiency in the Industries. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 457–468. Outstanding deficiencies in production processes. Concise statements by leading representatives of chemical and related industries in answer to question, "What would contribute most to increased production efficiency in your industry?"

CHIMNEYS

Compound. The Nast System of Compound Chimneys (Die schalungslose Verbundbauweise "Nast"), Paul Frei. Beton u. Eisen, vol. 21, nos. 5 and 6, Mar. 18 and Apr. 5, 1922, pp. 78–81 and 90–91, 7 figs. Mar. 18: Construction of reinforced concrete stacks, improvements introduced by patent of B. Nast. Apr. 5: Describes chimneys 62 to 117 m high at Oppau works, all of which passed through explosion unharmed.

CHROMIUM STEEL

Corrosion, Resistance to. Resistance to Corrosion of Various Types of Chromium Steels, Henry S. Rowdon and Alexander I. Krynitsky. Chem. & Met. Eng., vol. 27, no. 4, July 26, 1922, pp. 171–173. Abstract of research carried out at Bur. of Standards. Corrosion in air differs from that in dilute hydrochloric acid.

Solidification, Speed of. The Influence of Speed of Solidification on Double Carbide Steels (Ueber den Einfluss der Ertsarrungsgeschwindigkeit auf die Doppel-Karbidstähle) P. Oberhoffer. Stahl u. Eisen, vol. 42, no. 32, Aug. 10, 1922, pp. 1240–1242, 6 figs. Results of tests carried out on a series of chrome steels.

COAL HANDLING

Haulage, Hoisting and Dumping. Cambria Steel Co. Drops Coal Down Well, Loads It at Bottom and Hauls It to Ovens, George A. Richardson. Coal Age, vol. 22, no. 9, Aug. 31, 1922, pp. 313–317, 7 figs. Coal is passed down 110-ft. shaft from upper bed to lower and is reloaded for 2-mile run to Rosedale ovens; electrically actuated gates load through measuring hopper.

Haulage, Hoisting and Dumping Practices At Rosedale Mine, George A. Richardson. Coal Age, vol. 22, no. 10, Sept. 7, 1922, pp. 351–357, 22 figs. Practices of Cambria Steel Co. Largest mine locomotives made haul 145 cars, each holding $1^1/_2$ gross tons; hoisting shaft has coal well carrying coal to skip-loading level; shaft capacity 10,000 tons daily; steel guides; hilted sprags.

Pit Car Loaders. Mechanical Pit Car Loaders, Reginald Trautschold. Coal Industry, vol. 5, no. 6, June 1922, pp. 283–285, 4 figs. Mechanical loading device will operate to greatly reduce mining costs of given proper chance, but good management is essential to success; types of loaders and operating data.

Temperley Transporter. The Temperley Transporter for Coal Handling, H. Hubert. Commonwealth Engr., vol. 9, no. 11, June 1, 1922, pp. 391–395, 5 figs. Describes conditions which govern size of plant, and by actual examples, shows how existing requirements have been successfully met by Temperly transporters.

Turntables, Use of. Enlisting the Turntable in Mechanical Coal Loading, E. N. Zern. Coal Age, vol. 22, no. 8, Aug. 24, 1922, pp. 283–285, 2 figs. Turntable is located on room track opposite line of crosscuts which intersect five consecutive rooms and give a storage road for cars near loading machine.

COAL STORAGE

Cable Drag-Scraper Method. Coal Handling by Drag Scraper, C. W. Ross. Gas Age-Rec., vol. 50, no. 8, Aug. 19, 1922, pp. 230–232, 6 figs. Suggestions for storage so as to prevent spontaneous combustion; methods of storing; cable drag-scraper storing system.

Experiments. Experiments in Coal Preservation, M. Forrières. Gas Jl., vol. 159, no. 3092, Aug. 16, 1922, pp. 375–376. Results of very complete laboratory experiments carried out with view of determining behavior of similar coals, stored with free access to air circulation, with restricted air circulation, and under water.

COKE

Specific Gravity. Volumetric Determination of the Actual and Apparent Specific Gravity of Coke (Volumetrische Bestimmung des wirklichen und des scheinbaren spezifischen Gewichtes von Koks), A. Schmolke. Glückauf, vol. 58, no. 32, Aug. 12, 1922, pp. 977–980, 1 fig.; also Stahl u. Eisen, vol. 42, no. 32, Aug. 10, 1922, pp. 1237–1240, 1 fig. Describes simplified method of investigation.

COKE HANDLING

New System. A New System of Coke Handling, H. Blyth. Gas Engr., vol. 38, no. 556, Aug. 15, 1922, pp. 205–206, 2 figs. Method which effects considerable economy at very moderate capital expenditure.

COKE MANUFACTURE

By-Product. By-product Coking, F. W. Sperr, Jr. Jl. Indus. & Eng. Chem., vol. 14, no. 9, Sept. 1922, pp. 844–846. Property and process of coking; by-product formation; properties and utilization of coke; materials of plant construction.

COKE-OVEN GAS

Boilers for Burning. Coke-Oven Gas and Its Use in Boilers (Das Koksofengas und seine Verfeuerung in Dampfkesseln), A. Sauermann. Glückauf, vol. 58, no. 30, July 29, 1922, pp. 922–926, 4 figs. Fundamentals for design of boilers and burners for use of coke-oven gas. Properties of gas during combustion.

COLD STORAGE

Research. The Low Temperature Research Station at Cambridge, L. F. Newman. British Cold Storage & Ice Assn., vol. 18, no. 2, 1921–1922, pp. 5–17 and (discussion) 18–28. Investigation of entire problem of cold-storage losses and description of new station.

COLUMNS

Reinforced-Concrete. Slenderness - Ratio and Strength of Concrete Columns, F. E. Giesecke. Eng. News-Rec., vol. 89, no. 7, Aug. 17, 1922, pp. 271–276, 7 figs. Effect of length found to be negligible; influence of water ratio and mixing; buckling controlled by eccentric loading.

COMBUSTION

Maximum Temperature Calculation. Rapid Calculation of Theoretical Maximum Temperatures, George Granger Brown. Chem. & Met. Eng., vol. 27, no. 10, Sept. 6, 1922, pp. 497–500, 3 figs. Four methods for computing temperature developed by a reaction: graphical, by trial, algebraic, and slide rule. From paper read before Am. Chem. Soc.

CONDENSERS, STEAM

Air Extractors. Tests on Delas Air Extractor. Iron & Coal Trades Rev., vol. 105, no. 2839, July 28, 1922, pp. 116–117, 5 figs. Inventor has stabilized extractor by method of introducing external cold-water circulation instead of atmospheric air into divergent.

Surface. Surface Condensing Plant. Engineer, vol. 134, no. 3473, July 21, 1922, pp. 70–72, 9 figs.

Describes new installation in Pinkston power station of Mirrlees Watson surface condenser, designed to work with 10,000-kw 1500-rev turbo-generator, and capable of maintaining vacuum of 27.8 in., with cooling water at 75 deg. fahr. when dealing with 183,000 lb. of steam per hr.

CORROSION

Metals and Alloys. Preliminary Notes on Corrosion, Wilder D. Bancroft. Am. Soc. for Testing Matls. advance paper for meeting June 26-30, 1922, 5 pp. Points out desirability of developing rapid method for studying corrosion.

COST ACCOUNTING

Factory. Cost Accounting and Factory Efficiency, George P. Comer. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 417-421. Control of production, basic schemes of distribution, essential elements of cost, departmental cost sheet, costs of idle equipment, cost and sales summary, uniform cost systems.

Rolling-Stock Production. Railway Carriage and Wagon Building Costs. Ry. Engr., vol. 43, no. 511, Aug. 1922, pp. 289-294, 17 figs. New system installed at works of Midland Ry., Derby, for ascertaining and checking rolling-stock production costs.

CRANES

Cableway. Cableway Cranes (Kabelkrane), Friedrich Riedig. Fördertechnik u. Frachtverkehr, vol. 15, no. 15, July 21, 1922, pp. 195-201, 15 figs. Use of cableway cranes for building of bridges, dams, harbors, canals, etc., for loading of bulk goods, and for shipbuilding. Efficiency of such cranes and comparison with loading bridges.

Floating and Hammerhead. Large Cranes for Shipyards and Harbor Service, E. Krahnen. Mar. Eng., vol. 27, no. 9, Sept. 1922, pp. 583-585, 3 figs. Construction and operation of 250-ton hammerhead and floating cranes built in Germany for fitting out large ships.

Locomotive. A Crane Works at Rodley. Engineer, vol. 134, no. 3475, Aug. 4, 1922, pp. 122-123, 8 figs. Describes works of Thomas Smith & Sons, Ltd., for manufacture of locomotive cranes.

Workshop. The Louden-King Push-and-Pull Crane, George F. Zimmer. Eng. & Indus. Management, vol. 8, no. 3, Aug. 24, 1922, pp. 95-97, 7 figs. Overhead, hand-operated crane for loads up to 1000 lb.

CUPOLAS

Hot-Blast. Utilizing Heat of the Cupola to Warm the Blast. Can. Foundryman, vol. 13, no. 8, Aug. 1922, pp. 18-19, 3 figs. By having cast-iron jacket above melting zone, air is heated from waste heat of fuel, before passing into fire.

CUTTING TOOLS

Diamond. Diamond Tools as Cost Reducers. Machy. (N. Y.), vol. 29, no. 1, Sept. 1922, pp. 33-37, 7 figs. Gives brief description of preparation of diamonds for commercial use, indicates how they are set in holders, and furnishes information regarding their cost. Multiple-stone diamond dresser for emery wheels.

CYLINDERS

Metal-Faced Cores. Using Metal Faced Cores in Cylinders. Foundry, vol. 50, no. 16, Aug. 15, 1922, pp. 684-685, 4 figs. Patent claim of T. P. Greenhow is based on method of application and preparation employed to cover metal face of core to prevent metal from chilling. Method has been applied at plant of Buick Motor Co., Flint, Mich.

Welded, Tests on. Tests on Welded Cylinders, E. A. Fessenden and L. J. Bradford. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 581-586 and 592, 14 figs. Describes tests conducted in order to compare methods of constructing cylinders for handling anhydrous ammonia, and discusses results. Author concludes that vessels having forge-welded heads are least reliable and that burnt steel is often present in weld; principal defects in acetylene welds are coarse granular structure and porous spots and pinholes that develop with high pressures. Practical remedies are given. (Abridgment.)

D

DIE CASTING

Aluminum Bronze. Aluminum-Bronze Die Castings. Machy. (Lond.), vol. 20, no. 509, June 29, 1922, pp. 377-380, 6 figs. Die-cast and sand-cast pieces compared. Metal, dies, and methods used in process.

Operations and Equipment. Die Casting in a Small Shop. Eng. Production, vol. 5, no. 97, Aug. 10, 1922, pp. 129-132, 8 figs. Operations and equipment.

DIESEL ENGINES

Double-Acting Type. Design of Novel Diesel. Practical Engr., vol. 66, no. 1861, July 13, 1922, p. 26. Engine consists of two cylinders bolted together in middle and free to reciprocate relatively to covers.

Manufacture. The Manufacture of Diesel Engines. Engineer, vol. 133, no. 3465, May 26, 1922, pp. 588-590, 17 figs. Methods and equipment of Mirrlees, Bickerton & Day, Ltd., Hazel Grove.

Marine. A Double Acting Marine Diesel Engine. Mar. Eng., vol. 27, no. 9, Sept. 1922, pp. 567-569, 4 figs. Satisfactory tests on 250-hp. unit causes rapid construction of three-cylinder, two-cycle 2,000-b.hp. engine.

The 1600-Hp. 4-Stroke Diesel Engine of the Augsburg-Nurnberg Machine Factory (M. A. N.) (1600 PSe-Viertakt-Dieselmotor der Maschinenfabrik Augsburg-Nurnberg A. G., Werk Augsburg). Schiffbau, vol. 23, nos. 45 and 46-47, Aug. 9 and 16-23, 1922, pp. 1231-1236 and 1255-1258, 15 figs. Description of engine. 4-weeks duration test at the Augsburg Works. Operation with anthracite tar oil and viscous crude oil.

The Sulzer Two-Stroke Diesel Engine. Engineering, vol. 114, nos. 2954 and 2956, Aug. 11 and 25, 1922, pp. 169-173, 14 figs. partly on supp. plate, and 224-227, 7 figs. Most important feature of engine is said to be method of scavenging cylinders. Other important features and details. Results of tests.

Nordberg Small-Power. Diesel Engine for Small Plants. Power, vol. 56, no. 5, Aug. 1, 1922, pp. 163-165, 6 figs. Discusses motives prompting Nordberg Mfg. Co. to design Diesel engines of small powers and describes important details of design.

DRILLING MACHINES

Drill Heads, Multi-Spindle. Adjustable Multi-Spindle Drill Heads. Eng. Production, vol. 5, no. 93, July 13, 1922, pp. 28-29, 4 figs. Description of drill head in which spindles can be adjusted for height so that when setting up it is not necessary for drills to be of equal length.

DROP FORGING

Methods. Drop Forging. Eng. Production, vol. 5, no. 98, Aug. 17, 1922, pp. 157-163, 21 figs. Methods, equipment and products of Thomas Smith's Stamping Works, Ltd., Coventry, England.

DRY KILNS

Lumber Piling. The Value of Drykiln Efficiency Tests. Wood-Worker, vol. 41, no. 6, Aug. 1922, pp. 39-40, 4 figs. Results of series of tests made by Vancouver Lumber Co., Ltd., Vancouver, B. C., to determine most efficient methods of piling lumber in dry kilns.

DURALUMIN

Properties and Methods of Using. Properties and Methods of Using Duralumin. Automotive Industries, vol. 47, no. 8, Aug. 24, 1922, pp. 370-376, 10 figs. This aluminum alloy has about same ultimate strength as structural steel but weighs one-third as much; can be heat-treated, rolled, stamped, cast, forged, welded and readily machined; possesses characteristics which render it valuable to automotive industry.

E

ECONOMIZERS

Operation. Economisers and Economiser Operation, Frank H. Prouty. Power House, vol. 15, Aug. 5, 1922, pp. 25-26. Status in American practice. Progress in structural details. Modifications in soot-cleaning arrangements. Operating features.

EDUCATION, ENGINEERING

Petroleum Engineering. Petroleum Education, Edwin DeBarr and Fred W. Padgett. Chem. & Met. Eng., vol. 27, no. 3, July 19, 1922, pp. 125-127. Attempted outline of specialized courses for prospective graduates in petroleum engineering. Paper read before Am. Chem. Soc.

ELECTRIC DRIVE

Metal Works. Electrification of the International Nickel Company's Works for Monel Metal, F. C. Watson. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 415-454, 12 figs. Details of electric power-supply equipment of Huntington Works in West Virginia.

ELECTRIC FURNACES

Acid. Notes on Acid Electric Furnace Practice, Charles W. Francis. Iron Age, vol. 110, no. 6, Aug. 10, 1922, pp. 345-346. Basic scrap and how to charge it; making a new bottom; when to tap and how to pour; alloy additions in furnace.

Basic. Notes on Basic Electric Furnace Operation, Charles W. Francis. Iron Age, vol. 110, no. 7, Aug. 17, 1922, pp. 421-422. Grade of lime necessary; reducing phosphorus and sulphur; high and low tap voltages.

Circulation of Molten Metal. The Circulation of Molten Metal by Means of Electrodynamic Forces, Oscar Brophy. Chem. & Met. Eng., vol. 27, no. 10, Sept. 6, 1922, p. 489, 1 fig. Discusses the three important electrodynamic forces that may be used to circulate molten metal, viz., pinch, effect, corner effect, and motor effect.

Foundries. Economy Features of Electric Foundry, Charles W. Francis. Iron Age, vol. 110, no. 5, Aug. 3, 1922, pp. 277-278. Locating furnace and supply bins, handling materials; caring for electrodes.

The Electric Furnace for the Foundry, Charles W. Francis. Iron Age, vol. 110, no. 4, July 27, 1922, pp. 201-202. Considerations in choosing proper unit for making steel castings. Place of acid and basic operations.

Induction. A New Induction Furnace, J. Murray Weed. Am. Electrochem. Soc. advance paper, no. 5, for meeting, Sept. 21-23, 1922, pp. 27-34, 3 figs. Describes induction furnace for melting non-ferrous metals, in which secondary consists of molten charge which is distinct from melting pot.

Induction Furnace for Melting Non-Ferrous Metals. Metal Industry (N. Y.), vol. 20, no. 8, Aug. 1922, pp. 312-313, 2 figs. New type developed by Gen. Elec. Co.

Processes and Equipment. The Electric Furnace, John B. C. Kershaw. Eng. Production, vol. 5, nos. 96, 97 and 98, Aug. 3, 10 and 17, 1922, pp. 103-106, 122-125 and 146-148, 23 figs. Modern processes and equipment.

Smelting Pig Iron. Electric Smelting of Pig Iron in Sweden. Engineer, vol. 134, no. 3471, July 7, 1922, pp. 5-6, 4 figs. Describes Swedish electric furnace which is a combination of blast furnace shaft with an electric hearth.

Status. Status of Electric Furnaces, L. H. Knapp. Elec. World, vol. 80, no. 12, Sept. 16, 1922, pp. 605-609, 9 figs. Electric melting and refining fairly well established for high grade steel; application of electric heat to non-ferrous metallurgy and heat treating still growing rapidly.

Steel. Costs of Electric Steel Melting, Charles Wellman Francis. Iron Age, vol. 110, no. 9, Aug. 31, 1922, pp. 525-526. Comparison of methods shows basic higher than acid, power charge, electrodes and labor chief controlling items.

Furnace Has Sealed Electrodes, G. Vitali. Iron Trade Rev., vol. 71, no. 9, Aug. 31, 1922, pp. 585-586, 2 figs. Units in electric steel plant of Fiat establishment in Italy embody radical changes in design of electrodes. Use 130 volt current for melting and 75-volt for refining operation. Translated from Stahl u. Eisen.

ELECTRIC LOCOMOTIVES

Design. Electric Locomotives, Vincent L. Raven. Electrician, vol. 89, no. 2304, July 14, 1922, pp. 36-38, 2 figs. Requirements for which any locomotive must be designed, the various designs which have been worked out to meet these requirements, and advantages and disadvantages of the various designs which have been completed. Paper read before Instn. Mech. Engrs. See also Ry. Engr., vol. 43, no. 510, July 1922, pp. 252-256, 2 figs.

High-Speed. High-Speed Electric Passenger Locomotive, North Eastern Railway, V. L. Raven. Ry. Gaz., vol. 37, no. 1, July 7, 1922, pp. 23-24, 2 figs. partly on p. 22. Describes 4-6-4 type designed by author; total capacity, 1800 hp.; three pairs of motors; tractive effort, 15,900 lb.; speed, 43 m.p.h.

Passenger, N. E. Ry. High Speed Electric Passenger Locomotive, North Eastern Railway. Ry. Engr., vol. 43, no. 511, Aug. 1922, pp. 296-297 and 313, 3 figs. Characteristics: Wheel arrangement, 4-6-4; electric system, d.c.; voltage, 1500; overall length, 53 ft. 6 in.; overall width, 8 ft. 10 in.; driving wheel diam., 6 ft. 8 in.; rigid wheelbase, 16 ft.; weight, 102 tons; horsepower, 1300; speed 51.5 m.p.h.

Vibration-Recording Apparatus. The Recording of Vibrations, Especially Torsional Fluctuations (Die Registrierung von Erschütterungen, insbesondere von Dreh-Schwankungen), Schweizerische Bauzeitung, vol. 80, no. 7, Aug. 12, 1922, p. 80, 3 figs. Details of the torsiograph, a recording apparatus, designed by J. Geiger, Augsburg, Germany. Results of tests by Brown, Boveri & Cie.

ELECTRIC RAILWAYS

Equipment N. Y., N. H. & H. New Single Phase Equipment for the New Haven, Walter H. Smith. Ry. Elec. Engr., vol. 13, no. 8, Aug. 1922, pp. 259-262, 8 figs. Dimensions and equipment of new motor cars, employing four 175-hp. Westinghouse-type 409-D single-phase, 25-cycle, series motors. Two master controllers installed in trail cars permit operation from any car in train.

Multiple-Unit Equipment. New Multiple-Unit Equipment for Long Island R. R., R. H. Freeland. Ry. Rev., vol. 71, no. 3, July 15, 1922, pp. 81-83, 3 figs. Improved Westinghouse control adds to desirability of multiple-unit system for suburban operation.

Norway. The Electrified Cristiania-Drammenbrane Line (Den elektriserte Kristiania-Drammenbane), Hj. Schreiner. Teknisk Ukeblad, vol. 69, nos. 28 and 29, July 14 and 21, 1922, pp. 263-267 and 273-277, 13 figs. Connecting arrangements, overhead lines, locomotives, transformer stations; wiring diagrams.

Switzerland. Electric Traction on the St. Gothard Line (La trazione elttrica sull'intiera linea del Gottardo). Rivista Tecnica della Svizzera Italiana, vol. 11, no. 6, June 1922, pp. 64-69. Advantages of electric traction; hydroelectric works; substations; electric locomotives; etc.

ELECTRIC WELDING

Ship Construction. Electric Welding Applied to Steel Construction, with Special Reference to Ships, A. T. Wall. Eng. & Indus. Mangagement, vol. 7, nos. 13 and 15, May 4 and June 1, 1922, pp. 397-399 and 469-472 and vol. 8, no. 2, Aug. 10, 1922, pp. 54-55, 14 figs. Present practice and future possibilities; necessary precautions.

Welding Car. Construction and Use of an Electric Welding Car (Construction et emploi d'un poste mobile de soudure electrique), Jacques Schopfer. Industrie des Tramways, vol. 16, no. 184, Apr. 1922, pp. 87-93, 10 figs. Construction and equipment of car which runs along street tracks and is used for welding worn street rails.

ELECTRIC WELDING, ARC

Locomotive Work. Use and Abuse in Electric Arc Welding in Locomotive Work, C. W. Roberts. Am. Welding Soc. Jl., vol. 1, no. 7, July 1922, pp. 9-19, 19 figs. General description and practical data.

Quality and Application. Quality and Application of Electric Arc Welding (Qualitätsuntersuchungen und Verwendungen elektrischer Lichtbogen-Schweissung), Oskar Kjellberg. Autogene Metallbearbeitung, vol. 15, nos. 9, 10, 11, 12 and 13, May 1, 15, June 1, 15 and July 1, 1922, pp. 124-129, 135-143, 149-155, 166-172 and 178-184, 43 figs. May 1:

Describes author's process and its adaptation to meet Lloyd's requirements; also application to shipbuilding. May 15: Marine boilers of Scotch type; electric welding rules of Lloyd's Register. May 15, June 1, 15 and July 1. Discussion.

ELECTRIC WELDING, RESISTANCE

Nomenclature. Terms Used in Electric Welding. Ry. Jl., vol 28, no. 9, Sept. 1922, pp. 18–19. Nomenclature report made by resistance welding committee of Am. Bur. of Welding.

EMPLOYMENT MANAGEMENT

Employee Suggestion Plans. Employee Suggestion Plans, Sanford DeHart Am. Mach., vol. 57, no. 10, Sept. 7, 1922, pp. 365–367. Reward for suggestions in money and promotion. How priority of suggestions is determined. Some successful plans in practice.

Personnel Records. Visualizing Potential Occupations, Ralph W. Immel. Management Eng., vol. 3, no. 3, Sept. 1922, pp. 143–146, 2 figs. Describes and illustrates form of personnel record sheet.

ENGINEERING

Status of Profession. The Proper Status of the Engineering Profession, R. A. Hart. Chem. & Met. Eng., vol. 27, no. 6, Aug 9, 1922, pp. 245–248. Sets forth ideals toward which individual engineers must strive, and examines critically shortcomings of present-day engineer.

ENGINEERING SOCIETIES

Federated American Engineering Societies. A Lay View of the Function of the Federated American Engineering Societies. Min. & Metallurgy, no. 189, Sept. 1922, pp. 29–31. Reprint of closing chapter entitled Science and Engineering of Prof. Cassius J. Keyser's work, Mathematical Philosophy.

ENGINEHOUSES

Turntables. Twin Span Turntable Reduces Load on Center. Ry. Age, vol. 73, no. 9, Aug. 26, 1922, pp. 383–385, 5 figs. Describes turntable having two separate girder spans with simple bearings at center; operation becomes largely independent of ordinary settlement of center or variations in level of circular rail.

EVAPORATION

Liquid into Gas. The Evaporation of a Liquid into a Gas, W. K. Lewis. Mech. Eng., vol. 44, no. 7, July 1922, pp. 445–446 Investigates mechanism of evaporation of liquid into gas as applied to such processes as are found in gas scrubbers, humidifiers, dehumidifiers, water coolers, air driers, etc. Establishes formula for calculating humidity of air from wet- and dry-bulb thermometer readings (Abridgment.)

EXHAUST STEAM

Utilization. Exhaust-Steam Utilization (Abwärme-Verwertung), M. Hottinger. Schweizerische Bauzeitung, vol. 80, nos. 3, 4 and 5, July 15, 22 and 29, 1922, pp. 31–32, 37–41 and 52–54, 17 figs. July 15: Heat balance of a steam engine plant; diagrams and tables on steam consumption of turbines and piston engines. July 22: Utilization of waste and intermediary steam. July 29: Exhaust-steam utilization from steam hammers and similar arrangements.

F

FEEDWATER HEATERS

Locomotive. Feed Water Heaters for Locomotives. Boiler Maker, vol. 22, no. 7, July 1922, pp. 196–197. Statistical data on use and tests of locomotive feedwater heaters. From report before Am. Ry. Assn.

Feed Water Heating and Boiler Circulating Apparatus for Locomotives. Ry Gaz., vol. 37, no. 6, Aug. 11, 1922, pp. 198–202, 10 figs Describes systems for heating boiler feedwater by flue gases and exhaust steam, either separately or in combination.

FLAME PROPAGATION

Vapor-Air Mixtures. Limits for the Propagation of Flame in Vapour-Air Mixtures, Albert G. White. Chem. Soc. Jl., vol. 122, July 1922, pp. 1244–1270, 2 figs. Mixtures of air and one vapor at ordinary temperature and pressure.

FLIGHT

Motorless. Motorless Flight Impossible as Transportation Means, Edward P. Warner. Automotive Industries, vol. 47, no. 11, Sept. 14, 1922, pp. 530–531. Air sailing or gliding promises significant developments in aeronautics. Describes European competitions.

FLOUR MILLS

Modern. A Modern Flour Mill. Engineer, vol. 133, nos. 3466, 3467, 3468 and 3469, June 2, 9, 16 and 23, 1922, pp. 616–617, 12 figs. partly on p. 612, 627–629, 8 figs., 664–666, 10 figs. and 687–688, 4 figs. Detailed description of complete system of flour milling as practiced by Millennium Mills, Victoria Dock, London, and illustrations of some of principal machines employed.

FLOW OF FLUIDS

Condensation in Return Pipes. Theory for the Flow of Condensation in Return Pipes, R. V. Frost. Am. Soc. Heat & Vent. Engrs. Jl., vol. 28, no. 6, Sept. 1922, pp 655–659 and (discussion) pp. 659–663. Factors affecting proportions of return pipes.

FLOW OF GASES

Venturi Tubes. Venturi Tubes and Orifices for Bulk Gas Measurement, Johnstone-Taylor. Am. Gas Jl., vol. 117, no. 7, Aug. 12, 1922, pp. 139–141 and 144, 4 figs. With special reference to British practice.

FLOW OF LIQUIDS

Cones. Liquids Flowing Through Cones, W. N. Bond. Physical Soc. of Lond. Proc., vol. 34, part 5, Aug. 15, 1922, pp. 187–196, 7 figs. Consideration of pressure gradient in liquid that flows through conical tube. Results of experiments.

Laminary and Turbulent. Investigations of Laminary and Turbulent Flow (Untersuchungen über laminare und turbulente Strömung), L. Schiller. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 248, 1922, 36 pp., 29 figs. Results of investigations carried out in Inst. for Applied Mechanics of University of Gottingen.

FLOW OF WATER

Channels. The Flow of Water in Open Channels (Ueber die Bewegung des Wassers in Offenen Gerinnen), Armin Schoklitsch. Schweizerische Bauzeitung, vol. 80, no. 5, July 29, 1922, pp. 47–50, 7 figs. Results of author's measurements of pulsations. Behavior of flowing water in vicinity of wall and on surface.

The Correlation of Momentum and Energy Changes in Steady Flow With Varying Velocity and the Application of the Former to Problems of Unsteady Flow or Surges, in Open Channels, Raymond D. Johnson. Engrs. & Eng., vol. 39, no. 7, July 1922, pp. 233–240, 9 figs.

FORGING

Header Machine. Header Machine Makes Forgings, H. E. Diller. Iron Trade Rev., vol. 71, no. 10, Sept. 7, 1922, pp. 643–645 and 650, 7 figs. Intricate parts formerly made on power hammer now are pressed into shape on an upsetting machine. Pole piece is forged in one operation and ring gear in three.

FOUNDATIONS

Concrete Stresses in. Stresses in Concrete Foundations (Die Beanspruchungen in Betonfundamenten), W. Gehler. Bauingenieur, vol. 3, nos. 14 and 15, July 31 and Aug. 15, 1922, pp. 421–427 and 456–462, 23 figs. The sliding surfaces of concrete bodies are investigated and calculated with aid of the Mohr stress diagram. Based on model tests with concrete blocks, origin of cracks in structures is explained and safety measures are recommended.

Machinery. The Foundations for High-Power Engines (Fundamente fur Grosskraftmaschinen), August Wolfsholz. Zeit. des Vereines deutscher Ingeneieure, vol. 66, no. 31–32, Aug. 12, 1922, pp. 773–776, 19 figs. Gives example of modern highly stressed engine foundation. Failures of old foundations and their causes; reconstruction. Suggestions for building crack- and break-proof foundations with aid of pressed concrete piles, construction of which is described.

Pressure Transmission through Soils. Transmission of Pressure through Solids and Soils and the Related Engineering Phenomena, George Paaswell. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 5, May 1922, pp. 1075–1089, 8 figs. It is shown that, in restricted sense, present-day rule-of-thumb methods of assumed stress paths hold true. Deals with two types of materials, namely, true granular, such as ordinary soils, and concrete aggregates, such as rock soils and concrete materials.

FOUNDRIES

Bronze. The Bronze Foundry (La Fonderie de Bronze), Derdinger. Fonderie Moderne, no. 7, July 1922, pp. 9–20 and (discussion) 21–24, 11 figs. Detailed discussion of organization of modern bronze foundry; layout, equipment, furnaces, sand, alloys, treatment of slag, illumination, etc.

FREIGHT HANDLING

Motor-Truck. Development and Future of Motor Truck Freight Handling, F. W. Fenn Automotive Mfr., vol. 64, no. 4, July 1922, pp. 15–17. Present situation at freight terminals and ability of motor truck to relieve congestion and open up new country. Particular reference to reducing terminal cost of handling less than car load.

Terminal. Terminal Relief by Direct Freight Delivery. Ry Age, vol. 73, no. 12, Sept. 16, 1922, pp. 514–516. Successful system necessitates complete coöperation of railroad shipper and responsible trucking medium. Abstract of talks before Soc. Terminal Engrs.

Veri-Direct Method. The Veri Direct Method of Loading L.C.L. Freight, C. G. Johnson. Railroad Herald, vol 26, no. 9, Aug. 1922, pp. 29–33 Also discusses veri check record of handling inbound freight effective at larger stations on Ohio region of Erie Railroad.

FUELS

Colloidal. Colloidal Fuel, Lindon W Bates. Steam, vol. 30, no 2, Aug. 1922, pp. 41–44. Outline of nature of colloidal fuel and its relation to railway systems of United States

Heating Values. Thermo Calorimetric Heating Values of Fuels, J Hudler. Mech. Eng., vol. 44, no. 9, Sept 1922, pp 596–597, 3 figs. Author indicates method for determining heating value of fuels which he claims is superior to straight calorimeter method. Translated from Zeit. des Vereines deutscher Ingeneiure, vol. 66, no 20, May 20, 1922, pp. 495–497.

Refuse. Power from Refuse in Britain, C. H. S. Tupholme. Power Plant Eng., vol. 26, no. 17, Sept. 1, 1922, pp. 853–854. Producer gas made from factory and dust-bin refuse used in gas engines and boiler furnaces.

Wood Waste, Gasification of. Utilization of Wood Refuse through Gasification (Verwertung der Holzabfalle durch Vergasung), Hans Neumann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 31–32, Aug. 12, 1922, pp. 757–763, 23 figs. Review of wood-gasification plants; the Deutzer double producer with tar-washing plant and practical results obtained therewith; wood-gasification plant of the Liusen-Woxna Works. Relative economy of wood-burning furnaces and wood-gasification plants for power supply of saw mills with regard to waste-heat utilization, tar recovery and wood residue.

[See also PULVERIZED COAL.]

FURNACES, BOILER

Air Spraying of Fuel. Air-Spraying the Fuel. Practical Engr., vol. 66, no. 1818, July 27, 1922, pp. 52–53, 2 figs. Describes apparatus known as "air-spray" for ensuring complete combustion of fuel.

Plate Thickness. Chart for Boiler-furnace Plate Thickness, Arnold A. Arnold. Mech. World, vol. 72, no. 1859, Aug. 18, 1922, pp. 118–119, 2 figs. Presents chart based on formulas applicable to plain furnaces or boiler flues given in latest rules for boiler strengths issued by (Brit.) Board of Trade under title, Standard Conditions for the Design and Construction of Marine Boilers.

Volumetric Dimensions. The Volumetric Dimensions of Boiler Furnaces. Engineer, vol. 134, no. 3479, Sept. 1, 1922, pp. 217–218. Notes on large combustion chambers and use of pulverized fuel; question of furnace volume and boiler design.

FURNACES, HEATING

Continuous. Continuous Heating Furnaces for Steel, W. E. Groume-Grjimailo. Iron Age, vol. 110, no. 8, Aug. 24, 1922, pp. 465–467, 8 figs. Importance of careful attention to roof slope; flow of gases outlined to prevent uneven heating of ingots or billets. (Abstract.) From The Flow of Gases in Furnaces, Wiley & Co., translated by A. D. Williams.

Regenerative. Regeneratively Fired Heating Furnaces, W.-E. Groume-Grjimailo. Iron Age, vol. 110, no. 9, Aug. 31, 1922, pp. 537–538, 4 figs. Conditions necessary for freeing hearth of waste gases. Good and bad examples. Translated from The Flow of Gases in Furnaces, published by Wiley & Co.

FURNACES, METALLURGICAL

Heat Losses. Calculating Heat Losses in Furnaces, O. I. Hansen. Blast Furnace & Steel Plant, vol. 10, no. 8, Aug. 1922, pp. 437–440, 1 fig. New method for determination of heat losses due to incomplete combustion. Translated from Danish.

Types. Metallurgical Furnaces (Les Fours métallurgiques), Sigma. Métallurgie, vol. 54, nos. 11 and 12, Mar. 16 and 23, 1922, pp. 401–402 and 437–439. Mar. 16: Furnaces for solid, liquid and gaseous fuel; electric, blast, and reverberatory furnaces. Mar. 23: Recuperation in various types.

G

GAGES

Screw-Thread. Heat Treatment of Screw Gauges Eng. Production, vol. 5, no. 97, Aug. 10, 1922, p. 138. Résumé of experimental work conducted over period of nine months with view to determining best conditions for production of hardened screw gages to satisfy stringent tests of Nat. Physical Laboratory.

Some Notes on Hardening Various Screw Gauges, F. A. Livermore. Can. Machy., vol. 28, no. 2, July 13, 1922, pp. 26–27. Results of experimental work; effort to obtain process that will eliminate warpage and change of shape; methods of heat treating and quenching; expansion and contraction.

GALVANIZING

Heat Transmission. Heat Transmission in the Hot-Galvanizing Process—II, J. D. Keller. Blast Furnace & Steel Plant, vol. 10, no. 8, Aug. 1922, pp. 407–411, 4 figs. Describes temperature distribution of process.

GAS PRODUCERS

Ash-Fusion. An Ash-Fusion Producer, M. Rivière. Gas Jl., vol. 159, no. 3093, Aug. 23, 1922, pp. 424–425, 1 fig. Describes Marconnet producer for gasification of coke breeze. Translated from paper read before Société Technique du Gaz.

Körting. The New Körting Gas Producers (Die neuen Korting-Gaserzeuger), H. Pradel. Wärme, vol. 45, no. 29, July 28, 1922, pp. 356–357, 4 figs. Details of two new types of producers for burning of low-grade fuel, for suction-gas operation, and with tar-recovery plant. One is revolving-grate type.

GAS TURBINES

Hepburn-Forbes System. The Internal Combustion Turbine, W. A. D. Forbes. Engineer, vol. 134, no. 3479, Sept. 1, 1922, pp. 221–225, 2 figs. Comparison of types and efficiencies. Description of new system of operation proposed by author and H. A. Hepburn, based on new theory of nozzle action and involving use of novel type of pump, known as kinetic compressor.

Problem. The Problem of the Internal Combustion Turbine. Mar. Engr. & Nav. Architect, vol. 45, no. 539, Aug. 1922, pp. 287–290, 1 fig. Comparison of temperature conditions in internal-combustion turbine and reciprocating engine. Internal-combustion turbine a possible economic intermediary between and Diesel engines.

GASOLINE

Synthetic. Progress in Synthetic-Gasoline Production, Roy Cross. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 583-585 and 621, 3 figs. Particulars regarding processes employed. Results of tests of improved synthetic-crude system. Comparative costs of manufacturing gasoline by different processes. (Abridgment.)

GEAR CUTTING

Hobbing. Rapid Production of Gears by Hobbing Process. Can. Machy., vol. 28, no. 7, Aug. 17, 1922, pp. 26-27, 6 figs. Continuous cutting movement, one passage of hob completes gear, even distribution of generated heat, special arbors for different types of blanks, automatic indexing.

GEARS

Calculation. Calculation of Wheel Gears (Berechnung von Rädergetrieben), Rud. Böttger. Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 426-430, 7 figs. Equations are developed for calculation of pressure at pitch line of spiral gears.

Calculation of Tooth Wheels (Berechnung von Zahnrädern). Zeit. für die gesamte Giessereipraxis, vol. 43, nos. 28 and 29, July 22 and 29, 1922, pp. 391-393 and 408-409, 4 figs. Dimensions of teeth and their parts, and of wheels. Calculations.

Nomenclature and Rules for Laying out the Teeth of Spur and Bevel Gears (Bezeichnungen und Vorschriften für die Verzahnung von Stirn- und Kegelrädern), K. Kutzbach. Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 412-422, 25 figs. Problem for every kind of involute gear is solved. Preliminary work for standardization of gears.

Helical and Spur. Helical Gears and Spur Gears—III, W. C. Dunkley. Machy. (Lond.), vol. 20, no. 515, Aug. 10, 1922, pp. 578-580, 8 figs. Load variation of spur gears compared with helical gears, relative variation in periodical velocity transmission, conditions affecting relative efficiencies, effect of tooth inaccuracies.

Involute. Equalization of the Natural Errors in Involute Toothed Gears by Use of Standard Helicoidal Tools (Ausgleich der natürlichen Fehler von Evolventen-Zahnradgetrieben—bei Anwendung normaler Abwälzwerkzeuge), E. Toussaint. Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 401-412, 26 figs. Describes method developed by author and its advantages.

Long-Addendum. Lewis Constants Determined for Long Addendum Gears, P. M. Heldt. Automotive Industries, vol. 47, no. 5, Aug. 3, 1922, pp. 219-221, 3 figs. Method of obtaining value of constants for full-strength formula. Long addendum principle of value only in large reduction sets.

Methods of Forming Teeth. Different Methods of Forming Gear Teeth Profiles, C. B. Hamilton, Jr. Can. Machy., vol. 27, no. 21, May 25, 1922, pp. 23-24. Grinding process seldom used except for worms, producing thin gears in punch press; classification according to tooth shape, involute system in general practice.

Pump, Tooth Shapes. Tooth Shapes for Pump Gears, A. Fisher. Machy. (Lond.), vol. 20, no. 517, Aug. 24, 1922, pp. 633-634, 5 figs. Features of design to secure increased capacity.

Tooth-Chamfering Machine. A Gear Tooth Chamfering Machine. Eng. Production, vol. 5, no. 100, Aug. 31, 1922, pp. 194-195, 6 figs. Details of Parkinson machine which deals with gears up to 15-in. diameter by 5 diametral pitch and can mill single or double chamfer.

GLASS MANUFACTURE

Plants. New Plant of the United States Sheet and Window Glass Company at Shreveport, Louisiana, J. B. Krak. Glass Industry, vol. 3, no. 9, Sept. 1922, pp. 171-190, 19 figs. Description of buildings and equipment.

Tank Furnaces. The Production of Colourless Glass in Tank Furnaces with Particular Reference to the use of Selenium. Soc. of Glass Technology Jl., vol. 6, no. 22, Aug. 1922, pp. 168-181. Experimental results.

GRINDING

Automobile Parts. Grinding Ford Motor Car Parts, Fred B. Jacobs. Abrasive Industry, vol. 3, no. 8, Aug. 1922, pp. 231-237, 13 figs. Describes methods employed. Fixed-wheel principle employed extensively in finishing great variety of cylindrical work.

Grinding in the Automobile Industry. Machy. (Lond.), vol. 20, no. 517, Aug. 24, 1922, pp. 625-630, 12 figs. Methods of grinding steel balls, ball-bearing races, roller-bearing cups, cones and rollers.

Iron and Steel. Investigates Grinding of Steel, H. W. Wagner. Iron Trade Rev., vol. 71, no. 7, Aug. 17, 1922, pp. 444-446, 2 figs. Tests show effects of heat and mechanical treatment and chemical composition of iron and steel on grinding-wheel action. Finds manganese steel grinds readily when forced despite toughness.

Small-Tool Industry. Grinding in the Small Tool Industry. Machy. (N. Y.), vol. 29, no. 1, Sept. 1922, pp. 45-51, 19 figs. Grinding straightedges; sharpening cutters, grinding plug gages, micrometer parts, twist drills, taps and dies, lathe and planer tools.

GUNNERY

Gunsight Manufacture. Some Unique Operations in the Manufacture of Gunsights. Am. Mach., vol. 57, no. 8, Aug. 21, 1922, pp. 281-286, 17 figs. Delicate parts involve special machines and methods; fixtures and tools developed for work; automatic "digging" machine.

H

HANDLING MATERIALS

Chemical Plants. Increased Production Efficiency Means Good Material Handling, J. G. Hatman. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 396-399. Material-handling problem in chemical plant, analysis of problem and suggestions toward solution, advantages derived from good methods.

Iron and Steel Industry. Material-Handling Equipment as Used in the Iron and Steel Industry, F. L. Leach. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 494-499, 14 figs. Describes handling machinery and apparatus used in manufacture of steel. (Abstract.)

Rotary Tank Cars. Handling Bulk Materials of Various Kinds by Compressed Air and Rotary Tank Cars, Rudolph Welcker. Compressed Air Mag., vol. 27, no. 8, Aug. 1922, pp. 230-232, 3 figs. Design of rotary tank car. Detail of methods of loading and discharge.

Textile Mills. Mechanical Handling of Materials in Textile Plants, Charles M. Mumford. Engrs. & Eng., vol. 39, no. 8, Aug. 1922, pp. 282-288, 12 figs. Describes system for conveying stock in process which does work of many men who were formerly employed in trucking between departments.

Tiering Machines. Adapting the Tiering Machine to Industry, Matthew W. Potts. Management Eng., vol. 3, no. 3, Sept. 1922, pp. 155-160, 11 figs. Applications to storage, transportation and manufacturing.

Transporter for Printing Works. Transporting Appliances for a Printing Works. Engineering, vol. 114, no. 2956, Aug. 25, 1922, pp. 234-236, 16 figs. Details of electrically driven transporter erected at a London printing works for carrying reels and flat bundles of paper to paper stores from lorries or vans standing in street, or from paper stores to printing machines.

HANGARS

Airline, Elimination of. Eliminating the Airline Hangar, Archibald Black. Aviation, vol. 13, no. 8, Aug. 21, 1922, pp. 221 and 224, 2 figs. Reducing investment in buildings and overhead by mooring weather-proof airplanes in open.

HARMONIC ANALYSIS

Wave Forms. Harmonic Analysis by Selected Co-Ordinates, Albert E. Clayton. Elecn., vol. 89, no. 2309, Aug. 18, 1922, pp. 176-179, 6 figs. New form of schedule for analysis of wave forms.

HEAT

Conductivity. The Derivation of True Thermal Conductivity Coefficient from Overall Test Results, P. Nicholls. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 6, Sept. 1922, pp. 665-677 and (discussion) pp. 677-682, 8 figs. Method is developed for deriving curve of conductivity coefficient against temperature. Report of coöperative work of this Society and U. S. Bur. of Mines Experiment Station, Pittsburgh.

HEAT PUMPS

Process and Applications. The Heat Pump, T. B. Morley. Engineer, vol. 134, no. 3472, July 14, 1922, pp. 27-29, 5 figs. In heat-pump process vapor from evaporator is taken to a compressor, in which its pressure, and hence also its temperature, are raised to such a degree that the compressed vapor may serve as heating medium in evaporator. Details and application of heat pump.

HEAT TRANSMISSION

Buildings, Measuring Heat Flow in. Measuring the Flow of Heat in Buildings by Means of Resistance Wires, F. E. Giesecke. Heat. & Vent. Mag., vol. 19, no. 8, Aug. 1922, pp. 29-31, 5 figs. Account of tests made in cold storage building of Lone Star Ice Co., Austin, Tex.

HEATING AND VENTILATING

Detroit Junior High School. Mechanical Equipment of the Intermediate or Junior High School in Detroit, H. W. Anderson. Heat. & Vent. Mag., vol. 19, no. 7, July 1922, pp. 38-43, 9 figs. Details of "projection" method of air distribution, with ceiling fresh air outlets, as adopted in Barbour schools. From paper and before Am. Soc. Heat. & Vent. Engr.

HEATING, HOT-WATER

Steam-Jet Apparatus. Investigations of Steam-Jet Apparatus (Untersuchungen an Dampfstrahlapparaten), F. Heinl. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 256, 1922, 23 pp., 21 figs. Investigations to determine following questions: degree of water heating obtained under most favorable working conditions with given steam-supply conditions and discharge pressure; behavior of steam-jet apparatus with change of their normal water volume.

HEATING, STEAM

Exhaust Steam for. Recent Data on Exhaust Steam for Heating. Heat. & Vent. Mag., vol. 19, no. 7, July 1922, pp. 35-38, 17 figs. Records of operation in office buildings and hotels in New York City made basis of new coal consumption charts.

HELICOPTERS

Problems and Development. The Helicopter and the Variable Pitch Propeller. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 575-578, 5 figs. Notes on problems involved and present situation of development, particularly in United States.

Theory. The Problem of the Helicopter, Edward P. Warner. Nat. Advisory Committee for Aeronautics Technical Notes, no. 4, May 1920, 18 pp., 2 figs. and 2 blue prints. Theory of direct lifting screw propeller, safety of helicopters in forced descents; horizontal travel, stability and control of helicopter; results of tests.

HOISTS

Framework. New Reinforced Concrete Winding Frames. (Neue Fördertürme und Fördergerüste in Eisenbeton), F. Kögler. Glückauf, vol. 58, no. 30, July 29, 1922, pp. 917-922, 12 figs. Describes new types with and without struts. Desiderata for construction of such frames.

HYDRAULIC TURBINES

Design. The Hydraulic Turbine in Evolution, H. Birchard Taylor and Lewis F. Moody. Engrs. & Eng., vol. 39, no. 7, July 1922, pp. 241-259, 15 figs. Problems created by turbine evolution; some mechanical and hydraulic problems in design of high-speed turbines; efficiencies attained in turbines now developed, analysis of flow in high speed turbines; influence of turbine speed on setting and station structure.

Manitoba Power Co. Turbines for the Great Falls Development of the Manitoba Power Company, H. S. Van Patter. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 9, Sept. 1922, pp. 161-164, 5 figs. Special features of 28,000-hp. I. P. Morris turbines installed in this plant.

Water Admission with Shock. Loss Caused by Shock with Admission of Water in Turbine Blade (Der "Stossverlust" des Wassers beim Eintritt in Schaufelsysteme), D. Thoma. Schweizerische Bauzeitung, vol. 80, no. 8, Aug. 19, 1922, pp. 83-84, 4 figs. Formula is derived for calculation of loss of hydraulic pressure head.

HYDROELECTRIC DEVELOPMENTS

Austria. Economics and Development of Hydroelectric Plants in Austria (Wirtschaftlichkeit und Ausbau der Wasserkraftanlagen in Oesterreich), L. Rosenbaum. Zeit. des Oesterr. Ingenieur- u. Architekten-Vereines, vol. 74, no. 31-32, Aug. 4, 1922, pp. 150-152. Development in Austrian Empire until 1914, development in Austrian Republic, 1920; and projects for Republic to be completed in 1935.

Cameron Falls, Canada. Hydro-electric Development at Cameron Falls, Nipigon River, Ontario. Elec. News, vol. 31, no. 15, Aug. 1, 1922, pp. 40-44, 10 figs. Power house and electrical equipment. First two units of ultimate capacity totaling 75,000 hp. installed. See also Contract Rec., vol. 36, no. 31, Aug. 2, 1922, pp. 780-781, 10 figs.

Colorado. Future of Hydro-Electric Generation in Colorado, Herbert B. Dwight. Elec. World, vol. 80, no. 5, July 29, 1922, pp. 215-218, 5 figs. Many large power sites and other resources of great potentiality await development; principal factor delaying development is inadequate transportation.

Economics. Economics of Water-Power Development, Curtis A. Mees. Mech. Eng., vol. 44, no. 7, July 1922, pp. 431-434, 1 fig. Discusses production, maintenance and selling costs and fixed charges. Business hazards and unrecoverable losses.

Queenston-Chippawa, Canada. Queenston-Chippawa Power Development. Engrs. & Eng., vol. 39, no. 8, Aug. 1922, pp. 292-301, 8 figs. Article on general and economic features, by H. G. Acres, and article on electrical features, by Edgar T. J. Brandon.

Scotland. The Grampian Hydro-Electric Scheme. Engineer, vol. 133, no. 3465, May 26, 1922, pp. 571-573, 1 fig. Discusses bill before Parliament to develop extensive scheme in Scotland, involving total watershed area of 418 sq. mi., and to install plant of sufficient capacity to generate 56,000 hp. continuously.

HYDROELECTRIC PLANTS

Canada. Nipigon Hydro-Electric Power Development. Can. Engr., vol. 43, no. 5, Aug. 1, 1922, pp. 211-216, 4 figs. Description of plant at Cameron Falls, Ont.

Design. Hydroelectric Power-Plant Design, J. A. Sirnit. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 505-508, 8 figs. Describes Thurlow backwater suppressor utilizing waste water for removal of high tail water from discharge opening during flood periods. Describes two testing models and design of draft-tube orifice. Details of construction and equipment of plant of Ala. Power Co. at Mitchell Dam, Ala.

Hazards. Hazards in Hydroelectric Plants, Alex. E. Bauhan. Gen. Elec. Rev., vol. 25, no. 9, Sept. 1922, pp. 526-537, 10 figs. Some hydraulic and mechanical hazards present in operation of low-head hydroelectric plant and precautions which may be taken to avoid them.

Kern Canyon, Cal. How a 3,000-Kw. Hydro-Electric Plant Was Rebuilt to Develop 9,000 Kw., H. K. Fox and B. F. Jacobsen. Elec. World, vol. 80, no. 7, Aug. 12, 1922, pp. 315-318, 6 figs. Unusual construction difficulties and peculiar features of electrical installation.

Queenston-Chippawa, Canada. Queenston-Chippawa Development. Power Plant Eng., vol. 26, no. 15, Aug. 1, 1922, pp. 760-767, 12 figs. General description including generator units and accessories.

The Queenston-Chippawa 600,000-Hp. Hydro-Electric Station. Power, vol. 56, no. 8, Aug. 22, 1922, pp. 270-278, 19 figs. Describes headworks, penstocks, power house and electrical equipment.

Winnipeg, Can. Extensions to the Hydro-Electric System of the City of Winnipeg, E. V. Caton. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 9, Sept. 1922, pp. 441-444, 4 figs. Additional units installed in Point du Bois plant, on Winnipeg River.

I

ICE PLANTS

Raw-Water. An Interesting Raw-Water Ice Plant. Southern Engr., vol. 38, no. 1, Sept. 1922, pp. 64–67, 11 figs. Describes 40-ton can ice plant consisting of 10-ton horizontal belt-driven ammonia compressor, and its operation. Practically all operations are automatically performed and clear ice is manufactured.

IGNITION

Automobiles. What Are the Essentials of a Good Ignition System? C. H. Kindl. Automotive Industries, vol. 47, no. 11, Sept. 14, 1922, pp. 516–518, 8 figs. Briefly touches on some problems connected with high-tension ignition which are of interest to automotive engine manufacturers. Ability of system to fire plugs under adverse conditions, and igniting quality of spark are important; also reliability, longevity and effect on engine performance.

IMPACT TESTING

Development. Symposium on Impact Testing of Materials. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 107 pp., 34 figs. Review of development of impact testing of materials and discussion of significance and value of impact test.

INDUSTRIAL MANAGEMENT

Bedaux Methods. Application of Bedaux Management Methods in the Robbins & Myers Plants, L. C. Morrow. Am. Mach., vol. 57, nos. 7 and 8, Aug. 17 and 24, 1922, pp. 249–255 and 294–298, 12 figs. Aug. 17: Estimating, manufacturing, inspection and salvage; reports and graphs. Aug. 24: Time studies; premium for inspection; reports and graphs.

Planning Department. Practical Work Planning, G. M. Bryceson. Eng. Production, vol. 5, no. 100, Aug. 31, 1922, pp. 206–209, 7 figs. System for determining and recording machine-hour capacity of each department and subdividing this into machine-hour capacity for each type of machine in the various sections.

Production Records. Records as a Basis for Management, B. A. Franklin. Management Eng., vol. 3, no. 3, Sept. 1922, pp. 133–137. Discusses task of executive; pictures of costs, prices and profits; specifications for a record; standards or measuring rules; scope of records; records of information and control.

Textile Plants. Management Applied to Textile Plants, George S. Harris. Mech. Eng., vol. 44, no. 6, June 1922, pp. 382–384. Organization of cotton plant and its management. Comparison of cotton-manufacturing development in North and South.

INDUSTRIAL ORGANIZATION

Public Office. Organizing a Public Office to Conduct a $20,000,000 Building Program, Norris M. Perris. Management Eng., vol. 3, no. 3, Sept. 1922, pp. 147–153, 1 fig. It is claimed that saving of $30,000 in a $330,000 pay-roll was made in one year by increasing quantity production, and salaries were increased 25 per cent. Presents plan of new organization.

INDUSTRIAL RELATIONS

Delco Policy. An Industrial Relations Policy That Makes Production Cost Less, Harry Tipper. Automotive Industries, vol. 47, no. 10, Sept. 7, 1922, pp. 473–476, 2 figs. Practice of Dayton Eng. Laboratories Co. Personal grievances are constructively met by interview and adjustment. Social activities encouraged, but operated entirely by employees. Small items and trifles considered important.

INDUSTRIAL TRUCKS

Gas-Operated. A Gas-Operated Industrial Truck with Elevating Platform. Ry. Age, vol. 73, no. 6, Aug. 5, 1922, p. 263, 2 figs. Has platform 54 in. by 26 in. with 11 in. minimum height above floor, which can be raised to 16 in. by lifting mechanism.

INSULATING MATERIALS

Thermal Conductivity. Measurement of The Thermal Conductivity of Liquids, Insulating Materials and Metals (Messung des Wärmeleitvermögens von Flussigkeiten, Isolierstoffen und Metallen), Max Jakob. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 27, July 8, 1922, pp. 688–693, 4 figs. Measurements on liquids and poor heat conductors (solid); and on metals and alloys

INTERCHANGEABLE MANUFACTURE

Inspection. Control of Quantity Production (Vérification d'une fabrication de pièces en grande série), Danty-Lafrance. Vie Technique et Industrielle, vol. 3, nos. 33 and 34, June and July 1922, pp. 154–158 and 245–218, 7 figs. Necessity for rigid control and inspection in manufacture of interchangeable parts; tolerances allowable; inspection of general forms and threads, control of work done by inspecting staff

INTERNAL-COMBUSTION ENGINES

Compound. Compound the Combustion Engine. Mech. Eng., vol 44, no 8, Aug. 1922, pp. 525–527 and 551, 1 fig. Discussion of paper by Elmer A. Sperry, presented before A.S.M.E.

Frictional Losses. A New Method for Determining Engine Friction Losses. Automotive Industries, vol 47, no. 8, Aug 21, 1922, p. 369 Method developed by G. Lumet based on idea that friction couple varies with engine torque and consequently with mean effective pressure

Fuel Detonation. Detonation Characteristics of Blends of Aromatic and Paraffin Hydrocarbons, Thos Midgley, Jr. and T. A. Boyd. Jl. Indus. & Eng. Chem., vol. 14, no. 7, July 1922, pp. 589–593, 3 figs. Results obtained in careful measurement of effects of various concentrations of benzene, toluene, or xylene upon detonation tendency of paraffin fuels in badly carbonized or high compression engines.

Future of. The Future Automotive Engine (Der künftige Verkehrsmotor), Gg. Bergmann. *Motorwagen, vol. 24, nos. 26 and 29, Sept. 20 and Oct. 20, 1921, pp. 538–541 and 643–646, 10 figs. and vol. 25, nos. 2 and 7, Jan. 20 and Mar. 10, 1922, pp. 23–25 and 128–133, 8 figs. Scope and limitations of internal-combustion, Diesel and semi-Diesel and light airplane engines. Blowing engines. Comparison of explosion and internal-combustion engines.

Grote Two-Stroke. The Grote Two-Stroke Engine (Der Grote Zweitaktmotor), Paul H. Weise. Motorwagen, vol. 25, no. 19–20, July 10–20, 1922, pp. 372–374, 2 figs. Said to combine advantages of four-cycle with those of two-cycle engines, and to effect saving in fuel consumption.

Ignition. See IGNITION.

Marine. Comparison of Internal-Combustion Marine Engines, Two- and Four-Stroke (Comparaison des moteurs marine à combustion interne, à deux et quatre temps), Legrand-Ribet. Outillage, vol. 6, no. 30, July 29, 1922, pp. 930–931, 4 figs. Construction and operation; advantages of two-stroke as to weight, regularity of motion, facility of operation, etc.

Steel-Plant Power Generation. Internal Combustion Engines for Power Generation in Steel Plants, D. M. Petty. Assn. Iron & Steel Elec. Engrs., vol. 4, no 9, Sept. 1922, pp. 659–571, 5 figs. Describes 4-cylinder, 4-cycle double-acting gas engine and 4.6 or 8-cylinder, 2-cycle Diesel oil engine. Analysis of first cost and cost of operation.

Valve Action. Valve Actions in Relation to Internal-Combustion Engine Design, Chester S. Ricker and John C. Moore. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 284–289 and (discussion) 289–291, 11 figs. Results obtained from combined road and laboratory tests made to determine amount of power required to maintain given car speed. Discusses manifold gas velocity.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES.]

IRON

Rustproofing. The Rustproofing of Iron (Wesen und Ziele des Eisenschutzes), Leo Ivanovszky. Eisenbau, vol. 13, no. 7, July 25, 1922, pp. 153–162. With special consideration of so-called self-protection of iron—that is, treatment of iron in its natural state so as to render it rustproof.

IRON ALLOYS

Iron-Carbon. Conditions of Stable Equilibrium in Iron-Carbon Alloys, H. A. Schwartz, H. R. Payne, A. F. Gorton and M. M. Austin. Am. Inst. Min. & Met. Engrs. Trans., no. 1181-S, Aug. 1922, 12 pp., 6 figs. and (abstract) in Min. & Metallurgy, no. 188, Aug. 1922, pp. 38–39, 1 fig. Study of single, impure, iron-carbon alloy carried out in Research Laboratory of Nat. Malleable Castings Co.

IRON CASTINGS

Casting Without Feeding Heads. British Opinions on Making Castings without Feeding Heads. Foundry Trade Jl., vol. 26, no. 313, Aug. 17, 1922, pp. 136–139. Discussion of E. Ronceray's paper published in same journal, June 1.

Making Castings without Feedings Heads, S. G. Smith. Foundry Trade Jl., vol. 26, no. 313, Aug. 17, 1922, pp. 140–141, 1 fig. Refers to paper by E. Ronceray published in same journal, June 1, and discusses possibility of partially or wholly dispensing with feeders, feeding heads and dross heads.

J

JIGS

Manufacture. Some Small Jigs. Engineer, vol. 133, no. 3461, May 19, 1922, pp. 542–545, 12 figs. Methods employed in small tool works of C. A. Vandervell & Co., Brighton, England

L

LATHES

Auto-Lathes. Reducing Costs on Chucking Work, A. H. Lloyd. Eng Production, vol. 5, no. 93, July 13, 1922, pp. 26–27, 5 figs. Auto-lathes and their tool equipment.

Driving-Wheel. Driving Wheel Lathe Tests, G. T. R., Stratford Shops. Can. Ry. & Mar. World, no. 294, Aug. 1922, p. 422, 1 fig. Data of tests at Grand Trunk shops, Stratford, Ont., of 90 in. heavy driving wheel lathe. Results given in form of table

LIQUID AIR

Manufacture and Applications. Liquid Air—Its Manufacture and Applications. Chem. Trade Jl. & Chem. Engr., vol. 71, nos. 1839 and 1840, Aug. 18 and 25, 1922, pp. 189–191 and 221–223, 1 fig. Aug. 18. Theoretical considerations, properties of liquid air; manufacturing methods. Aug. 25. Production of oxygen and nitrogen, argon, helium, neon, and hydrogen; liquid air in explosives manufacture, recent uses

LOCOMOTIVE BOILERS

Design and Maintenance. Design and Maintenance of Locomotive Boilers. Ry. Age (Daily), vol. 72, no. 24e, June 22, 1922, pp. 1687–1690 and (discussion) 1690–1696, 4 figs. Comparison of radial stay and Belpaire types of construction; investigation of dry pipe situation. A. R. A. Mech. Div. Committee recommendations. See also Boiler Maker, vol. 22, no. 8, Aug. 1922, pp. 223–226, 3 figs

Mountain-Type Locomotives. Boiler of Union Pacific Mountain Type Locomotive. Boiler Maker vol. 22, no. 8, Aug. 1922, pp. 217–222, 9 figs. High boiler capacity obtained in 4–8–2 locomotive which is lightest per unit of power ever built.

LOCOMOTIVES

Accessories. New Locomotive Specialties Developed on the Union Pacific. Ry. Rev., vol. 71, no. 3, July 15, 1922, pp. 73–76, 5 figs. Fuller low-water alarm; Fetters drifting valve for superheater locomotives; outside joint for maintaining air-tight joint at intersection of outside steam pipe and smoke box.

Beardmore. Beardmore Locomotives. Ry. Gaz. vol. 37, no. 8, Aug. 25, 1922, p. 258, 4 figs. on p. 259 Dimensions of 2–8–0 heavy goods, 4–6–0 express passenger, 4–8–0 mixed traffic, and 4–6–0 express passenger types.

Booster. Dynamometer Tests of the Locomotive Booster. Ry. Age, vol. 73, no. 12, Sept. 16, 1922, pp. 511–514, 8 figs. Describes booster tested, and test equipment. Severe tests demonstrate reliability at heavy loads and high speeds; maximum drawbar pull 11,000 lb.

Booster for Tender Trucks Developed on D. & H. Ry. Age, vol. 73, no. 4, July 22, 1922, pp. 145–147, 6 figs. Utilization of excess boiler capacity and weight of tender as sources of revenue tractive power.

British. Great Northern Railway—Pacific Type Passenger Engine. Engineer, vol. 133, no. 3459, Apr. 14, 1922, pp. 412–413, 5 figs. partly on p. 416. Dimensions and ratios of most powerful express engine in Great Britain. Engine is 3-cylinder type; connecting rods and couplings are of nickel-chrome steel.

Electric. See ELECTRIC LOCOMOTIVES

Fireboxes. Locomotive Fireboxes. Ry. Gaz., vol. 37, no. 5, Aug. 4, 1922, p. 154. Method of protecting parts in contact with extreme heat and flame from damaging effects of oxidation.

Fireless. Fireless Locomotives. Times Trade & Eng. Supp., vol. 10, no. 215, Aug. 19, 1922, p. 465, 2 figs. Osmotic storage of energy. Refers to apparatus invented by Honigmann about 40 years ago, and recent improvement in arrangement proposed by Dr. Schreber. Boilers described might be used in passenger steamers over short distances or for driving of single cars on railway lines with light traffic.

4–8–0. Three-Cylinder Locomotive for Spanish Service. Ry. Mech. Engr., vol. 96, no. 8, Aug. 1922, pp. 415–449, 6 figs. 4–8–0 type, weighing 194,000 lb.; weight of tender, 112,500 lb. Sample locomotive built by Yorkshire Engine Co., Sheffield, England.

Garratt. A Garratt Locomotive Development. Ry. Gaz., vol. 37, no. 4, July 28, 1922, pp. 126–127. Describes 2–6–6–2 type engine constructed for S. African Railways; weight 133.75 tons; tractive effort 50,000 lb.

Gasoline Switching. Gasoline Switching Locomotive with Hydraulic Drive. Ry. Age, vol. 73, no. 8, Aug. 19, 1922, pp. 323–326, 7 figs. Universal oil transmission governs speed and direction and gives remarkable flexibility of control.

Internal-Combustion. A French Petrol Locomotive. Engineer, vol. 133, no. 3461, Apr. 28, 1922, p. 476, 2 figs. Details of Renault 19-ton gasoline locomotive. Translated from Génie Civil.

Meter-Gage. Meter Gauge Passenger Locomotives, Bombay, Baroda & Central India Railway. Ry. Gaz., vol. 37, no. 4, July 28, 1922, pp. 124–125, 5 figs Describes engines which have recently been rebuilt; details of tenders which are fitted with patented differential bearing spring gear.

Mikado. Michigan Central Mikado Has Many Special Features. Ry. Age, vol. 73, no. 10, Sept. 2, 1922, pp. 411–415, 5 figs. Describes 2–8–2-type locomotive for freight service designed to provide maximum hauling capacity with minimum fuel consumption without exceeding allowable limit of weight tractive effort without booster, 63–500 lb.

Palestine Railway. New Locomotives and Rolling-Stock for the Palestine Railway. Ry. Gaz., vol. 37, no. 6, Aug. 11, 1922, pp. 194–196, 7 figs. partly on p. 197. Built in England to special designs and specifications; describes 2–8–4-type heavy tank-engine locomotives, and first- and second-class passenger cars.

Rod Testing. How Locomotive Rods are Tested and Machined at Lima. Ry. Rev., vol. 71, no. 8, Aug. 19, 1922, pp. 231–234, 6 figs. New testing machine eliminates defective rods and use of special jigs insures uniform dimensions.

Stability at High Speeds. Stability of Locomotives at High Speeds. Ry. Engr., vol. 43, no. 511, Aug 1922, pp. 302–313, 13 figs. Experiments carried out on London, Brighton & South Coast Ry. with five different types of engines to determine relative actions of varying bogie control systems and locomotive wheel arrangements while hauling heavily loaded express trains on main line.

Steam-Turbine. Turbine Locomotives (La locomotive à turbines), J. Netter. Nature, no. 2514, June 10, 1922, pp. 365–367, 4 figs. Describes type manufactured in 1914 in Milan, and another type made by Escher Wiss & Co., Zurich, Switzerland, with special tender for necessary cooling apparatus for condenser.

The Ljungström Turbine Locomotive. Engineering, vol. 114, nos. 2951, 2953, 2954 and 2955, July 21, Aug. 4, 11 and 18, 1922, pp. 64–70, 26 figs., 131–133, 39 figs. partly on supp. plate, 163–168, 27 figs. and 198–203, 19 figs. Motive power is condensing steam turbine developing 1800 hp. which drives 3 pairs of coupled wheels by means of double-reduction gearing. Forced lubrication to all working parts.

Switching. Petrol Shunting Locomotive at Kelso, North British Railway. Ry. Gaz., vol. 37, no. 1, July 7, 1922, p. 17, 3 figs. Description of four-wheeled locomotive with 40 b.hp. engine with roller chains to axle.

Tank. New Express Passenger Tank Locomotives, Glasgow & South Western Railway. Ry. Engr., vol. 43, no. 511, Aug. 1922, pp. 298–301, 6 figs. Characteristics of 4-6-4 type locomotive. Cylinders, 22-in. diam. by 26-in. stroke, coupled wheels 6 ft. diam., total heating surface, 1983 sq. ft. coal capacity, 3½ tons. Account of trial run.

New 4-6-4 Type Tank Engines for Java. Ry. Gaz., vol. 37, no. 1, July 7, 1922, p. 18–19, 5 figs. Steam distribution to cylinders by means of inside admission piston valves.

Works. The Locomotive Works of Sir W. G. Armstrong Whitworth & Co., Ltd. Eng. Production, vol. 5, nos. 93 and 94, July 13 and 20, 1922, pp. 31–36 and 61–65, 21 figs. Description of plant and working methods.

LUBRICATING OILS

Storing and Clarifying. Storing and Clarifying Oil in Shops. Am. Mach., vol. 57, no. 4, July 27, 1922, pp. 125–127. Methods used in 12 well-known plants. Tanks, separators, mixtures and other details.

Wax Extraction. Wax Extraction by Centrifugal Force. Oil & Gas Jl., vol. 21, no. 7, July 13, 1922, pp. 14 and 92–93, 3 figs. Separating wax crystals from lubricating oils; latest developments by Maryland Refining Co.

LUBRICATION

Tests. Lubrication Tests, H. T. Newbigin. Engineering, vol. 114, no. 2957, Sept. 1, 1922, pp. 260–261, 7 figs. Describes tests made with segmental, pivoted blocks or pads, of Michell type, running against a plane surface thereby providing mechanical conditions necessary for formation of true pressure oil films.

M

MACHINE-TOOL INDUSTRY

Sweden. The Machine Tool Industry in Sweden. Machy. (N. Y.), vol. 29, no. 1, Sept. 1922, pp. 31–32. Notes on leading machine-tool building plants and their products.

MACHINE TOOLS

Design and Manufacture. Machine Tools; Their Design and Manufacture, Joseph Horner. Engineering, vol. 114, no. 2956, Aug. 25, 1922, pp. 231–233. Notes on increased complication of machine tools; changing aspects of tooling; problem of increased output, automatic movements; materials; manufacture; jigs; tolerances, interchangeability; shop drawings; etc.

MALLEABLE CASTINGS

Manufacture. Making Malleable Castings, Enrique Touceda. Foundry, vol. 50, nos. 14, 15 and 16, July 15, Aug. 1 and 15, 1922, pp. 583–593, 622–626 and 676–680, 16 figs. July 15: Suggestions covering principles governing layout of American malleable foundry, how air furnaces are designed; suggestions for bungs and grates. Aug. 1: Metallurgical problems encountered in melting; finishing castings. Aug. 15: Tests showing effect of size of grates in distribution of metal; causes of picture-frame structure. (Abstract.) Paper read before Inst. Brit. Foundrymen.

MALLEABLE IRON

Advantages. Malleable Cast Iron, Enrique Touceda. Am. Mach., vol. 57, no. 9, Aug. 31, 1922, pp. 321–323, 7 figs. Poor qualities of pure cast iron; factors that make malleable cast iron superior; soundness, strength and good machineability attained.

METAL SPRAYING

Schoop Process. Protective Coatings of Sprayed Metal, Robert G. Skerrett. Iron Age, vol. 110, no. 5, Aug. 3, 1922, pp. 286–287, 2 figs. Late developments with Schoop process abroad; examples of applications and operating features; spraying pistol operated electrically. Article, based on European information, does not refer to developments of Schoop process in United States.

METALLOGRAPHY

Etching Reagents. Metallographic Etching Reagents for Copper Alloys, Nickel, and the Alpha Alloys of Nickel, Henry S. Rawdon and Marjorie G. Lorentz. U. S. Bur. of Standards Sci. Papers, vol. 17, no. 435, Apr. 27, 1922, pp. 635–676, 27 figs. Gives experimental results to show importance of films varying in thickness upon different crystals in a metallographic specimen in producing a "contrast etch pattern."

Institute, Sweden. The Metallographical Institute (Metallografiska institutet), Carl Benedicks. Jernkontorets Annaler, vol. 106, no. 6, 1922, pp. 203–220, 7 figs. Description of institute, its buildings, departments and equipment; review of its work.

Microscopic, Macrography and. Recent Progress in Microscopic Metallography and Macrography (Les récents progrès de la metallographie microscopique et de la macrographie), Leon Guillet. Revue Universelle des Mines, vol. 14, no. 1, July 1, 1922, pp. 1–17 (Metallurgical Section). Methods of microscopic metallography and macrography, examination and preparation of photographs, requirements of apparatus; results obtained.

METALS

Acid-Resisting. Acid-Resisting Metals and Alloys, George A. Drysdale. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 579–580 and 621. Account of research work carried out on various non-ferrous metals and alloys, with especial reference to their use in manufacture of mine pumps and chemical apparatus.

Fatigue of. Fatigue or Progressive Failure of Metals under Repeated Stress, H. F. Moore, J. B. Kommers, and T. M. Jasper. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 23 pp., 21 figs. Discusses testing practice used in making repeated-stress tests, with especial reference to testing machines, test specimens and methods used in joint investigation of fatigue of metals now in progress. Recent test results are presented.

Fatigue of Metals, C. E. Stromeyer. S. Wales Inst. Engrs. Proc., vol. 38, no. 3, July 20, 1922, pp. 285–308 and (discussion) pp. 308–331, 2 figs. Description of fatigue-testing machine and results of tests.

Heat-Temperature Curves. Heat-Temperature Curves of Metals, Joseph F. Shagden. Iron Age, vol. 110, no. 4, July 27, 1922, pp. 218–222, 5 figs. Basis for average and instantaneous specific heat values provided by German laboratory tests. New specific heats for molten metal.

Properties. Deformation and Rupture of Solids (Déformation et rupture des solides), Mesnager. Révue de Métallurgie, vol. 19, nos. 6 and 7, June and July 1922, pp. 365–378 and 425–436, 37 figs. June: Elastic limit of mild steel and copper and experiments made in this connection. July: Rupture of fragile solids; difference between permanent deformation and rupture; experiments made by Dr. Karman at Göttingen on resistance of materials.

Tearing Tests. Tearing Tests on Metals, Henry L. Heathecote and C. G. Whinfrey. Chem. & Met. Eng., vol. 27, no. 7, Aug. 16, 1922, pp. 310–311, 2 figs. Methods and results of testing metals for resistance to tearing.

Tensile Strength. Tensile Strength of Plastic Metals, Friedrich Koerber. Mech. Eng., vol. 44, no. 6, June 1922, pp. 392–393, 2 figs. Presents method for computing tensile strength of metals from curve of "true" stresses; discusses mechanism of tensile rupture test and proposes theory of tensile stresses based on assumption of slip and torsion effects of crystalline elements in metal. Translated from Stahl u. Eisen, vol. 42, no. 10, Mar. 9, 1922, pp. 365–370.

X-Ray Investigation. X-Ray Investigations on Metals, R. Glockner. Iron & Coal Trades Rev., vol. 105, no. 2841, Aug. 11, 1922, p. 186, 2 figs. Suggestions based on writer's own work and work by other investigators. Translated from Stahl u. Eisen.

MILLING CUTTERS

Helical. Construction of Milling Cutters. Practical Engr., vol. 66, no. 1846, July 13, 1922, p. 19, 1 fig. Describes Kendal & Gent cutter, a steel forging in which plain helical grooves are milled; blades are bent in special machine.

MOLDING METHODS

Ingot Molds. Molding and Casting of Ingot Molds (Formen und Giessen von Blockformen), Carl Irresberger. Stahl u. Eisen, vol. 42, nos. 17 and 26, Apr. 27, and June 29, 1922, pp. 649–654 and 1013–1016, 29 figs. Apr. 27: Describes Kunze method adopted some 12 years ago which has been very successful. June 29: Process of Penn Mold and Mfg. Co., Dover, O.

MONEL METAL

Manipulation and Use. Monel Metal, S. E. Briggs. West. Machy. World, vol. 13, no. 8, Aug. 1922, pp. 276–277 and 282, 5 figs. Physical properties; directions for manipulation and use.

MOTOR BUSES

Trailer. Single Deck Trailer Bus Carries 65 People. Commercial Vehicle, vol. 26, no. 12, July 15, 1922, p. 28, 1 fig. Six-wheel design of Fruehauf Trailer Co. with air-operated doors and brakes.

MOTOR PLOWS

German. Germans Develop New Motor Plow Designs. Automotive Industries, vol. 47, no. 11, Sept. 14, 1922, pp. 524–527, 5 figs. Describes types shown at exhibition held by German Agricultural Soc.; 17 motor plow exhibits.

MOTOR TRUCKS

Chassis, Swiss. The 5-Ton Saurer Chassis. Automobile Engr., vol. 12, no. 166, Aug. 1922, pp. 226–236, 21 figs. Details of 5-ton lorry built by Saurer Co., St. Georgen, Switzerland.

Chassis Tests. Chassis Efficiency Tests, O. D. North. Automobile Engr., vol. 12, no. 166, Aug. 1922, pp. 237–242, 8 figs. Consideration of Riedler's investigation of a Bussing chain-driven truck.

Lacre. The New 4-Ton Lacre. Motor Transport, vol. 35, no. 910, Aug. 7, 1922, pp. 166–167, 5 figs. Details of chassis with spur-gear final drive, and 38.45-hp. 4-cycle engine.

Producer-Gas-Driven. The Thornycroft Suction Gas Vehicle. Motor Transport, vol. 35, no. 912, Aug. 21, 1922, pp. 235–237, 2 figs. Description of successful machine that won first prize in French producer gas trials.

Wheels. A New Process of Manufacturing Truck Wheels. Automotive Industries, vol. 47, no. 6, Aug. 10, 1922, pp. 270–273, 23 figs. Describes equipment for rapid production of wheel from rolled steel I beam, developed by Bethlehem Steel Co.; method involves series of cold punching and forming operations.

MOTOR TRUCKS, MILITARY

British War Office Specification. The New War Chassis. Motor Transport, vol. 35, no. 909, July 31, 1922, pp. 150–152. Specification of 30-cwt. pneumatic-tired lorry drawn up by British War Office M. T. Advisory Board. 24-hp. 4-cylinder engine; pump cooling; H. T. magneto; engine-driven tire pump; detachable wheels with detachable rims; chassis weight max. 29 cwt.; total weight 39 cwt.; speed 30 m.p.h.

MOTORCYCLES

British. The Raleigh Motor Bicycle. Engineering, vol. 114, no. 2957, Sept. 1, 1922, pp. 264–266, 11 figs. Engine is of 4-stroke type with mechanically operated valves.

German Types. German Motorcycles and Motorcycle Engines (Deutsche Motorräder und Kraftradmotoren), H. Maigel. Motorwagen, vol. 24, nos. 33 and 34, Nov. 30 and Dec. 10, 1921, pp. 727–730 and 751–755 and vol. 25, no. 7, Mar. 10, 1922, pp. 133–137, 35 figs. With special reference to types exhibited at German 1921 automobile show.

N

NATURAL GAS

Gasoline from. The Absorption of Gasoline from Natural Gas, R. C. Cantelo. Can. Chem. & Metallurgy, vol. 6, nos. 8 and Aug. and Sept. 1922, pp. 177–179 and 196–200, 1 fig. Aug.: Methods of testing natural gas from gasoline content. Theory and development of absorption process. Sept.: Calculating amount of absorbent necessary for complete removal of gasoline from gas. Results of experiments.

NICKEL ALLOYS

Nickel-Chromium. Exhaust Valves of Nickel-Chromium Alloy. Motorship, vol. 7, no. 9, Sept. 1922, p. 679, 4 figs. Describes nichrome, an alloy produced by Driver, Harris Co., Harrison, N. J., said to be practically immune to pitting, warping and other destructive forces.

Properties. Some Nickel Alloys. Metal Industry (Lond.), vol. 21, nos. 4 and 6, July 28 and Aug. 11, 1922, pp. 78–82 and 129–130, 5 figs. Properties and chief features of more important ferrous and non-ferrous nickel alloys.

NICKEL-CHROME STEEL

Manufacture. The Making, Forging and Heat Treating of Nickel Chromium Steels, Harry Brearley. Forging & Heat Treating, vol. 8, no. 8, Aug. 1922, pp. 341–345, 2 figs. Characteristics and nature of nickel-chromium steels; causes of failure and remedy therefor; comparison of nickel and nickel-chromium steels. Lecture before Assn. Drop Forgers & Stampers.

NOMENCLATURE

A.S.T.M. Committee Report. Report of Committee E-8 on Nomenclature and Definitions. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 11 pp. Report on tentative definitions.

NON-FERROUS METALS

A.S.T.M. Committee Report. Report of Committee B-2 on Non-Ferrous Metals and Alloys. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 23 pp., 2 figs. Includes notes on physical properties of A.S.T.M. tentative standard white-metal bearing alloys, by John R. Freeman, Jr. Proposed tentative specifications for copper pipe, brass pipe, and seamless admiralty condenser tubes and ferrule stock.

Gas Absorption and Oxidation. Gas Absorption and Oxidation of Non-Ferrous Metals, B. Woyski and John W. Boeck. Metal Industry (N. Y.), vol. 20, nos. 7 and 8, July and Aug. 1922, pp. 267–268 and 307–308, 2 figs. Discussion of furnace atmospheres and their relation to condition of metal.

O

OIL

World Supply. The Oil Supply of the World, David White. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 567–569. Estimates of oil resources of various regions of earth. Economic future as to oil in United States. Measures necessary to be taken in order to increase and conserve domestic supply. (Abridgment.)

OIL ENGINES

Brotherhood. Brotherhood Oil Engines for Crude and Residual Fuels. Oil Eng. & Finance, vol. 1, no. 25, July 1, 1922, pp. 837–840, 6 figs. Description of Brotherhood gas and oil engines.

Brotherhood-Still. The "Brotherhood-Still" Oil

Engine. Oil Eng. & Finance, vol. 1, no. 21, June 24, 1922, pp. 777–778, 1 fig. Compound steam and internal combustion engine containing double action piston with usual air exhaust and admission valves showing phenomenal fuel consumption.

Fullagar Land-Type. The Fullagar Oil Engine for Land Purposes. Engineer, vol. 133, no. 3461, Apr. 28, 1922, pp. 466–468, 7 figs., partly on p. 470. Describes land type engine built on Fullagar system, which is said to have all advantages of marine type, chief among them being excellent balancing of reciprocating parts. See also English Elec. Jl., vol. 2, no. 2, Apr.-July, pp. 61–67, 8 figs.

Marine. Developments in the Design of Marine Oil Engines. Mar. Engr. & Naval Architect, vol. 45, nos. 534, 535, 537 and 539, Mar., Apr., June and Aug., 1922, pp. 124–126, 147–149, 225–228 and 305–308, 38 figs. Mar.: Different types Burmeister & Wain, Vickers, North British Diesel, Tosi, Werkspoor, Doxford, and Camellaird-Fullagar. Apr.: Built, solid, and partly built crankshafts, trend of column and framing design, two and four-stroke pistons and cylinder covers; piston clearances and methods of cooling; June: Construction of reciprocating parts; starting and inlet valve arrangements; high-pressure solid-injection fuel pumps, air compressors. Aug.: Valve operating mechanism; material and design of cams valve setting diagrams; methods of reversing.

OIL FUEL

Burners. Navy Testing Plant Perfects Oil Burner, Charles E. Kern. Oil & Gas Jl., vol. 21, no. 5, June 29, 1922, pp. 11 and 100. Mechanical pressure of oil atomizes it giving rapid whirling motion inside burner which causes expansion into cone that disintegrates into fine oil mist.

Distribution in Industrial Plants. Distribution of Fuel Oil in Industrial Plants, J. A. Brown. Forging & Heat Treating, vol. 8, no. 8, Aug. 1922, pp. 336–340, 4 figs. Character of fuel oil defined in terms of temperature, gravity and viscosity; effect of pipe size, velocity and viscosity on friction head; analysis of cost service.

OPEN-HEARTH FURNACES

Progress. Progress in the Open-Hearth Process, Willis McKee. Iron Age, vol. 110, no. 3, July 20, 1922, pp. 147–149, 2 figs. Results from blowtorch furnace; its principles and advantages. Steel-encased regenerators. (Abstract.) Paper read before Am. Foundrymen's Assn.

Talbot Process. The Talbot Process Compared with other Processes. Iron & Coal Trades Rev., vol. 105, no. 2840, Aug. 4, 1922, p. 146. Conclusions regarding advantages of Talbot process over other open-hearth steel-making processes. Translated from Stahl u. Eisen.

OXY-ACETYLENE CUTTING

Production Costs. Oxygen for Cutting Purposes. Eng. Production, vol. 5, no. 98, Aug. 17, 1922, p. 152. Comparative data on production costs.

OXY-ACETYLENE WELDING

Ingot-Iron Composition. Composition of Ingot Iron for Effective Autogenous Welding (Beschaffenheit des Flusseisens für gute Schmelzflammen-Schweissung), C. Diegel. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 246, 1922, 44 pp., 146 figs. on supp. plates. Experiments to determine effect of 0.27 per cent Si and 0.25 per cent Ni, which show that Si is injurious while Ni is not.

P

PACKINGS

Labyrinth. Steam Loss in Labyrinth Packings (Dampfverlust in Labyringthdichtungen), A. Winkhaus. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 33–34, Aug. 26, 1922, pp. 804–807, 9 figs. Determination of discharge and its application to calculation of a labyrinth.

PAINTS

Accelerated Weathering. Accelerated Weathering of Paints on Wood and Metal Surfaces, Harley A. Nelson. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 15 pp., 6 figs. Describes effort to reproduce directly on typical surfaces, not only changes in some one physical property, but all of more common paint failures observed on painted wood and metal structures.

Black Pigments. The Manufacture and Use of Black Pigments, H. L. Blachford. Can. Chem. & Metallurgy, vol. 6, nos. 7 and 8, July and Aug. 1922, pp. 156–158 and 180–181. Definition, manufacture and uses of carbon, lamp, bone, charcoal and various other blacks.

Specifications. Report of Committee D-1 on Preservative Coatings for Structural Materials. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 60 pp., 1 fig. Proposed revised tentative definitions of terms relating to paint specifications, specifications for raw or refined soya bean and perilla oil and raw tung oil; methods of analysis of yellow and orange pigments, blue pigments and chrome green; report on varnish; specifications for carbon black, lampblack, bone black, chrome yellow and chrome green.

Physical Properties. Some Physical Properties of Paints, P. H. Walker and J. G. Thompson. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 19 pp., 6 figs. Results of investigations on plastometer measurements, preparation of paint films, effect of varying composition on paint films, thinning power of turpentine, and aging of basic carbonate white lead paints before application.

PAPER MANUFACTURE

Beating. Is Beating Really Understood? Paper, vol. 30, no. 21, July 26, 1922, pp. 7–10. Preparation of pulps for bond and ledger papers made principally from rag fiber.

Improvements. Recent Advances in Pulp and Paper, Clarence J. West. Jl. Indus. & Eng. Chem., vol. 14, no. 9, Sept. 1922, pp. 858–860. Deals with raw materials; improvements in processes; analytical methods; beating, bleaching, and sizing.

Lime in Pulp Manufacture. Uses of Lime in Pulp Manufacture, George K. Spence. Paper, vol. 30, no. 19, July 12, 1922, pp. 7–9. Old and new methods of causticizing soda with lime in soda and sulphate processes.

Strawboard Wastes. The Treatment and Disposal of Strawboard Wastes, H. B. Hommon. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 6, Aug. 1922, pp. 1397–1402. Complete account of studies made at American Strawboard Mill, Noblesville, Ind., for developing methods to treat wastes resulting from manufacture of paper from straw.

PAPER MILLS

Electric Drive. Sectional Paper Machine Drive, Stephen A. Staege. Paper, vol. 30, nos. 17 and 18, June 28 and July 5, 1922, pp. 9–11 and 17. Electrical way of individual motors has simplified equipment and proved best.

Steam Utilization. Steam Utilization in a Modern Newsprint Mill, S. W. Slater and J. E. A. Warner, Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 587–592, 6 figs. Analysis of conditions obtaining in modern paper mill manufacturing newsprint, dealing with selection of prime mover, electric vs. rope drive for paper machines, drying of paper, ventilation requirements, etc. (Abridgment.)

Wastes. Wastes from Pulp and Paper Mills Chemically Considered, H. W. Clark. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 6, Aug. 1922, pp. 1393–1396. Writer states it is often possible to remove 70 per cent or more of primary polluting matters of paper-mill wastes. Apparently only wastes recovered with profit as yet are those from soda-pulp process and wastes from paper machine.

PIPE, STEEL

Bending Large. Bending Large Pipe, Charles O. Herb. Machy. (N. Y.), vol. 29, no. 1, Sept. 1922, pp. 1–7, 8 figs. Procedure in hand-bending large-sized wrought-iron and steel pipe while hot and packed with sand.

PIPE, WROUGHT IRON

Heat Losses. Heat Losses from Bare and Covered W. I. Pipe at Temperatures up to 800 Deg. Fahr., R. H. Heilman. Mech. Eng., vol. 44, no. 7, July 1922, pp. 435–437, 3 figs. Presents findings of experimental investigation conducted in Mellon Inst. of Indus. Research of University of Pittsburgh. Empirical formulas are presented whereby loss from insulated pipes of any diameter may be readily calculated. (Abridgment.)

PISTON RINGS

Design. Piston-Rings and Ring Grooves, C. R. Manes. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 262–264 and (discussion) 228–231, 1 fig. Defines purpose of piston ring for internal-combustion engine and discusses gas and oil leakage, disputing H. H. Platt's views on these two points in recent paper. Advantage of multiple-piece rings over one-piece type. Table giving width and depth for piston-ring grooves.

Engineering and Manufacturing Practice. Piston-Rings, John Magee. Soc. Automotive Engrs. Jl., vol., 11, no. 3, Sept. 1922, pp. 273–274 and (discussion) 228–231. Comments with view to standardization of best engineering and manufacturing practice. States that cast iron is only satisfactory metal suitable for use in internal-combustion engines. Discusses leakage and oil-pumping, width and form, and manufacturing difficulties.

Oil-Scraper, Test of. Test of Oil Scraper Piston Ring and Piston Fitted with Oil Drain Holes, H. S. McDewell. Nat. Advisory Committee for Aeronautics Tech. Notes, nos. 88 and 114, Aug. and Sept. 1922, 12 pp., 2 figs. and 8 pp. Tests to determine whether or not properly located and designed oil-scraper piston ring, installed on piston provided with oil drain holes of sufficient area, would prevent excessive oiling of Liberty engine.

PISTONS

Aluminum. Aluminum Pistons, Ferdinand Jehle and Frank Jardine. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 225–228 and (discussion) 228–231, 8 figs. Discusses thermal properties, such as actual operating temperature, temperature distribution, and effect of cooling-water temperature and piston material on piston temperature.

The Aluminum-Alloy Piston, James E. Diamond. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 258–261 and (discussion) 228–231, 1 fig. Discusses piston and cylinder relations; aluminum alloys suitable for pistons; outlines progress of design; ring-groove wear; gives tabular data and chart relative to heat treatment.

Light-Metal Alloys for. Light Metal Alloys for Pistons, Wallace Dent Williams. Raw Material, vol. 5, no. 7, Aug. 1922, pp. 259–266, 21 figs. Cast aluminum alloy pistons; cast and drawn magnesium alloy pistons. Special contrivances used in tests to investigate operating values of various light-metal pistons; influence of crust of soot.

PITOT TUBES

Wind Velocity, Measurement of. On the Use of Very Small Pitot-Tubes for Measuring Wind Velocity, Muriel Barker. Royal Soc. Proc., vol. 101, no. A712, Aug. 1, 1922, pp. 435–445, 5 figs. Account of experiments and results.

PLANERS

Controller, Electric. Electric Control of Planer Table Movement. Can. Machy., vol. 28, no. 7, Aug. 17, 1922, pp. 21 and 39, 2 figs. Describes Cutler-Hammer full-magnetic planer controller, and its operation.

PNEUMATIC TOOLS

Machining and Assembling. Machining and Assembling Operations on Pneumatic Tools, Howard Campbell. Am. Mach., vol. 57, nos. 2, 3, 4 and 5, July 13, 20, 27 and Aug. 3, 1922, pp. 49–51, 101–104, 134–136 and 175–177, 42 figs. July 13: Drilling air-hammer parts; boring, reaming, grinding and lapping piston holes. July 20: Turning and drilling crankshafts for air motors; machining valves. July 27: Milling and grinding operations on connecting rods for air motors; swaging and milling. Aug. 3: Boring and reaming air-motor cylinders; setting valves; testing brake.

POWER GENERATION

Prime-Movers Statistics. Prime Movers in Central Stations Total 19,737,361-Hp. Elec. World, vol. 80, no. 4, July 22, 1922, p. 169. Analysis of development of electric light and power companies indicates total of 13,331,933 hp. in steam motors, of which 87 per cent is for steam turbines; boiler installation totals 4,042,922 hp.

POWER PLANTS

Design. Developments in Power Station Design. Engineer, vol. 133, nos. 3459, 3461, 3463, 3464, 3465, 3466 and 3467, Apr. 14, 28, May 12, 19, 26, June 2 and 9, 1922, pp. 406–409, 8 figs.; 457–459, 7 figs.; 529–532, 12 figs.; 545–547, 11 figs.; 574–578, 14 figs.; 608–610, 13 figs.; and 631–634, 14 figs. Apr. 14: Parsons 10,500-kw. turbo-generator at Carville station. Apr. 28: Hickson-Hargreaves surface condensing plant, ejectair, and jet condenser. May 12: Mirlees-Watson condensing plant built for Bankside station of London Elec. Light Co.; jet condensers with Delas air extractors. May 19: Flow of fluids in pipes; electrical flow meters. May 26: Circular-type condensers of English Elec. Co.; Willan's condensing plant at Dalmarnock. June 2: Air filters for power-house use; water-cooled rotors; design of switchgear. June 9: Transformers; current-limiting reactances; rectifiers.

Economies. Power Plant Economies, George E. Wood. Coal Industry, vol. 5, no. 6, June 1922, pp. 267–270, 5 figs. Practical value of accurate boiler room records; evil results of scale accumulation; losses from soot as high as $15,000 per year; uncovering of air leaks and bad pipe connections.

Jenckes Spinning Co., Pawtucket. The Tamarack Power Plant. Power Plant Eng., vol. 26, no. 17, Sept. 1, 1922, pp. 837–843, 14 figs. Plant supplying power to largest procedures of tire fabric in United States, designed by its operating engineer.

Oil Refining. Power for the Atlantic Refining Co. Power Plant Eng., vol. 26, no. 15, Aug. 1, 1922, pp. 739–746, 14 figs. Describes construction and methods of operation of one of 17 power plants ranging from 500 to 1000 hp. per unit.

POWER TRANSMISSION

Paper Mills. Power-Transmission Systems of Three Big Paper Mills, H. Hilman Smith, Jr. Belting, vol. 21, no. 2, Aug. 1922, pp. 21–25, 8 figs. Layouts in Haverhill, Piermont and Chicago divisions of Robert Gair Co. Rubber belts used chiefly.

PRODUCER GAS

Production and Use. Production of Producer Gas and Use in Open-Hearth Furnaces (Considérations sur la production et l'utilisation du gaz pauvre de gazogènes pour le chauffage des fours Martin), G. Husson. Révue de l'Industrie Minérale, no. 38, July 15, 1922, pp. 373–406, 3 figs. Technical value of a gas; theory of gasification of coke; influence of different kinds of coal; handling of different gas producers; etc.

PULLEYS

Automatically Lubricated. Pulleys with Automatic Lubrication, J. H. Blakey. Power Plant Eng., vol. 26, no. 15, Aug. 1, 1922, p. 759, 5 figs. Description of pulley of French origin with automatic lubrication for use especially in cranes which are difficult of access.

PULVERIZED COAL

Boiler Firing. Experiments With Pulverized Coal Firing (Versuche mit einer Kohlenstaubfeuerung), F. Kaiser. Zeit. des Bayerischen Revisions-Vereins, vol. 26, nos. 13, 14 and 15, July 15, 31 and Aug. 15, 1922, pp. 106–107, 115–117 and 122–121, 3 figs. Preparation, drying and conveying of coal; firing pulverized coal; effect of radiation.

Hazards. Pulverized Fuel and Its Hazards. Steam, vol. 30, no. 3, Sept. 1922, pp. 67–71. Advantages of pulverized fuel; considers types of systems, dryer, burner construction, crushing, drying and pulverizing with regard to explosion hazard.

PUMPING

Hot Liquids. The Pumping of Hot Liquids, Wm. Mason. Gas Jl., vol. 159, no. 3092, Aug. 16, 1922, pp. 374–375, 2 figs. Difficulties are explained and method of circumventing them set forth.

PUMPS, CENTRIFUGAL

Development and Operation. Centrifugal Pumps, H. Kilian. Fördertechnik u. Frachtverkehr, vol.

15, no. 16, Aug. 4, 1922, pp. 212-216, 7 figs. Notes on development, operation, delivery and suction head, efficiency, power consumption, regulations for erection, attendance, etc.

Dredging and Sand Pumping. Pumps Used in Dredging and for Pumping Sand, E. T. Keenan. Cement, Mill & Quarry, vol. 21, no. 4, Aug. 20, 1922, pp. 29-31, 3 figs. Design of pumps handling sand and rock.

Electrically Driven. Electrically Driven High Pressure Centrifugal Pump. Engineer, vol. 133, no. 3463, May 26, 1922, p. 591, 3 figs. partly on p. 584. Capable of delivery 800 gal. per min. at pressure of 1150 lb. per sq. in. Installed in pumping station, Manchester, England.

PYROMETERS

Radiation. The New Radiation Pyrometer "Pyro" (Das neue Strahlungs-Pyrometer "Pyro"). Zeit. für die gesamte Giessereipraxis, vol. 43, no. 27, July 15, 1922, p. 377. Its advantages, simplicity of operation and application to high and low temperatures.

Total Radiation. Total Radiation Pyrometer, Eberhard Zopf. Eng. Progress, vol. 3, no. 8, Aug. 1922, p. 180, 2 figs. Describes ardometer constructed by Siemens & Halske.

R

RAILS

Heat Treatment. The Improvement of Rails and Tyres by Means of Heat Treatment, James Waite. Commonwealth Engr., vol. 9, no. 12, July 1, 1922, pp. 435-438, 4 figs. Notes on Sandberg treatment.

Joints. Why Use Base Plates With Welded Rail Joints? Howard H. George. Elec. Ry. Jl., vol. 60, no. 8, Aug. 19, 1922, pp. 265-266. Base plates not needed if correct design of joint plate is worked out, additional weight of metal and increased amount of welding do not economically solve problem.

121-Lb.-Section. A New 121-Lb. "Market Street Rail" for San Francisco. Elec. Ry. Jl., vol. 60, no. 5, July 29, 1922, p. 163, 2 figs. Data on new rails to be laid in Market Street tracks which are modification of present standard 9-in. girder rail.

Wear, Measurement of. Determination of Rail Wear for Valuation Purposes, J. P. Newell. Eng. News-Rec., vol. 89, no. 8, Aug. 24, 1922, pp. 310-312, 3 figs. Cross-sections accurately measured in field; rails rated by scientific analysis of observed deterioration. Describes rail pantograph invented by S. W. Fairweather.

RAILWAY ELECTRIFICATION

Argentine. Steam Road Electrifications in the Argentine, Lynn G. Riley. Ry. Age, vol. 73, no. 9, Aug. 26, 1922, pp. 375-378, 7 figs. Electrification of Buenos Aires & Western, its service conditions and locomotive equipment.

British. British Railways Electrification. Elec. Ry. & Tramway Jl., vol. 46, no. 1136, June 16, 1922, pp. 257-264, 5 figs. South Eastern and Chatham electrification, London Tube, Great Eastern; London and North-Western; London, Brighton and South-Coast, and Metropolitan railways.

Germany. Electric Traction on German State Railways (Die elektrische Zugförderung auf den deutschen Reichsbahnen), H. Gleichmann. Organ für die Fortschritte des Eisenbahnwesens, vol. 77, nos. 9, 10 and 11, May 1, 15 and June 1, 1922, pp. 127-132, 143-147 and 159-163, 47 figs. mainly on supp. plates. Notes on selection of current, the Bavarian system, a three-phase system of 100 kv., Bavaria's available water power, the Walchen Lake hydroelectric plant; the Isar-River plants. Possibilities for development of electric traction in Germany.

London & North Western. Electrification of the London and North-Western Railway. Elec. Times, vol. 62, no. 1604, July 13, 1922, pp. 27-28, 2 figs. Data on electrification of suburban lines recently completed by conversion of line from Euston to Willesden. Description of rolling stock, power-generating stations and auxiliaries. Indicators with names of stations carried at each end of train.

RAILWAY MOTOR CARS

Diesel-Electric. Swedish Railways Increase Use of Diesel Electrics. Elec. Ry. Jl., vol. 60, no. 6, Aug. 5, 1922, pp. 193-195, 4 figs. Success of small motor cars leads to introduction of those with 160 and 250 hp. capacity, reduction in operating cost and improved service, performance data, dimensions and weights.

Gasoline. The Gasoline-Driven Motor-Coach for Railroad Service, Charles O. Guernsey. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 275-278 and (discussion) 278-280 and 283, 11 figs. Why so little progress has been made in developing railroad equipment operated by gasoline engines and what the field is for this class of equipment.

RAILWAY OPERATION

Freight Rates. Board of Railway Commissioners' Judgment and Order Reducing Freight Rates, etc. Can. Ry. & Mar. World, no. 294, Aug. 1922, pp. 395-400. Decision of Can. Board of Ry. Commissioners reducing freight rates.

Reclamation, Decentralized. De-Centralized Reclamation on the C. M. & St. P. Railway. Ry. Rev., vol. 71, no. 5, July 29, 1922, pp. 131-137, 8 figs. Policy of road to localize reclamation work wherever possible appears to possess certain advantages both from standpoint of reduced length of haul and wider coöperation enlisted. Account of organization of work and reclamation activities on road during past year.

Safety. "Safety in Railway Operation," J. W. Pringle. Inst. of Transport Jl., vol. 3, no. 5, July 1922, pp. 436-443 and (discussion) 443-450. Gives outline of fundamental principles governing safe conduct of traffic in respect of methods of operation, equipment, etc., and shows how accidents originate, with reference mainly to conditions and practice prevailing in England.

Suburban Passenger Service. The Operation of Heavy Suburban Passenger Services on a Steam Railway With Particular Reference to Density of Service, Terminal and Other Facilities, F. V. Russell. Inst. of Transport Jl., vol. 3, no. 5, July 1922, pp. 451-475, 7 figs.

Time Tables. The Planning of Time Tables (Zur Lehre vom Fahrplan), J. Jahn. Glasers Annalen, vol. 91, no. 2, July 15, 1922, pp. 19-26, 10 figs. Formulas are developed for calculation of time tables based on ratios between varying speed of train and length of line.

Train Control. The Report of the Automatic Train Control Committee. Ry. Gaz., vol. 37, no. 7, Aug. 18, 1922, pp. 228-230. Conditions to be satisfied; essential requisites; anticipated cost and summary of recommendations.

Official Report on Train Control for British Railways. Ry. Rev., vol. 71, nos. 4 and 5, July 22 and 29, 1922, pp. 113-117 and 140-141. Report of Automatic Train Control Committee advising introduction of control at least at selected points.

Report of Automatic Train Control Committee. Ry. Engr., vol. 43, no. 510, July 1922, pp. 265-267. Committee recommends gradual adoption of automatic control, introduction of train-stops at stop-signals and warning-control at distant signals, and the formation of a committee of experts.

Wages and Working Conditions. Railway Wages and Working Conditions in Canada and the United States. Can. Ry. & Mar. World, no. 294, Aug. 1922, pp. 401-404. Comparison of situation in Canada and United States.

RAILWAY SHOPS

Electric Heat in. Use of Electric Heat in the Railway Shop, E. F. Collins. Ry. Rev., vol. 71, no. 3, July 15, 1922, pp. 69-72, 6 figs. Economy and wide range of usefulness for electric heating in railway shops not generally appreciated. Paper read before Assn. of Ry. Elec. Engrs.

Transfer Tables. Transfer Tables for Railway Shops (Schiebebühnen für Eisenbahnwerkstätten), H. Benedict. Fördertechnik u. Frachtverkehr, vol. 15, no. 16, Aug. 4, 1922, pp. 216-217, 4 figs. Discusses different types for locomotive works and railway shops; sunk and surface types.

RAILWAY SIGNALING

Automatic. The Re-Signaling of the Mersey Railway. Engineer, vol. 134, no. 3471, July 7, 1922, pp. 16-18, 11 figs. Scheme carried out for automatic signaling between Liverpool, Central and Hamilton-Square stations, effect of which would allow number of block signals sections between stations named to be increased from two to four.

Power-Operated Facing Points. Long Distance Operation of Facing Points on Railways. Engineer, vol. 133, no. 3461, May 19, 1922, pp. 560-561, 5 figs. Describes power-operated facing points at Ashington Colliery.

St. Louis. Report on Improvement of Railroad Terminals in St. Louis. Ry. Rev., vol. 71, nos. 1 and 2, July 1 and 8, 1922, pp. 1-9 and 37-49, 17 figs. Engineers' Committee report to St. Louis Chamber of Commerce. July 1: Unification; bridges; rerouting East-Side passenger trains; improvements in Mill Creek Valley. July 8: Freight terminals and freight movements; time study; handling freight cars; proposed operation through outer group yards. See also Ry. Age, vol. 73, no. 2, July 8, 1922, pp. 63-68, 4 figs.

RAILWAY TIES

Creosoting Plant. A Sleeper Creosoting Plant. Engineer, vol. 133, no. 3463, May 12, 1922, p. 534, 4 figs. partly on p. 526. Describes creosoting plant built for Kenya, East Africa, comprising two large receptacles, of which lower one is working cylinder, together with necessary pumps and boiler. Capacity is 900 meter-gage sleepers per day of 8 hr.

Treated, Tests Results. Treated Tie Records on the C. B. & Q. R. R. Ry. Rev., vol. 71, no. 9, Aug. 26, 1922, pp. 272-274, 1 fig. Results of 12 years of tests, which show that ties treated with creosote are in best condition after 12 years' service and ties treated with mixture of zinc chloride and creosote are giving better service than those treated with zinc chloride alone.

RAILWAY TRACK

Track Bolts, Impact Loads on. Determining the Impact Loads on Track Bolts. Ry. Age, vol. 73, no. 7, Aug. 12, 1922, pp. 277-278, 4 figs. Tests performed on Philadelphia & Reading to evaluate and compare induced stresses.

RAILWAY YARDS

Moncton, Can. Improvements to Moncton Yard and Engine Facilities, S. B. Wass. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 9, Sept. 1922, pp. 445-450, 2 figs. Construction methods employed to minimize interference with traffic.

RAILWAYS

British Malaya. Railways in British Malaya. Engineer, vol. 134, no. 3475, Aug. 4, 1922, pp. 114-116, 12 figs. partly on p. 118. Review of development.

Eastern Africa. Recent Railway Developments in Eastern Africa. Eng. News-Rec., vol. 89, no. 10, Sept. 7, 1922, pp. 400-401, 3 figs. Nile and lakes, linked with east coast. Labor gangs of 1000 natives on 200 mi. line. Zambesi railway opened.

Foreign Practice. Foreign Railway Practice, J. Carlier. Inst. of Transport Jl., vol. 3, no. 5, July 1922, pp. 426-433 and (discussion) 433-436, 1 fig. Remarks on electric traction, notes on some new forms of locomotives including Heilmann, Ramsay, Zoelly, Societe Cockerill, Pieper, Strang, Sulzer Freres, etc., actual traction tendency.

REFRACTORIES

Fireclays. Manufacture on Fireclay Refractories, Alan G. Wikoff. Chem. & Met. Eng., vol. 27, no. 10, Sept. 6, 1922, pp. 505-509, 7 figs. Outline of plant operations at Evens & Howard Fire Brick Co., St. Louis, forming brick and special shapes, drying, burning.

Glass. A Critical Review of the Provisional Specifications for Glass Refractory Materials, W. J. Rees. Soc. of Glass Technology Jl., vol. 6, no. 22, Aug. 1922, pp. 181-193 and (discussion) pp. 193-201, 2 figs. Discusses specifications for silica bricks and cement, tank blocks, and pot clays.

Monolithic Furnace Lining. Refractory as a Factor of Furnace Life, I. S. Pieters. Power House, vol. 15, no. 15, Aug. 5, 1922, pp. 30-31. Modern tendencies said to be toward monolithic type of lining.

Thermal Conductivity. Report of Committee C-8 on Refractories. Am. Soc. for Testing Matls. advance paper for meeting June 26-30, 1922, 14 pp. Status of thermal conductivity in specifications for refractories.

REFRIGERATION

Compressors. Refrigeration for the Power Plant Engineer, T. H. Fenner. Power House, vol. 15, nos. 10, 11 and 12, May 20, June 5 and 20, 1922, pp. 19-22, 28-29, 31-32 and 31, 12 figs. May 20: Single and double-acting compressor, water jacketing, wet compression and oil sealing, oil separators, condensers and liquid receivers are described. June 5: Expansion valve and its function. June 20: Absorption process; aqua ammonia; parts and operating features of machine.

Two Suction Pressures. Refrigeration with Two Suction Pressures, H. J. Macintire. Power, vol. 56, no. 8, Aug. 22, pp. 279-281, 5 figs. Author attempts to show where there will be an advantage in compressing gas using two suction pressures in same cylinder.

REFRIGERATING MACHINES

CO_2 Compressor. The Carbonic Compressor, H. J. Macintire. Refrig. World, vol. 57, no. 7, July 1922, pp. 16-18, 3 figs. Advantages and disadvantages of CO_2 machines considered with diagram showing horsepower per ton of refrigeration for ammonia and carbon dioxide.

REFRIGERATING PLANTS

Ammonia Leaks, Locating. Locating Ammonia Leaks in Refrigerating Plants, A. J. Dixon. Southern Engr., vol. 38, no. 1, Sept. 1922, pp. 72-73, 1 fig. Practical pointers regarding simple methods of detecting ammonia leaks in piping, coils and condensers.

Precooler. Lettuce and Celery Pre-cooling Plant, Southern Engr., vol. 38, no. 1, Sept. 1922, pp. 60-63, 4 figs. Describes new system of precooling which reduces time of cooling before loading into refrigerator cars and also eliminates all re-icing of cars in transit.

RIVETING

Efficiency. Experiments to Determine the Changes Taking Place in Sheet Metal During Riveting (Versuche zur Ermittlung der in den Blechen beim Nieten bewirkten Formänderungen), R. Baumann. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 252, 1922, 66 pp., 132 figs. Effects of high pressure in riveting; cold, warm and hot riveting; deformations due to pressure of rivet head. Advises not to apply unnecessarily high pressure in riveting.

ROLLING MILLS

Electrically Driven. New Development in Rolling Mill Drive, A. K. Bushman. Blast Furnace & Steel Plant, vol. 10, no. 9, Sept. 1922, pp. 467-469, 3 figs. Describes new electric drive for hot strip mill of Trumbull Steel Co. at Warren, Ohio.

Plate Mills, Motor Drive for. Special Drive Designed for Plate Mill, F. D. Egan. Blast Furnace & Steel Plant, vol. 10, no. 9, Sept. 1922, pp. 461-463, 3 figs. Describes main motor drive for new 100-in. 3-high plate mill for Nat. Stamping & Enameling Co., rated 3,000 hp., 40 deg. cent., 2,200 volt, 3 phase, 60 cycle, 236 r.p.m.

Sheffield, England. The Hecla and East Hecla Works of Hadfields, Ltd., Sheffield, England. Iron & Coal Trades Rev., vol. 105, no. 2811, Aug. 11, 1922, pp. 179-182, 10 figs. partly on pp. 193-196. Details of steel foundry works including steel-making facilities, new rolling-mill shop and 28-in. mill; powerful boom-shearing plant, gas-producing plant and hydraulic water service. See also Engineer, vol. 134, no. 3476, Aug. 11, 1922, pp. 134-137, 14 figs. partly on supp. plate.

Sheet Mills. Boscarelli System of Sheet Rolling. Iron & Coal Trades Rev., vol. 105, no. 2812, Aug. 18, 1922, pp. 220-221, 10 figs. partly on p. 222. Advantages claimed are (1) saving in labor and fuel; (2) thickness of sheets more uniform, and thinner sheets can be rolled; and (3) increased production.

RUST PREVENTION

Parker Process. Parkerizing—A Rustproofing Process, L. C. Morrow. Am. Mach., vol. 57, no. 10, Sept.

7, 1922, pp. 361–364, 6 figs. Describes process and application. Kinds of parts treated. Apparatus and equipment required.

S

SCREW MACHINES

Automatic. Automatic Production of Parts, C. A. Handschin. West. Machy. World, vol. 13, no. 8, Aug. 1922, pp. 279–282, 4 figs. Notes on use of modern screw machines and design of cams for automatic duplication of special forms.

Economical Production on Automatics. Eng. Production, vol. 5, no. 99, Aug. 21, 1922, pp. 172–176, 22 figs. Principles underlying efficient tooling and caming of automatic screw machines. Examples of automatic production illustrating uses of standard Brown & Sharpe tools.

SCREW THREADS

Measurement. Work at the National Physical Laboratory—II. Machy. (Lond.), vol. 20, no. 514, Aug. 3, 1922, pp. 558–561, 7 figs. Internal effective diameter measurement of screw threads.

SCREWS

Standard. Report of the German Industry Committee on Standards (Normenausschuss der Deutschen Industrie). Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 473–492, 27 figs. Includes list of newly published and newly accepted standard sheets. Proposals for rivets, Whitworth and metric fine thread. Proposed tentative standards for screw holes and heads; testing workshop material. Alterations in standard sheets for hexagonal and cylindrical screws.

SEMI-STEEL

French Opinion of. A French Opinion of Semi-Steel. Foundry Trade Jl., vol. 26, no. 313, Aug. 17, 1922, pp. 128–129, 2 figs. Communication by E. Ronceray on J. Cameron's paper on semi-steel.

Metallurgy. The Metallurgy of Semi-Steel, David McLain. Foundry Trade Jl., vol. 26, no. 312, Aug. 10, 1922, pp. 110–114, 8 figs. Discusses potentialities, merits and development.

Production and Applicability. Melting Steel and Cast Iron together in the Cupola, J. Hogg. Foundry Trade Jl., vol. 26, no. 314, Aug. 24, 1922, pp. 160–162. Practical details based on author's experiences; applicability of semi-steel.

SHAFTS

Rotating. The Stability of Rotating Shafts (Zur Frage der Stabilität rotierender Wellen), Theodor Pöschl. Schweizerische Bauzeitung, vol. 80, no. 3, July 15, 1922, pp. 23–25, 2 figs. Simplification of the Lagrange equations. Investigation of flywheel excentrically keyed on to a thin shaft.

SPARK PLUGS

Knocking, Suppression of. Multiple Sparkplugs and the Suppression of Knocking, C. A. Norman. Automotive Industries, vol. 47, no. 7, Aug. 17, 1922, pp. 316–318, 3 figs. Experimental evidence intended to show how location of sparkplug and timing of spark affect tendency of engine to knock.

SPRINGS

Elliptic, Calculation of. The Calculation of Elliptic Springs, W. H. Armstrong. Ry. Mech. Engr., vol. 96, no. 8, Aug. 1922, pp. 438–440. Formulas and tables for rapid determination of capacity and deflexion.

Leaf. Modern Methods of Making Leaf Springs, E. F. Lake. Iron Age, vol. 109, nos. 19 and 20, May 11 and 18, 1922, pp. 1269–1274 and 1343–1346, 12 figs. May 11: Continuous process for automobile springs; preparing plates; automatic hardening; forming and quenching machines. May 18: Tempering furnaces; assembling, testing and inspecting.

STEAM

Flow in Pipes. Capacities of Steam Heating Mains as Affected by Critical Velocities of Steam and Condensate Mixtures, F. C. Houghten and L. Ebin. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 6, Sept. 1922, pp. 643–648 and (discussion), pp. 649–654, 4 figs. Report of coöperative work of this Society and U. S. Bur. of Mines Experiment Station, Pittsburgh.

The Critical Velocity of Steam in One-Pipe Systems, F. E. Giesecke. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 6, Sept. 1922, pp. 637–642, 5 figs. The term, one-pipe system, is used to designate steam-heating system in which steam flows in one direction and condensate in opposite direction through same pipe at same time. (Discussion), pp. 649–654.

Pressure-Reducing Valve. A Unique Reducing Valve, C. C. Brown. Power Plant Eng., vol. 26, no. 18, Sept. 15, 1922, pp. 912–913, 4 figs. Describes chronometer valve, a specially designed arrangement for reducing steam pressure, used successfully in large sugar refinery plant.

Properties at High Pressure. Properties of Steam at High Pressures, G. Eichelberg. Mech. Eng., vol. 44, no. 7, July 1922, pp. 447–449, 6 figs. Investigation into values of heat of vaporization of steam. Author attempts to establish relation between exponents in adiabatic equation, heat of vaporization, and specific heats of steam, and measure indirectly specific heats of saturated steam by using this relation. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 12, Mar. 25, 1922, pp. 275–277.

Raising, Electric. Steam Raising by Electricity. Elec. Rev., vol. 91, no. 2331, July 28, 1922, pp. 140–141, 2 figs. Economic and some mechanical features including description of 18,000-kw. 3-unit electric steam generator.

STEAM ACCUMULATORS

Electric Hot-Water and. Electric Heat-Storage Plants (Elektrische Warmespeicheranlagen). Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 33–34, Aug. 26, 1922, pp. 793–796, 8 figs. Description of plants for storage of heat in form of hot water or steam. Calculation and economy of such accumulators. Information from Sulzer Bros., Winterthur, Switzerland.

Osmotic. From Honigmann's Soda Locomotive to Osmotic Storage of Energy (Von Honigmanns Natronlokomotive zum osmotischen Energiespeicher), K. Schreber. Wärme, vol. 45, no. 29, July 28, 1922, pp. 353–355. Comparison of described osmotic accumulator with a Ruth steam accumulator demonstrates economy of former. Osmotic accumulator for a textile mill.

See also LOCOMOTIVES, Fireless.

STEAM ENGINES

Exhaust Energy, Use of. Using Exhaust Energy in Reciprocating Engines, J. Stumpf and C. C. Trump. Mech. Eng., vol. 44, no. 6, June 1922, pp. 369–372, 15 figs. Theoretical problems are discussed and practical applications to either single-cylinder or multi-cylinder engines are suggested.

Heat Transformers. A New and a Long Life to the Steam Engine, Wm. P. Durtnall. Petroleum Times, vol. 7, no. 180, June 17, 1922, p. 857. Describes paragon heat-transformer which converts small volume of gases at 3,500 deg. to a larger volume in form of perhaps 200-lb. steam at temperature of 720 deg. Fahr. without use of ordinary boilers.

Pass-Out. Atlas One Cylinder Pass-Out Engine. Power House, vol. 15, no. 13, July 5, 1922, pp. 26–28, 9 figs. Engine developed for working economically in plants where large heating demand exists in comparison with power requirements, by Atlas Co., Copenhagen. See also Engineer, vol. 133, no. 3466, June 2, 1922, pp. 604–606, 10 figs.

Triple-Expansion, Compounding. The Compounding of a Triple Expansion Engine. Engineering, vol. 114, no. 2955, Aug. 18, 1922, pp. 203–206, 11 figs. Details of conversion work carried out on triple-expansion vertical Corliss engine.

Uniflow. Uniflow Steam Engines. Times Trade & Eng. Supp., vol. 10, no. 215, Aug. 19, 1922, p. 467, 1 fig. Application to railway locomotives.

The Efficiency of Unaflow Engines, A. D. Skinner Power, vol. 56, no. 9, Aug. 29, 1922, pp. 327–329, 1 fig. Points of engine design that determine results to be obtained from unaflow engines.

Valve Leakage. Experiments on Steam Engine Valve Leakage, J. E. Bycroft. Engineer, vol. 134, no. 3473, July 21, 1922, pp. 62–63, 5 figs. Results of experiments carried out by author in investigating leakage of steam past a piston drop valve 9-in. diam., designed to supply steam to central exhaust or uniflow engine.

STEAM PIPING

Testing Coverings. Efficiency of Steam-Pipe Coverings at High Temperatures. Engineering, vol. 114, no. 2953, Aug. 4, 1922, p. 155, 2 figs. Describes apparatus for determining efficiency of steam-pipe coverings designed by C. Jakeman of Nat. Physical Laboratory and constructed there.

STEAM POWER PLANTS

Condensate Disposal. Disposal of Condensate in Power Plants, Charles L. Hubbard. Nat. Engr., vol. 26, no. 9, Sept. 1922, pp. 398–402, 12 figs. Determination of method to be used; examples in use for varied services; operating details.

STEAM TURBINES

Belliss and Morcom. The Belliss and Morcom Steam Turbine. Engineering, vol. 113, nos. 2947 and 2948, June 23 and 30, 1922, pp. 773–776 and 803–805, 36 figs. partly on supp. plate. Review of reciprocating engines and turbines manufactured by this company. Producing turbines from 10 kw. to 10,000 kw. Destructive factors.

Blades, Machining. Machining Turbine Blades. Machy. (Lond.), vol. 20, no. 514, Aug. 3, 1922, pp. 537–543 and 547. Machines and methods employed in works of Wm. Beardmore & Co., Ltd., Dalmuir.

Calculation. The Graphic Calculation of Steam Turbines (Beitrag zur Berechnung der Dampfturbinen auf zeichnerischer Grundlage), Erich Henne. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 260, 1922, 58 pp., 22 figs. partly on supp. plate. Methods are derived for graphic calculation of reaction and impulse turbines.

High Pressure and Superheat. Possibilities of High Pressure and Superheat for Steam Turbines, J. A. Polson. Power Plant Eng., vol. 26, no. 18, Sept. 15, 1922, pp. 893–896, 3 figs. Theoretical discussion of problems from standpoints of constant heat content, constant temperature, and constant pressure.

Operation. Steam Turbine Operation, L. W. Heller. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 673–699, 14 figs. Discusses methods used by the Duquanw Light Co., Pittsburgh, in operation of steam-generating equipment on their system.

Trip Valves and Emergency Governors. Steam-Turbine Emergency Governors and Trip Valves, A. D. Palmer. Power, vol. 56, no. 9, Aug. 29, 1922, pp. 324–326, 8 figs. Different types are described.

STEEL

Alloy. See ALLOY STEELS.

Carbon. Treatment of Carbon Steels, Dean Harvey. Am. Mach., vol. 57, no. 10, Sept. 7, 1922, pp. 378–379. What various chemical compositions and treatments in steel making produce. Properties and uses of some steels. Methods of working.

Chromium. See CHROMIUM STEEL.

Cold-Drawn. Advantages and Limitations of Cold Drawn Steel in Automotive Work, Walter Rosenhain. Automotive Industries, vol. 47, no. 10, Sept. 7, 1922, pp. 469–472, 8 figs. Cold drawn work produces excellent finish and operations are simple and foolproof. Necessity for high ductility limits such work to softer grades of material. Notes on soft metals, effects on microstructure, bending, annealing, and alloy steels.

Gases in. Amount of Gases in Steel. Iron Age, vol. 110, no. 9, Aug. 31, 1922, p. 534. Results of some new German methods of analysis on basic Bessemer metal. Translated from article by Oberhoffer and Piwowarsky in Stahl u. Eisen, May 25, 1922.

High-Speed. See STEEL, HIGH-SPEED.

Nickel-Chrome. See NICKEL-CHROME STEEL.

Rate of Loading, Effect of. Effect of Rate of Loading on Tensile Properties of Boiler Plate, H. J. French. Chem. & Met. Eng., vol. 27, no. 7, Aug. 16, 1922, pp. 309–310. Effect of decrease in rate of loading on steel is different above and below blue heat, but little variation in tensile properties was observed when tests were performed 30 times as fast as ordinarily.

Rustless. Rustless Steels (Rostfreie Stähle), Karl Daevew. Stahl u. Eisen, vol. 42, no. 34, Aug. 24, 1922, pp. 1315–1320, 5 figs. Notes on composition, properties, method of treatment and uses.

Semi-Steel. See SEMI-STEEL.

Stainless. Stainless Steel at High Temperatures, H. J. French. Iron Age, vol. 110, no. 7, Aug. 17, 1922, pp. 404–405, 3 figs. Heat treatment which produces greatest strength for use in valves of internal-combustion engines. Published by permission of Bur. of Standards.

Tests. Tests with Mild Steel (Versuche mit Weicheisen), Richard Baumann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 35, Sept. 2, 1922, pp. 825–826, 8 figs. Tensile and notched-bar tests at higher temperature (notched-bar tests also at low temperature) demonstrate that metal which is unusually soft or tough at usual temperature shows same behavior as ordinary mild steel at high and low temperatures. At temperatures above 200 deg. cent. a high degree of elongation takes place.

Thermal Expansion. Thermal Expansion of a Few Steels, Wilmer Souder and Peter Hidnert. U. S. Bur. of Standards Sci. Papers, vol. 17, no. 433, Apr. 10, 1922, pp. 611–626, 22 figs. Data are given on 28 specimens of iron and steel. Review of previous work on expansion.

STEEL CASTINGS

Specifications. The Trend of Specifications for Steel Castings, E. R. Young. Blast Furnace & Steel Plant, vol. 10, no. 9, Sept. 1922, pp. 463–466. General discussion covering important features such as chemical composition, physical properties, ductility and testing.

Tensile Properties. Tensile Properties of Steel Castings, Lawford, H. Fry. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 23 pp., 8 figs. Study of grades currently used for railroad service.

STEEL, HEAT TREATMENT OF

Annealing. Annealing, Tempering and Reheating (Recuit, Trempe et Revenu), Sigma. Métallurgie, vol. 54, nos. 27 and 28, July 6 and 13, 1922, pp. 992–994 and 1029–1030. Discusses operations in detail and their effect on steel.

STEEL, HIGH-SPEED

Heat Treatment. Shrinkage and Expansion of High-Speed Steel Due to Heat-Treatment, Marcus A. Grossmann. Chem. & Met. Eng., vol. 27, no. 11, Sept. 13, 1922, pp. 541–544, 2 figs. Describes tests undertaken to obtain data on amount which should be allowed for shrinkage or expansion. Results throw sidelight on nature of reactions taking place during heat treating.

STEEL MANUFACTURE

Bessemer Converter Plants. Modern Developments in Small Bessemer Converter Plants in Germany, Hubert Hermann. Eng. Progress, vol. 3, no. 8, Aug. 1922, pp. 173–176, 8 figs. Action of small converters; working arrangement; construction types; metallurgical process.

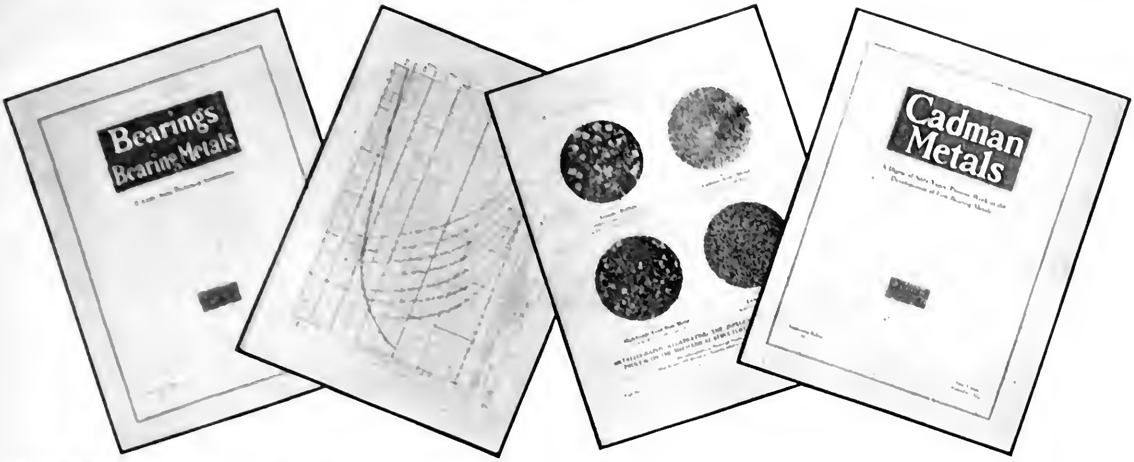
Bessemer Process. Use of Bessemer Process for Small Charges and Recent Experiences in a German Duplex Plant (Die Anwendung der Kleinbessemerei, namentlich in Duplexanordnung, und neuere Betriebserfahrungen in einer deutschen Duplexanlage), Hubert Hermanns, Giesserei-Zeitung, vol. 19, nos. 28 and 29, July 18 and 25, 1922, pp. 407–412 and 419–423 and (discussion), pp. 423–426, 16 figs. History of Development.

Direct Process. The Production of Iron and Steel Direct from the Ore, Ralph Whitfield. Iron & Coal Trades Rev., vol. 105, no. 2838, July 21, 1922, p. 81, 2 figs. Notes on the Hasset and Bourcoud processes.

Without Pig Iron. Making Steel Without Using Pig Iron, Edwin F. Cone. Iron Age, vol. 110, no. 10, Sept. 7, 1922, pp. 585–586. "Scrap and Carbon" basic open-hearth process as employed at an Eastern plate mill; residual manganese an essential feature.

STEEL WORKS

British. The Devonshire Works of the Staveley Coal and Iron Company, Limited. Iron & Coal Trades Rev., vol. 105, no. 2843, Aug. 25, 1922, pp. 249–253, 15 figs. on pp. 263–270. Description



The Babbitt with a Reason Why

Cadman Metals, BEARITE and ACORN, for definite scientific reasons, are guaranteed to double the life of the bearings for which they are respectively recommended. They are the culmination of sixty years unique practical and metallurgical bearing service to the principal industries of America.

Every pound of Cadman Metal for sixty years has carried an unqualified money back guarantee.

Will you let us send you any desired quantity of either metal, or both, on ninety days free trial? If at the end of this time Cadman Metals have not proven their great superiority and more than fulfilled our claims our invoice may be destroyed. If this proposition does not appeal to you, make your own.

The technical press is unanimous in its praises of Engineering Bulletins M-1 and M-2. They contain the reasons mentioned above. Have you received your copies?

(Clip the coupon or simply enclose your card in an envelope)

A.W. Cadman Manufacturing Co.
Pittsburgh Pa.

Master Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletins M-1 and M-2, samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:.. Position:.......................

Company Name:..

Address:..

of blast-furnace plant, coke-oven and by-product plant, and chemical works.

The Park Gate Ironworks Engineer, vol. 134, no. 3479, Sept. 1, 1922, pp. 216–217, 6 figs. partly on p. 220 and supp. plate. Describes large plant near Rotherham, England, Details of blast-furnace, open-hearth and rolling-mill plants, and power house.

Electrification. A Review of Steel Mill Electrification, B. G. Lamme and W. Sykes. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 545–566. Review of development.

German. German Development of the Iron Industry in Lorraine and Luxemburg Up to 1918 (Stand des deutschen Ausbaues der lothringischen und luxemburgischen Eisenindustrie bis zum Jahre 1918), Hubert Hoff. Stahl u. Eisen, vol. 42, nos. 27 and 28, July 6 and 13, 1922, pp. 1041–1050 and 1089–1097, 24 figs. Describes steel works and rolling mills of United Iron Works Burbach-Eich-Dubelingen at Esch

Heat Balances. Heat Balances of Blast Furnace and Steel Plants, W. Trinks. Blast Furnace & Steel Plant, vol. 10, no. 9, Sept. 1922, pp. 451–456, 4 figs. Gives charts showing heat balance for uneconomical, average, economical, and ideally operated steel plants.

STOKERS

Bituminous-Coal-Burning. Burning Bituminous Coal on Stokers Mech. Eng., vol. 44, no. 6, June 1922, pp. 373–374 and 381. Three papers, by G. E. Wood, O. J. Richmond, and R. A. Sanders, on stoker operation with soft coal, presented before Joint Fuel Conference of New Haven branch of A.S.M.E. New Haven Chamber of Commerce, and other engineering societies.

Costs and Efficiency. The Stoker from an Operating Viewpoint, Robert E. Dillon. Combustion, vol. 7, no. 3, Sept. 1922, pp. 155–157. Consideration of reliability, maintenance, efficiency, cost of operation, and first cost. (Abstract.) Paper presented at Stoker Mfrs. Assn.

Forced-Draft. The Burning of Ash- and Water-Rich Fuels on Forced-Draft Stokers (Die Verheizung stark asche- und wasserhaltiger Brennstoffe auf Unterwind-Vorschubrosten), H. Pradel. Wärme, vol. 45, no. 26, June 30, 1922, pp. 319–322. Results of series of evaporation tests and practical experiences with Pluto stokers show to what extent the ash and water content of fuel effects economy of its use on such stokers.

Pit-Refuse Utilization. Utilization of Pit Refuse for Raising Steam. Iron & Coal Trades Rev., vol. 105, no. 2839, July 28, 1922, pp. 120–121, 1 fig. Description of Bennis stokers for utilization of pit refuse in use at Gordon House Colliery, Durham, England. Results of tests.

Shovel. Shovel Stokers and Forced-Draft Horizontal Grates (Wurfbeschicker und Unterwindplanrost), H. Pradel. Wärme- u. Kalte-Technik, vol. 24, no. 15, Aug. 1, 1922, pp. 173–175, 6 figs. Describes new arrangement introduced by Adler & Hentzen, Coswig, Germany, for high-capacity boilers.

Underfeed, for Low-Grade Fuel. Burning a Low Grade of Fuel on Underfeed Stokers. Power, vol. 56, no 7, Aug. 15, 1922, pp. 247–251, 8 figs. Description of plant in Minneapolis installed under 5,600-sq. ft. boilers. Tuyeres used to prevent clinker formation and steam jets to mix furnace gases.

STREET RAILWAYS

Cars, Double-End Turnstile. Double-End Turnstile Car Tried in New York. Elec. Ry. Jl., vol. 60, no. 8, Aug. 19, 1922, pp. 259–261, 5 figs. Third Ave. railway has remodeled one of its semi-convertible pay-as-you-enter cars and installed turnstiles and other automatic equipment to permit of one-man operation.

Two-Car Train. Two-Car Train Weighs 490 Lb. per Seat. Elec. Ry. Jl., vol 60, no. 10, Sept. 2, 1922, pp. 317–319, 10 figs. Experimental two-car unit, built by Twin City Rapid Transit Co., weighs 51,500 lb. and seats 105 passengers; has low-floor, inside-journal bearings, trucks equipped with band brakes and front car heated with resistors.

T

TAPERS

Standard. Standard Tapers, Luther D. Burlingame. Am. Mach., vol 57, no. 4, July 27, 1922, pp. 130–133, 3 figs. Statement of case for existing standards; suitability of tapers for specific jobs; objections to Jarno taper

TERMINALS, MARINE

River. River Terminals and Water Depths, H. McL. Harding. Port & Terminal, vol. 2, no. 6, July 1922, pp. 9–10 and 24–25, 3 figs. Points out that proper design of inland river barges is important to effective development.

TERMINALS, RAILWAY

Design. Factors Governing the Design of Passenger Terminals, A. S. Baldwin. Ry. Age, vol. 73, no. 10, Sept. 2, 1922, pp. 429–435, 1 fig. Analysis of operating conditions which influence plans for large station. Abstracted from report before Int. Ry. Congress in Rome.

TESTS AND TESTING

Brinell Ball Indentation. Some Measurements of the Shape of Brinell Ball Indentation, Fred E. Foss and R. C. Brumfield. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 24 pp., 13 figs. Description of methods used in investigation, analysis of results obtained and conclusions arrived at.

Methods and Machines. Report of Committee E-1 on Methods of Testing. Am. Soc. for Testing Matls. advance paper meeting June 26–30, 1922, 27 pp., 5 figs. Suggested definitions relating to methods of testing and for verification of testing machines.

TEXTILE INDUSTRY

Weaving Machinery. Weaving Machinery, L. B. Jenckes. Mech. Eng., vol. 44, no. 6, June 1922, pp. 375–381, 11 figs. Weaving styles and kinds of fabrics produced. Details of methods employed. Functions of special machine devices. Different types of looms. (Abstract.)

TEXTILE MILLS

Power Supply. Problems and Economics of the Textile Power Plant, Leo Loeb. Engrs. & Eng., vol. 39, no. 7, July 1922, pp. 260–265 and (discussion) 266–272, 14 figs. Methods of approach and analysis of problem of whether return on investment in betterments of mill power system will be comparable to return in dollars and cents on same amount of capital invested in extending manufacturing facilities. Applicability of purchased power from local public utility system.

THERMIT WELDING

Rails. Development of Thermit Welding (Entwicklungsgeschichte der Thermit-Schienenschweissung und ihre Lehren). Autogene Metallbearbeitung, vol. 15, nos. 12, 13 and 14, June 15, July 1 and 15, 1922, pp. 161–166, 184–188 and 195–197, 12 figs. Method of welding rails end to end by surrounding joints with liquid thermit mass supplying necessary heat. Apparatus, clamps, ratchets, etc., used.

THERMOMETERS

Specifications. Report of Committee D-15 on Thermometers. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 12 pp. Summary of existing specifications, and proposed tentative specifications for A.S.T.M. partial-immersion thermometers.

Transmitting. The "N and Z" Transmitting Thermometer. Gas Jl., vol. 159, no. 3087, July 12, 1922, p. 94, 4 figs. Description of thermometer patented by Negretti and Zambra having capillary tube made of high-expansion material.

TIRES, RUBBER

Drum-Built. Drum Built Tires. India Rubber World, vol. 66, no. 6, Sept. 1, 1922, pp. 799–800, 6 figs. New tire-building process.

Power Losses in. Power Losses in Automobile Tires, W. L. Holt and P. L. Wormeley. U. S. Bur. of Standards Technologic Papers, vol. 16, no. 213, May 20, 1922, pp. 451–461, 8 figs. Relates to power loss or energy dissipated as heat in automobile tires when operated under different conditions of axle load, inflation pressure, speed, and tractive effort.

V

VALVES

Cams and, Behavior of. Cams and Poppet Valves, S. E. Scholes. Gas & Oil Power, vol. 17, no. 203, Aug. 3, 1922, p. 181, 2 figs. Notes on autographic apparatus designed by author for demonstrating valve operation. From paper read before Instn. Automobile Engrs.

VENTILATION

Factory. Modern Factory Ventilation. Eng. Production, vol. 5, no. 100, Aug. 31, 1922, pp. 199–201, 15 figs. Describes plant developed by Ozonair, Ltd., Lond., principal feature of which is impregnation with ozone of all air circulated, also some typical installations.

The Elements of Ventilation in Industrial Works Frank E. Gooding. Indus. Engr., vol. 80, No. 8, Aug. 1922, pp. 369–377 and 410, 25 figs. Conditions that should be studied when processes are added or changes made.

Katathermometer. Recent Progress of English Investigators in Determining the Relation of Atmospheric Conditions to Fatigue. Heat. & Vent. Mag., vol 19, no 8, Aug 1922, pp. 31–35, 3 figs. What the katathermometer has done in furnishing data for relief of workers in oppressive atmospheres.

VISCOSIMETERS

Redwood. The Redwood Viscometer, Winslow H. Herschel. U. S. Bur. of Standards Technologic Papers, no. 210, Apr 10, 1922, pp. 227–246, 8 figs. Investigation of two common errors in viscosimetry with following conclusions: that error due to inaccuracy in Meissner formula for average head is negligible in ordinary work, that error due to cooling of oil after leaving outlet tube may be neglected at low temperatures but should be corrected at temperatures near boiling point of water.

W

WAGES

Systems. Wages, Harrington Emerson. Chem. & Met. Eng., vol. 27, no 9, Aug. 30, 1922, pp. 400–403. Essentials of good wage system; how wages should be measured; how these theories work out in practice illustrated by results obtained in Ford industries.

WASTE HEAT

Utilization. The Utilization of Waste Heat. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 513–518, 4 figs. Three papers presented before Lehigh Valley Section of A.S.M.E.: Waste-Heat Boilers, H. B. Smith; Utilization of Waste Heat in the Steel Industry, A. T. Lewis; Utilization of Waste Heat from Rotary Cement Kilns, Joseph Brobston. (Abridgment.)

Utilization of Exhaust Gas (Abgasverwertung), P. Morgenstern. Warme, vol. 45, no. 28, July 21, 1922, pp. 343–347, 2 figs. Notes on heat transmission and influence of temperature on losses; utilization of waste heat; waste-heat plants in gas works; water-preheating arrangements of different types; saving effected by feedwater heating.

WATER POWER

Paper Industry. Relation of Water Power to the Pulp and Paper Industry in Canada, J. B. Challies and I. J. Johnston. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 6, Aug. 1922, pp. 1403–1407, 1 fig. Importance of industry in Canada; total power installation; electric drive; motive power by Provinces; future power requirements.

WELDING

Cutting and. Welding and Cutting, F. Horner. Eng. Production, vol. 4, nos. 85, 86, 87, 88, 89, 90 and 91, May 18, 25, June 1, 8, 15, 22 and 29, 1922, pp. 469–473, 487–489, 517–520, 535–538, 565–568, 581–586 and 607–610, and vol. 5, nos. 92, 93, 94, 95, 96 and 97, July 6, 13, 20, 27, Aug. 3 and 10, 1922, pp. 13–17, 37–41, 55–58, 76–82, 112–118 and 133–137, 168 figs. Review of modern methods and appliances.

Electric and Autogenous. Electric and Autogenous Welding with Regard to Covered Weld Wires (Elektrische und Schmelzflammen-Schweissung unter Berücksichtigung von Schweissdrähten mit Umhullung), C. Diegel. Stahl u. Eisen, vol. 42, no. 34, Aug. 24, 1922, pp. 1309–1315, 13 figs. Comparative welding tests showed autogenous welded seams to be stronger then electric. A covering suitable for electrically welded wire was not suitable for autogenous welding.

Forge Welding, Steel for. Steel for Forge Welding, Frank N. Speller. Mech. Eng., vol. 44, no. 7, July 1922, pp. 443–444. Discusses principal factors affecting welding quality of steel, and compares average results of 80 tests made on forge welds of hammer-welded pipe with original material. (Abridgment.)

Pressure Vessels. Some Principles of the Construction of Unfired Pressure Vessels, S. W. Miller. Mech. Eng., vol. 44, no. 6, June 1922, pp. 360–368, 15 figs. Discusses forge and fusion welding and riveting and factors affecting welding efficiency. Includes two appendices, first, dealing with testing of ten specimens of welded plates; second, dealing with testing of four half-inch plate-steel and two Armco iron welded tanks. (Abridgment.)

Problems. Welding Session Develops Salient Facts. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 521–523. Gathering under auspices of Am. Welding Soc. and A.S.M.E. Boiler Code Committee emphasizes problems to be met in advancing art of welding.

Tube, Contraction in. Contraction in Tube Welding, Marcel Piette. Welding Engr., vol. 7, no. 8, Aug. 1922, pp. 19–20, 6 figs. Points out that distortion can be avoided by expanding pieces in opposite sense before welding. Translated from Revue de la Soudure Autogène.

[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; ELECTRIC WELDING, RESISTANCE; OXY-ACETYLENE WELDING; THERMIT WELDING.]

WELDS

Testing. Electrical and Magnetic Weld Testing as Applied to Butt-Welded Steel Plates, T. Spooner and I. F. Kinnard. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 11 pp., 7 figs. Describes series of laboratory tests applied to arc butt-welded steel plates to determine possibility of developing electrical and magnetic tests capable of revealing quality of such welds. See also Iron Age, vol. 110, no. 3, July 20, 1922, pp. 139–141, 6 figs.

WIND MOTORS

Induction Generators, Use of. The Use of Asynchronous Generators in Wind Motors (Ueber die Verwendung von Asynchrongeneratoren in Windkraftanlagen), Kurt Herzog. Elektrotechnische Zeit., vol 43, no. 29, July 29, 1922, pp. 961–963, 6 figs. Points out advantages and disadvantages of three-phase-current generation by means of wind motors in mountainous regions; adaptability of asynchronous generators for such purposes.

WIND TUNNELS

Balances for. The Six-Component Wind Balance, A. F. Zahm. Nat. Advisory Committee for Aeronautics, Report No. 146, 1922, 12 pp., 8 figs. Description of three dimensional aerodynamic balance capable of rapid and accurate measurement which was installed in 8-by-8-foot tunnel; translation mechanism; measurement of lift, drag, and side drag; rotation mechanism; etc.

WOOD

Fire-Retarding Chemicals for. The Effect of Chemicals on the Ignition Temperature of Wood, W. O. Hanfield and W. S. Peck. Can. Chem. & Metallurgy, vol. 6, no. 8, Aug. 1922, pp. 172–176, 3 figs. Results of experiments carried out at Univ. of Brit. Columbia. Search for practical fire-retarding chemical.

Mechanical Engineering

The Monthly Journal Published by

The American Society of Mechanical Engineers

Publication Office, 207 Church Street, Easton, Pa. Editorial and Advertising Departments at the Headquarters of the Society, 29 West Thirty-ninth Street, New York

Volume 44 December, 1922 Number 12

TABLE OF CONTENTS

Price 50 Cents a Copy, $4.00 a Year: to Members and Affiliates, 40 cents a Copy, $3.00 a Year. Postage to Canada, 50 Cents Additional; to Foreign Countries, $1.00 Additional. Changes of address should be sent to the Society Headquarters.

Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921.

Contributors and Contributions

Size Standardization by Preferred Numbers

Clarence E. Hirshfeld and C. Howard Berry contribute a paper to this issue which tells of preferred-number systems for use in standardization of sizes. Preferred numbers have already been successfully used in Germany and other European countries. Mr. Hirshfeld since 1914 has been chief of the Research Department of the Detroit Edison Company. He holds degrees from the University of California and Cornell University. From 1903 to 1913 he was an instructor and professor at Sibley College. He is the author of a number of books and has been a contributor to the technical press.

Mr. Berry is also with the Detroit Edison Company. He received his M.E. and M.M.E. from Cornell University in 1912 and 1916, and before accepting his present position in 1919 he was for five years an instructor and professor at Cornell.

Steam Distribution in the Locomotive

A new sleeve-valve arrangement for locomotives that can be applied to old engines is discussed in a paper by George H. Hartman. When a young man he became associated with Charles J. Pilliod, of Toledo, who designed the sleeve-valve arrangement discussed in this paper, and although he has left Toledo from time to time he has never severed this association. He has been employed at various times as a designing and consulting engineer for the International Nickel Company, the Dayton Wright Airplane Company, the Willys-Overland Company, the Bacon Motors Corporation and the Hickok Producing Company. At present he is chief engineer and a director of the Cleveland Vending Machine Company.

Machining and Lapping Very Deep Holes

Major John B. Rose of the Ordnance Department, U. S. Army, discusses in detail the shop operations in the production of long and very accurately formed cylindrical holes, such as those in the forgings from which gun-recoil mechanisms are made. Major Rose is a West Point man, class of 1907. Since 1909 he has been in the Ordnance Department and received post-graduate instruction in ordnance engineering. For three years he was in charge of inspection and repair of all ordnance in the fortifications of the Atlantic Coast from Portland to New York City. During the war he was in charge of engineering work relating to the manufacture of our field-artillery material. Since then he has been in charge of the design and manufacture of the field-artillery gun carriages made under the post-war development program.

A New System of Helical Involute Gearing for Use on Metal Planers

Particulars of a system of helical gearing designed by Forrest E. Cardullo for use on metal planers are related by him in a paper in this issue. Mr. Cardullo, who received his degree in mechanical engineering in 1901 from Cornell University spent the first four years after graduation working on the design of heavy gas engines and steam pumping engines. From 1905 to 1914 he was instructor and professor in mechanical engineering at Syracuse University and New Hampshire State University. He then became chief draftsman for the Pierce Arrow Motor Car Company, leaving them to be engineer of tests with the Curtiss Aeroplane and Motor Corporation. Since the war Mr. Cardullo has been chief engineer for the G. A. Gray Co. at Cincinnati.

A New Method for Determining the Effect of Speed upon the Strength of Gear Teeth

The problem of the effect of speed on the strength of gear teeth is presented by Wilfred Lewis, for more than twenty years president of the Tabor Manufacturing Company, of Philadelphia. After his graduation from the Massachusetts Institute of Technology in 1875, Mr. Lewis entered the employ of William Sellers and Company, with whom he remained until assuming his present position. Mr. Lewis has made extensive experiments and investigations along the lines of gearing. He has been the recipient of the Longstreth Medal for some of his inventions and is a frequent contributor to technical journals.

Influence of Design on Cost of Operating Airplanes

Archibald Black, who discusses the cost of operating commercial airplanes, was in charge of the design of the experimental airplane in which the first Liberty airplane engine was installed and was the designer of the L-W-F Model G, the first all-American fighting airplane. Born in Scotland, Mr. Black came to this country at an early age and received his education at Cooper Union, Case Technical Institute, and Columbia University. Before taking up airplane work he was engaged in electrical construction and electrical engineering of power plants for the New York Edison Company, the Detroit Edison Company and the Interborough Rapid Transit Company.

Relieving Industry of Burden

A general plan for lifting the burden from industries suffering from idleness and waste as a result of post-war conditions is presented by Wallace Clark. Mr. Clark is a consulting management engineer of New York City. He was graduated from the University of Cincinnati in 1902. A few years later, after varied experience in this country and the Orient, Mr. Clark became manager of the executive offices of the Remington Typewriter Company, under the direction of H. L. Gantt. Later he became a member of Mr. Gantt's staff.

A.S.M.E. ANNUAL MEETING

New York, December 4-7

Four days of splendid opportunities for professional fellowship at the Engineering Societies Building are to be followed by the National Exposition of Power and Mechanical Engineering at the Grand Central Palace, December 7 to 13.

The January issue of MECHANICAL ENGINEERING will contain a complete account of the technical features of the Meeting, while the A.S.M.E. News will take care of the social events.

MECHANICAL ENGINEERING

Volume 44 December, 1922 No. 12

Size Standardization by Preferred Numbers

By C. F. HIRSHFELD[1] AND C. H. BERRY,[2] DETROIT, MICH

A careful study of manufactured articles shows that even when sizes are determined by utility or use value, the choice of size is largely arbitrary. It is therefore obvious that if certain numerical values are universally accepted as preferred values, and if they are so spaced and of such extent as to fit in with all requirements met in deciding on sizes to be used, the arbitrary choices may be so made as to yield sizes expressible in terms of these preferred numbers.

Preferred numbers have been successfully used in Germany and some other European countries and this paper is presented as a background for a study of the subject in connection with American conditions and problems. The authors develop preferred-number systems based on the theory of geometrical series and apply them to various industries. Graphs and tables illustrate the points brought out.

SIZE figures in one way or another in all manufactured articles and, in fact, in all articles of commerce. For present purposes the word "size" must be interpreted in its broadest possible sense. It may indicate any one of the following specifications: a purely arbitrary size, such as Model No. 1, Model No. 2, 3, etc., of a given line of manufactured article; a conventional size upon which all manufacturers in a given line have agreed, as sizes of hats or shoes; the weight of a package in which a given material is sold; the weight of some arbitrarily chosen quantity, as 100-lb. rails or 10-oz. duck; an actual or conventional significant dimension, as 1-in. round stock or 1-in. lumber; or any one of the numerous dimensions which may be required in the design, fabrication or marketing of a given article or manufactured product.

Viewed from one aspect, size is second only to the product itself when dealing with the materialistic side of manufacture and commerce. All manufacture and all commerce are carried on in terms of size. In fact, the need for means of expressing size is probably the underlying reason for the heterogeneously assorted system of expression now in use.

Further, size, in the general sense of the word and also in the specific sense, is directly or indirectly made up of two components or factors. One of these is a number and the other a dimension, as in "1-in." bar stock.

Numerous cases will be found in which this composite structure is not evident, but it will always appear if the search is carried far enough. When a given kind of equipment is sold under the size designations, Model No. 1, Model No. 2, etc., the model size itself is determined by its physical size or capacity. Thus Model No. 1 may be 4 ft. high, or may have a capacity of 1 ton in a given time, while Model No. 2 may be 6 ft. high or have a capacity of 2 tons, etc.

In any general study of sizes we must therefore consider two components which are respectively numerals and units of measurement. These units of measurement are matters of custom or use which vary both with the type of measurement and with the systems adopted in different countries.

In considering the so-called "Preferred Numbers" we have no direct interest in these dimensional units. Our concern is entirely with the numerical part of the doublet used for expressing size, except in so far as the relations between dimensions in any one system of measurement may make certain numerals more or less convenient. As an example of the significance of this exception, consider the possible means of expressing a length of 27 ft. in the English system. This might be called 9 yd., 27 ft., or 324 in. In measuring dress goods the yard is the most convenient or at least the conventional unit and thus brings about the necessity for the use of the numeral 9 in expressing the size indicated. In certain other types of measurement, as, for instance, in measuring length of lumber, the foot unit is the most convenient and thus makes necessary the use of the numeral 27. The inconvenience of using the number 324 probably explains the use of feet and yards instead of inches for large measurements.

Sizes used in industry and commerce may be divided into several different categories or classes, as follows:

1 Sizes which are entirely matters of style, such as the lengths of coats, the heights of hats, and other dimensions which change from year to year.

2 Sizes which are determined entirely by personal comfort, such as the sizes of men's collars, the sizes of hats and shoes, etc. Each of these series of sizes has been worked out by experience and it is not unreasonable to assume that at the present time they form satisfactory systems.

3 Sizes which are entirely matters of taste, though not necessarily matters of fashion. Thus the proportions of a Doric column entering into a structure are not determined by strength but by appearance. Proportions or sizes of furniture, objects of art, and many architectural features fall in this class.

4 Sizes which are determined by a combination of appearance and utility. The sizes of drawer pulls, door knobs and the like fall into this class, but for the present they are outside the scope of this paper though they may later fall partly or wholly within it.

5 Sizes which are determined entirely by utility or use value.

Class 1 sizes are by nature arbitrary and changeable and those of classes 2, 3 and 4 are outside the scope of the present paper. Such sizes as are grouped under class 5, whether they refer to buckets and pails, pots and kettles, bolts, wires, or to any of the innumerable machine parts, fall within the scope of what may be called the Theory of Preferred Numbers.

With the preceding paragraphs by way of introduction, something may now be said with respect to this theory, what it is, and what it is for.

The Theory of Preferred Numbers

At the present time there is much that is arbitrary in the choice of size, even when size is determined by utility or use value, and careful study will show that slight variations in the sizes finally decided upon would not make a great difference in the use value of the pieces. For example, have we any proof that pails should be made in 8-, 10-, 12-, and 14-qt. sizes instead of in, say, 9-, 11-, 13- and 15-qt. sizes? Or again, when we calculate the required diameter of a circular section in a piece of machinery to be 2.237 in., are we justified in assuming our calculation so accurate that 2.25 or 2.2 in., or possibly even 2 or 2.5 in., will not prove equally suitable?

Careful study in any drafting room will show that the latitude of choice allowed the designer is such that his decision with respect to final dimensions is arbitrary within certain limits, and quite often within very wide limits.

In view of these facts it is quite obvious that if certain numerical values are universally accepted as preferred values and if they are so spaced and of such extent as to fit in with all requirements met in deciding on sizes to be used, the arbitrary choices may be so made as

---

[1] Chief, Research Department, The Detroit Edison Company. Mem. Am.Soc.M.E.

[2] Engineer, vice-president's office, The Detroit Edison Company. Mem. Am.Soc.M.E.

Contributed by the Standardization Committee for presentation at the Annual Meeting, New York, December 4 to 7, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

to yield sizes expressible in terms of these preferred numbers. Moreover, if such a thing is possible, very material savings should result from its use, some of the most obvious of which are:

a Mill products which are used in the fabrication of manufactured articles could be made in a minimum number of standard sizes so chosen as to meet the needs of users who have adopted preferred numbers for the sizes of their wares.

b Measuring instruments and production machinery might be simplified and cheapened because it would be necessary to provide for their use with preferred dimensions only instead of providing for universal adjustment.

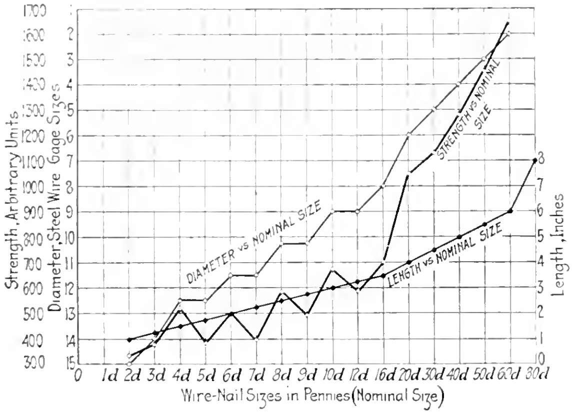


Fig. 1 Commercial Sizes of Wire Nails

c Odd sizes, manufactured through ignorance of real requirements or to meet the supposed, but really illogical, needs of a customer or industry, might be eliminated.

d Life would be made simpler for both the producers and the users, because calculation, manufacture, commerce, catalogs, price lists and human memory would deal only with certain easily memorized and widely used numerals. Certain other advantages will become apparent as the subject is further developed.

One of a practical turn of mind is likely to think that there is much of theory in all this and little of practical worth. Sizes have been developed by a cut-and-try process and with commercial necessity acting as a brake on the overdevelopment of sizes. It might be assumed, therefore, that present-day industry is using the minimum number of sizes consistent with the meeting of human needs and that these sizes are most advantageously chosen. Such arguments are weighty and worthy of serious consideration.

However, systems of preferred numbers have been accepted to a certain extent in Germany, and several other European countries are indicating an intention of following this lead after having made a study of the German systems. It would seem, therefore, that we should not complacently accept our present methods and practices, but instead give serious thought and study to this problem.

The authors of this paper are not urging the adoption of a system or systems of preferred numbers, but they do urge most emphatically a study of the subject in connection with American conditions and problems to the end that decision for or against may be made with full knowledge of all that is involved. Such a study may probably be most conveniently undertaken by considering sizes actually in use in this country and the relation which such sizes bear to a possible series or to several possible series of preferred numbers. Some examples of common cases are given in the paragraphs immediately following.

Common wire nails are sold in sizes expressed in terms of "pennies;" thus we have 2d nails, 3d nails, and so on up to 80d nails. These designations originally indicated the price per hundred, but now, by arbitrary agreement, they represent certain lengths which are expressed in even inches and fractions of inches which have no connection whatever with the number used in expressing the commercial size. The diameters of stock from which the nails are made vary from a small value at the low end of the series to a large value at the upper end. Presumably the nail is intentionally or unintentionally proportioned as a long column, and there is therefore probably some approximation to a definite relation between diameter and length.

The values of length and diameter for wire nails are plotted against the commercial sizes in Fig. 1, from which it can be seen that wire-gage sizes and lengths of wire nails are not as well coordinated as they might be. The nearest convenient commercial size of wire has been combined with the desired length to give a certain size of nail. In fact, half and quarter gage sizes have been used in some cases. The effect of this is indicated by the jagged line showing strength plotted against size. It is obvious that the use of one size of wire for two successive sizes of nails results in most erratic variations in strength. The nails are of course commercially satisfactory, but this does not mean that they are constructed with the minimum use of material or that a more satisfactory line of nails might not be developed. This matter will be considered later after certain other matters have been discussed.

Wire is sold in certain sizes specified as "gages." Copper wire is measured in terms of the American or Brown and Sharpe Gage. The diameters corresponding to successive gage sizes are plotted to semi-logarithmic coördinates in Fig. 2 and it is apparent that this series of sizes was developed according to a definite and consistent plan.

Steel wire is measured in terms of the Washburn and Moen, Roebling, or Steel Wire Gage. The diameters corresponding to successive gage sizes are also plotted in Fig. 2. Evidently there is some underlying plan, but it follows what appear to be imperfect laws. Apparently a certain law of variation is followed until it cannot be followed further. Another is then chosen but later abandoned, and so on. There may be good reasons back of this peculiar variation, but it seems probable that this gage might have

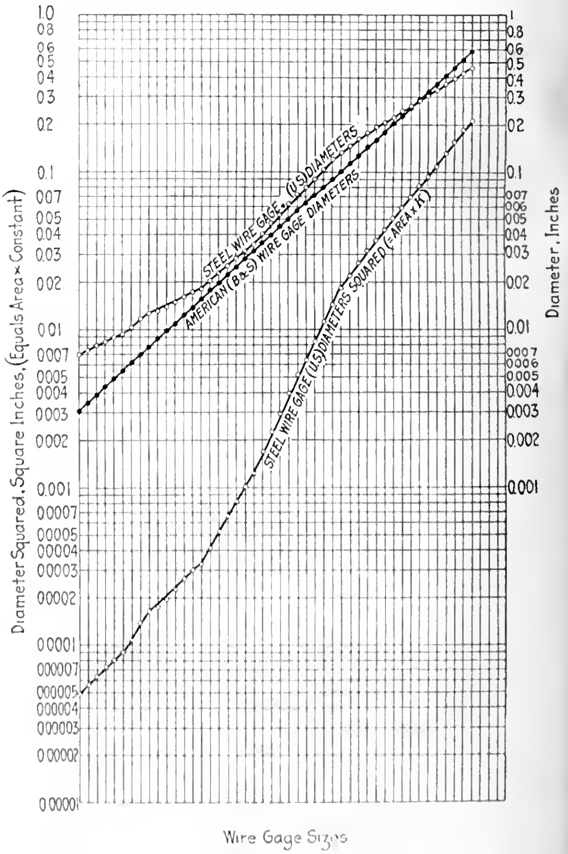


Fig. 2 Semi-Logarithmic Plotting of Wire-Gage Sizes

been built up upon a much simpler basis. More will be said about this in later paragraphs.

As another example of sizes in commercial use we may consider frying pans. The diameters of one well-known make of frying pans are plotted against commercial or nominal sizes in Figs. 3 and 4. This matter will also be considered later.

Saucepans and preserving kettles are sold in sizes designated in terms of quarts. Saucepans are made in comparatively small sizes and preserving kettles in comparatively large sizes, but the two overlap so that sizes of equal capacity can be obtained in the larger sizes of saucepans and in the smaller sizes of preserving kettles. The two kinds of utensils are interchangeable in use, so that it is probably not illogical to consider them together. The sizes available in one make are plotted to ordinary coördinates in Fig. 5. The same values are plotted to semi-logarithmic coördinates in Fig. 6.

Liquid measures are available in numerous sizes, all commonly designated in terms of capacity. The sizes obtainable from one well-known maker are plotted to semi-logarithmic coördinates in Fig. 7.

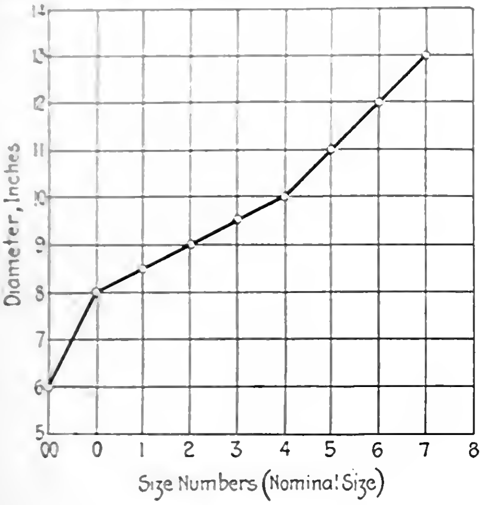


Fig. 3

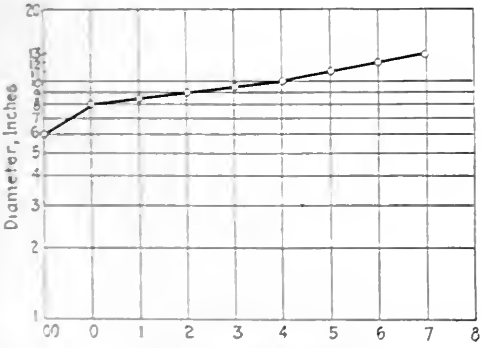


Fig. 4

Figs. 3 and 4 Diameters of Frying Pans Plotted against Commercial or Nominal Sizes

Commercial sizes of steel shafting are shown in Fig. 8.

Bolts have been standardized in different ways and for different purposes by various organizations. One very complete standard is that of the Society of Automotive Engineers. The diameter, area of stock, and area at root of thread for S.A.E. Standard bolts are plotted to semi-logarithmic coördinates in Fig. 9. A similar set of graphs for the United States Standard is given in Fig. 10.

Pipes are well standardized in several different weights. They are sold in terms of nominal diameters and the actual diameters practically never equal the nominal diameters. The actual inside diameters and areas of standard full-weight wrought-iron pipes from $^1/_8$ in. to 10 in. nominal diameter are plotted to semi-logarithmic coördinates in Fig. 11.

A brief survey of Figs. 2, 4, 6, 7, 8, 9, 10 and 11, all of which show sizes plotted to semi logarithmic coördinates, will indicate a surprisingly large number of cases in which successive sizes fall very nearly on one straight line or on two or three straight lines of slightly different slopes. If space permitted many more examples of the same thing could be given.

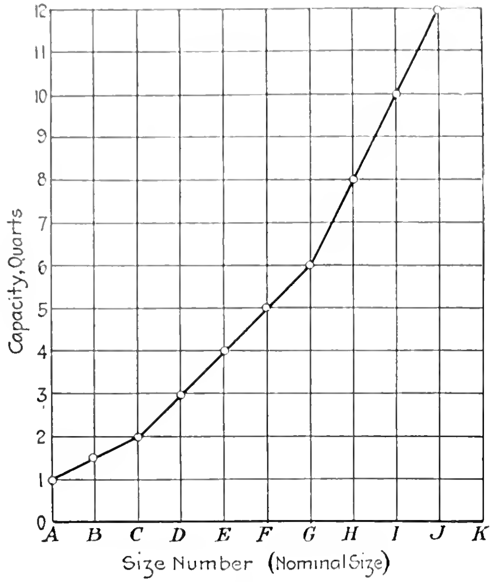


Fig. 5

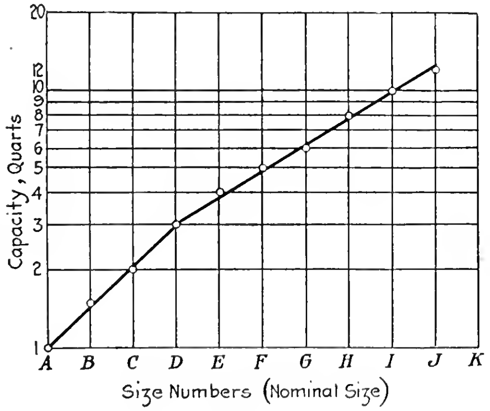


Fig. 6

Figs. 5 and 6 Capacities of Saucepans Plotted against Commercial or Nominal Sizes

This peculiar tendency naturally suggests some underlying law of size or size variation. If sizes tend to fall on such straight lines, it follows that the mathematical characteristics of such lines must express what we may call the natural law of size variation.

The Application of the Theory of Geometrical Series

On semi-logarithmic paper a straight line which is not parallel to either axis is the plot of a geometrical series. That is, such a line represents a succession of terms each of which bears a constant

ratio to the preceding one. The following succession of terms represents part of a geometric series:

$$a,\ 2a,\ 4a,\ 8a,\ 16a,\ \ldots\ldots\ldots\ \text{etc.}$$

Such a series can be written symbolically, as:

$$a,\ ra,\ r^2a,\ r^3a,\ \ldots\ldots\ldots\ldots r^{n-1}a$$

in which—

a = first term of the series or the number on which it is built up
r = ratio of each term to the preceding term, and
n = the number of the term in the series.

German scientists and technicians have investigated this matter of size variation, including several geometrical series which may be used an expressions of the law of size variation. While they have not yet formally adopted them, they are leaning very markedly toward a system of series with ratios equal to the 5th, 10th, 20th, 40th and 80th roots of 10 and have, in fact, adopted it tentatively. Such series would be simply expressed as follows for the 10th-root series:

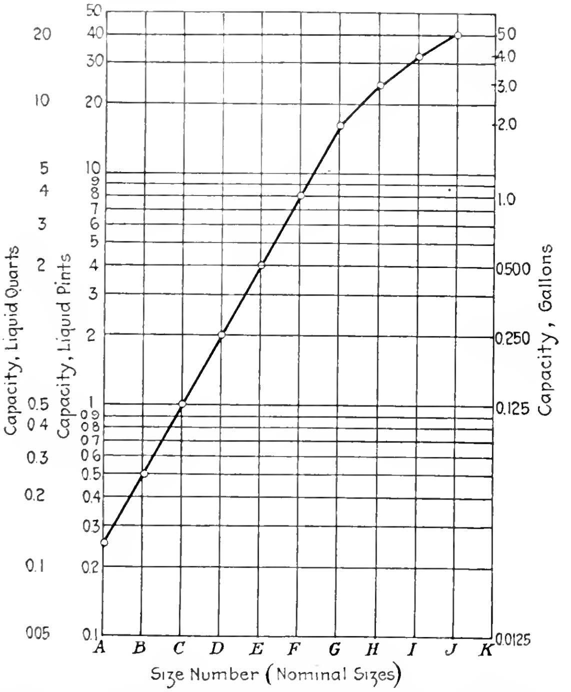


Fig. 7 Capacities of Liquid Measures Plotted against Nominal Sizes

$$a,\ \sqrt[10]{10}\,a,\ (\sqrt[10]{10})^2\,a,\ (\sqrt[10]{10})^3\,a,\ \text{etc.}$$

which is equal to—

$$a,\quad 1.259a,\quad 1.58a,\quad 1.99a,\quad \text{etc.}$$

For the 20th-root series:

$$a,\ \sqrt[20]{10}\,a,\ (\sqrt[20]{10})^2\,a,\ (\sqrt[20]{10})^3\,a,\ \text{etc.}$$

which is equal to—

$$a,\quad 1.122a,\quad 1.259a,\quad 1.41a,\quad \text{etc.}$$

The whole idea can be illustrated most clearly by dealing with the series which has a ratio equal to $\sqrt[100]{10}$, i.e., $10^{1/100}$. Such a series built upon the number 1, that is, with a equal to 1, is drawn to semi-logarithmic coördinates in Fig. 12.

Assume that it is desired to make a given article in eleven sizes progressing as in this series. The size designations are indicated as *A*, *B*, *C*, *D*, etc., in Fig. 12. The dimensional sizes are given by the values of the ordinates above the size designations. If a smaller number of models equally distributed over the same range of dimensional sizes is required, we might use sizes *A*, *C*, *E*, *G*, *I*, and *K*. But such a choice would be exactly equivalent to using a series such as that shown at the left in Fig. 13, which is a series with the ratio $\sqrt[50]{10}$. Or if we desired only three sizes, say, *A*, *F*, and *K*, this would be equivalent to using the $\sqrt[20]{10}$, or a series such as that shown to the right of Fig. 13.

Bearing these ideas in mind, inspection of Fig. 14 will show that a series with ratio $\sqrt[10]{10}$ makes available only two of the sizes here under consideration, namely, the first and the last. A series with ratio $\sqrt[20]{10}$ gives three sizes, the same two extremes and one intermediate corresponding to *F* of the original arrangement. A series with ratio $\sqrt[30]{10}$ yields four sizes, the two intermediates not corresponding to previous sizes because 30 is not evenly divisible into 100. A proportionate number of sizes is obtainable with the series with ratios equal to $\sqrt[40]{10}$, $\sqrt[60]{10}$, $\sqrt[70]{10}$, $\sqrt[80]{10}$, and $\sqrt[90]{10}$. The series with ratio equal to $\sqrt[50]{10}$ yields six of the original sizes as previously indicated.

Going back now to the original series with ratio equal to $\sqrt[100]{10}$, shown in Fig. 12, let us assume that the 11 sizes designated by letters *A* to *K*, inclusive, are not sufficient, that is, that finer subdivisions are required. These can be obtained by inserting sizes midway between *A* and *B*, *B* and *C*, *C* and *D*, etc., as shown in Fig. 15. We should then get sizes which might be designated as *A*, $A^1/_2$, *B*, $B^1/_2$, *C*, $C^1/_2$, etc., and the dimensions of each size would be related to the dimension of the preceding size by the same ratio, but this ratio would not be the same as that in the case first considered.

The last statement is likely to be a bit puzzling to those who do not handle such series frequently, but it is easily explained. The line as drawn yields a value of 10 as ordinate for 100 of the smallest divisions on the horizontal axis. But 10 is the 100th power of $\sqrt[100]{10}$. The ordinate of the first small division counting from the left on the horizontal axis is therefore equal to the ordinate at *A* multiplied by $\sqrt[100]{10}$; the ordinate of the second small horizontal division is the ordinate at *A* multiplied by $\sqrt[100]{10} \times \sqrt[100]{10}$, or $(\sqrt[100]{10})^2$; the ordinate at *B* is equal to the ordinate at *A* multiplied by $(\sqrt[100]{10})^{10}$; the ordinate at *C* is equal to the ordinate at *A* multiplied by $(\sqrt[100]{10})^{20}$; and so on. It is therefore obvious that—

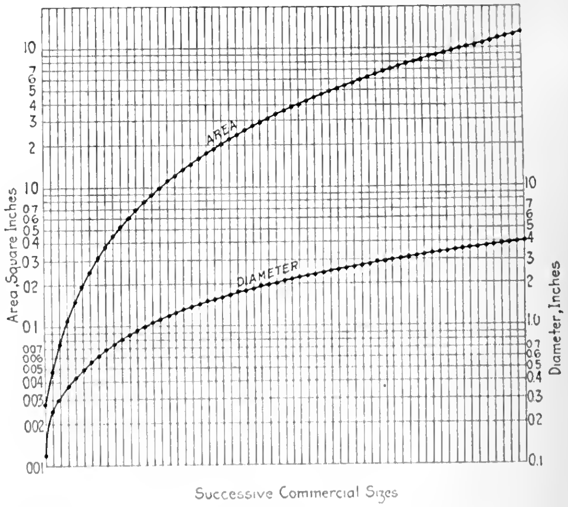


Fig. 8 Diameters and Areas of Steel Shafting Plotted against Successive Commercial Sizes

$$\text{Ordinate at } B = \text{Ordinate at } A \times (\sqrt[100]{10})^{10}$$

$$\text{Ordinate at } C = \text{Ordinate at } B \times (\sqrt[100]{10})^{10},\ \text{etc.}$$

but—

$$\text{Ordinate at } A^1/_2 = \text{Ordinate at } A \times (\sqrt[100]{10})^{5},\ \text{and}$$

$$\text{Ordinate at } B = \text{Ordinate at } A^1/_2 \times (\sqrt[100]{10})^{5}.$$

That is, the ratio between successive sizes of the *A*, *B*, *C*, *D*, etc., series is $(\sqrt[100]{10})^{10} = \sqrt[10]{10}$, and the ratio between successive sizes of the $A^1/_2$, *A*, *B*, $B^1/_2$, etc., series is $(\sqrt[100]{10})^{5} = \sqrt[20]{10}$. If

desired, the subdivision can be carried to any extent, but no matter how far it is carried the same characteristic relations will hold true.

If the requirements to be met are such that comparatively small variations of size are required in the smaller sizes and larger variations in the larger sizes, we might choose an arrangement such as that shown in Fig. 16. This appears to be a very minor variation of what has preceded, but in fact it is quite a major variation. The series of sizes resulting from such uneven subdivision no longer has the same characteristics as were described in connection with the sizes *A*, *B*, *C*, *D*, etc. The ratio between successive sizes changes at *E*, *H*, *I*, and *J*. This is shown clearly by plotting dimensions from Fig. 16 with nominal sizes evenly spaced as in Fig. 17. The ratios are indicated on each part of the broken line of this figure.

From what has been done in developing the graph in Fig. 16, it is apparent that its shape will vary with the way in which one chooses to distribute nominal sizes among the possible evenly distributed sizes. If the nominal sizes be closely spaced with reference to possible sizes with any assumed even increments, the resultant line will be less steep than if the nominal sizes are more widely spaced among the possible sizes.

Comparison of Figs. 12 to 17, inclusive, with Figs. 2, 4, and 6 to 11, inclusive, will show sufficient resemblance between the two groups to lead one to suspect that possibly the geometrical series is an expression of the law which underlies variation of size in articles whose size is determined by use value. One may object to such a conclusion by pointing out that in many cases in which actual sizes are plotted they do not fall exactly on the straight lines which have been drawn, and, further, that the use of a logarithmic scale distorts the significance of vertical departure from the lines so that it is possible that a small departure on the plot may mean a large discrepancy in actual size.

PRESENT SYSTEM SIMILAR TO PREFERRED NUMBERS

These criticisms are valid but they do not vitiate the suggested conclusion. Rather peculiarly, this is true because we are already more or less unconsciously using a set of preferred numbers. We use certain fractions of inches for dimensions smaller than one inch in preference to all other possible fractions. Thus our first choice is $^1/_2$ in.; the next, $^1/_4$ and $^3/_4$ in.; the next $^1/_8$, $^3/_8$, $^5/_8$, and so on. For dimensions larger than one inch we do the same sort of thing but in two different ways. Our choice with respect to fractions of one inch is the same as before, namely, a system based on eight with preference given to $^4/_8$; $^2/_8$, $^4/_8$, and $^6/_8$; $^1/_8$, $^2/_8$, $^3/_8$, $^4/_8$, $^5/_8$, $^6/_8$, and $^7/_8$; etc., in the order indicated by groups. But for fractions of one foot we use a system based on twelve and, whether we express ourselves in inches or in fractions of a foot, we give preference to $^6/_{12}$; $^3/_{12}$, $^6/_{12}$, $^9/_{12}$; $^2/_{12}$, $^4/_{12}$, $^6/_{12}$, $^8/_{12}$, $^{10}/_{12}$; etc., in the order indicated by groups.

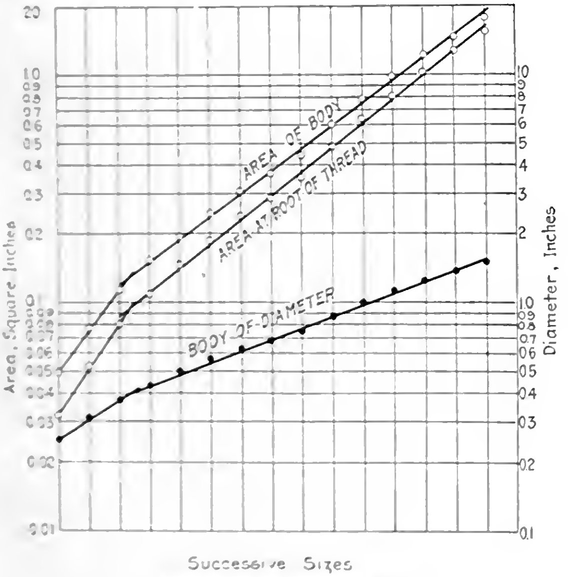


FIG. 9 S.A.E. STANDARD BOLTS

Therefore, in actually setting the dimensions which shall characterize different sizes of manufactured products, we generally choose on the basis of these preferred numbers, using that one which happens to fall nearest to our desire in each case.

Consider, for example, the dimensions of frying pans as plotted in Fig. 3. Diameter is certainly the most significant dimension of a frying pan. After that would come depth, and after that the combination of dimensions which affect ability to stack different sizes or a number of the same size. The smallest diameter is 6 in., a very convenient number, actually the preferred $^6/_{12}$ or $^1/_2$. This size is used for such purposes as frying a single egg, a single chop, or other small quantities of food. The next size has a diameter of 8 in., another one of our unconsciously preferred numbers, and beyond that diameters increase by half-inches to a diameter of 10 in. Beyond this size the diameters increase by 1-in. increments.

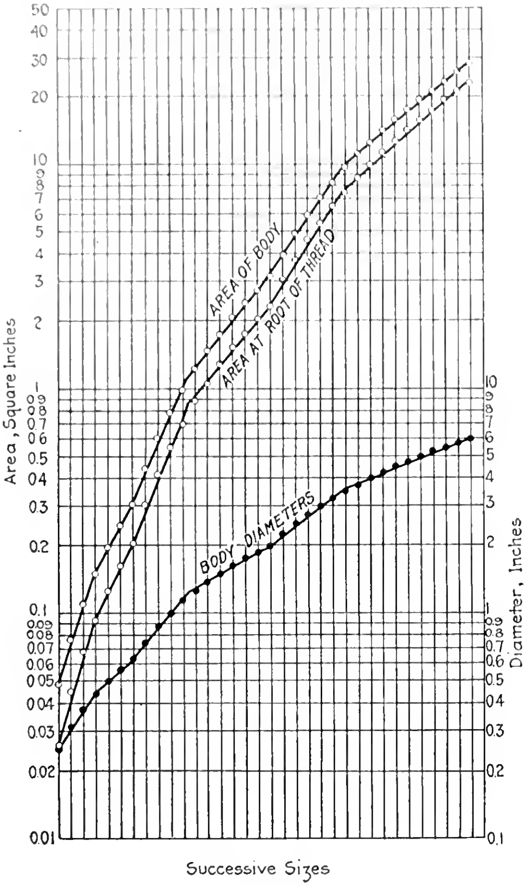


FIG. 10 U. S. STANDARD BOLTS

If there is any significance to the diameter of a frying pan it must result from the fact that the area is proportional to the square of that dimension. The squares of the diameters, and therefore figures proportional to cooking area, are plotted against nominal sizes in Fig. 18. The most casual inspection shows that in all probability no law underlies the choice of these diameters, and one is driven to the conclusion that sizes of about the proportions made have been found useful and that they have been chosen to fall on the preferred half-inch and whole-inch intervals.

Let us assume for the sake of argument that a 6-in., an 8-in., and a 13-in. size are necessary and that the cooking area is the underlying, governing criterion in choice of size. Let us also assume that six sizes are required between the 8-in. and the 13-in.

sizes. The simplest possible arrangement would result if we used diameters consistent with a straight line drawn through the 8-in. and 13-in. points in Fig. 18. The resultant areas and diameters are given in Table 1 for ready comparison with the actual commercial diameters.

TABLE 1 COMPARISON OF CALCULATED AND COMMERCIAL DIAMETERS OF FRYING PANS

Nominal Size	Area	Diameter	Commercial Diameter
0	64.0	8.00	8.0
1	73.5	8.56	8.5
2	84.0	9.16	9.0
3	96.5	9.83	9.5
4	111.0	10.53	10.0
5	128.0	11.31	11.0
6	147.0	12.12	12.0
7	169.0	13.00	13.0

It is at once apparent that the diameters corresponding to the smooth line of Fig. 18 are most inconvenient numerical values in comparison with the more commonly used numerical values which represent the actual commercial diameters. On the other hand, it is probably true that the resulting sizes are far more rational and would prove of greater use value, if there were any means of measuring such use value, since each size bears a certain definite constant relation to that which precedes it and that which follows it in the series. It is possible that a still better result could be obtained by using two different slopes between the two extremes so that diameters increased more slowly at the start and more rapidly later. Such an arrangement would correspond more nearly to present commercial sizes.

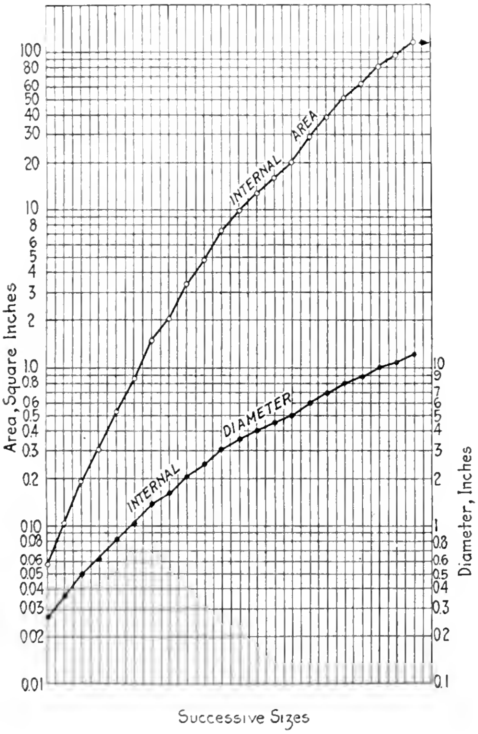


Fig. 11 Standard Wrought-Iron Pipe

Now suppose for a moment that instead of using such values as even inches and half-inches we had at some time arbitrarily decided to give preference to, let us say, the curious numbers 8, 8.5, 9.2, 9.8, 10.5, 11.3, 12.1 and 13. If, under those circumstances, we developed a set of diameters for frying pans as given in the third column of Table 1 we should have driven ourselves into the situation illustrated by Table 2.

Obviously, we would not hesitate to round out the calculated values to the preferred values, and the frying pans built upon the preferred-number diameters would probably have just as great a use value as would pans built upon the calculated diameters.

TABLE 2 COMPARISON OF CALCULATED AND PREFERRED DIAMETERS OF FRYING PANS

Calculated Diameter	Preferred Numbers
8.00	8.0
8.56	8.5
9.16	9.2
9.83	9.8
10.53	10.5
11.31	11.3
12.12	12.1
13.00	13.0

As another example of the use of preferred numbers, consider the matter of wrought-iron and steel pipe sizes. This material is sold in several different "weights" or wall thicknesses, additional thickness being obtained in most cases at the expense of internal diameter. In order to simplify matters to the greatest possible extent only one weight will be considered, namely, Standard Full Weight, and only such sizes will be used as are commonly sold on the basis of nominal inside diameter, that is, sizes up to and including 12-in. pipe. The sizes in which such pipe is graded are designated in inches and fractions of inches and refer to a nominal inside diameter, not to a real diameter. Table 3 will indicate the extent to which the nominal diameter is purely a fictitious designation.

TABLE 3 NOMINAL AND APPROXIMATE ACTUAL PIPE SIZES

Nominal Diameter, in.	Decimal Equivalent of Nominal Diameter, in.	Approximate Internal Diameter, in.
1/8	0.125	0.269
1/4	0.250	0.364
3/8	0.375	0.493
1/2	0.500	0.622
3/4	0.750	0.824
1	1.000	1.049
1 1/4	1.250	1.380
1 1/2	1.500	1.610
2	2.000	2.067
2 1/2	2.500	2.469
3	3.000	3.068
3 1/2	3.500	3.548
4	4.000	4.026
....	.....	.....
....	.....	.....
....	.....	.....
10	10.000	10.192
11	11.000	11.000
12	12.000	12.090

It is of interest to note that while we purchase such pipe in terms of even inches and fractions of inches, what we really purchase is pipe having internal diameters designated by figures which are apparently just as inconvenient as any of those which were worked out for frying-pan diameters. We are thus in fact using figures of this same form and sort but disguising them in order to express sizes in our preferred-number system.

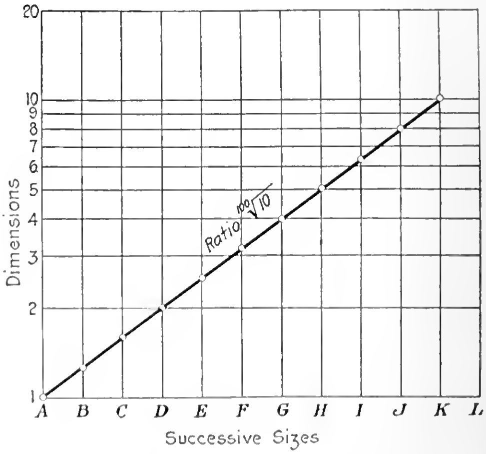


Fig. 12 Graph of Size Series with Ratio $\sqrt[100]{10}$

Pipes are used principally as conveyors of liquids and gases and the significant dimension is the internal diameter, since this determines the cross-sectional area and therefore the carrying capacity of the pipe. Inspection of Fig. 11 shows a rather ordered progress of cross-sectional area from the smallest to the largest pipe sizes. It is probable that there was originally some reason back of the variations from exact order in successive sizes and areas. Possibly it had something to do with thickness of material available, or with some necessary relation between internal and external diameters.

or, more remotely, it may have had something to do with strength against bursting.

However, it should certainly be possible to make pipe to areas such as those indicated by the straight lines drawn on Figure 19. If this were done, the actual internal diameters would be as indicated by the other series of lines on the same figure. Inspection of the locations of the points representing the actual present-day diameters with reference to their proximity to the new-diameter lines will show that the new diameters required will not vary greatly from those actually in use. The variation appears to be of a much smaller order than was found in the study of frying pans.

If one objected to designating pipes in terms of these odd actual internal diameters, it would be perfectly possible to use the same sort of fiction which we now use under exactly the same conditions.

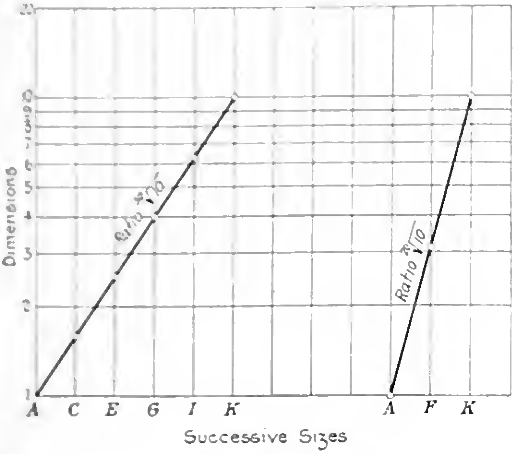


FIG. 13 GRAPHS OF SIZE SERIES HAVING RATIOS $^{10}\sqrt{10}$ AND $^{2}\sqrt{10}$

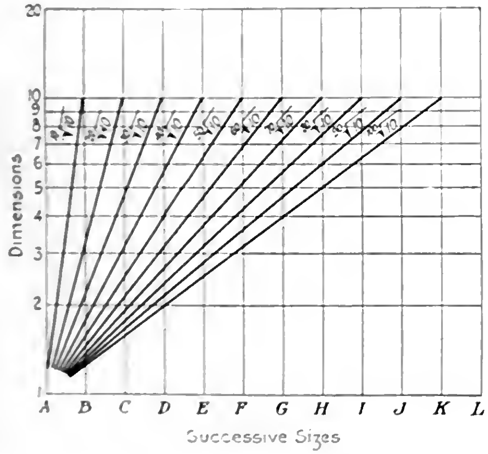


FIG. 14 SIZES AVAILABLE WHEN SERIES WITH DIFFERENT RATIOS ARE EMPLOYED

Examples of these sorts could be produced in almost endless variety, but it seems as though those just cited are sufficient to illustrate the points under discussion. We do use preferred numbers now, and very often these preferred numbers are used in a purely nominal sense while the real size dimensions are expressed in unwieldly decimal fractions. In some cases this is so extreme that we give these inconvenient decimal fractions special designations so that we will not have to deal with the numbers themselves. Such a case has just been considered in connection with pipes. Many others exist. Thus a No. 22 copper wire means something to almost every engineer, and yet there are very few who know that a No. 22 copper wire has a diameter of 0.0253 in. And why should they when the convenient round number 22 meets all ordinary needs and when exact diameter and area can always be obtained from a gageable if needed?

Unfortunately our preferred numbers are most irrationally related from many points of view. This follows directly from our conventional use of the inch and foot and from the way in which our system of numbers is built up. The effect of the inch and foot is illustrated in Fig. 20, in which a length of 12 in. is laid out to an arbitrary scale with certain preferred subdivisions set in in such a way that the length of the subdivision line represents the order of preference. It is apparent that any series of sizes which starts with dimensions less than one inch and ends with dimensions expressed in feet, inches, and fractions of an inch must almost certainly be made up on steps of most varying mathematical character.

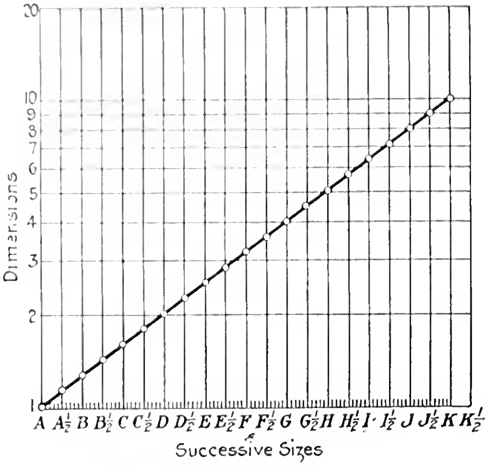


FIG. 15 SHOWING METHOD OF INTERPOLATING SIZES IN A SERIES

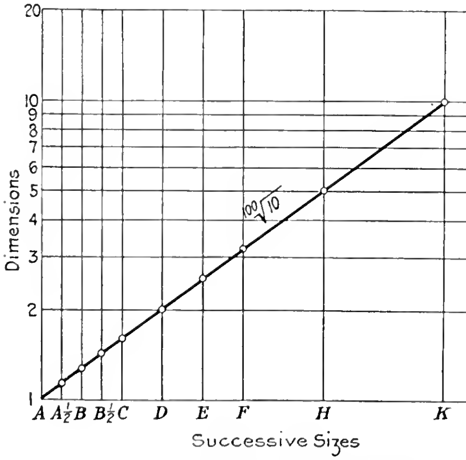


FIG. 16 UNEVEN SUBDIVISION OF SIZES

CONSTRUCTION OF GEOMETRICAL SERIES

Again, our system of numbers is itself basically peculiar. The logical steps of progression from 1 to 10 are by units or by simple or fractional multiples of units. The tendency is always toward even steps and there are surprisingly few possibilites. Thus we may use the following:

1, 10
1, 5, 10
(1, 2.5, 5, 7.5, 10)
1, 2, 4, 6, 8, 10
1, 2, 3, 4, 5, 6, 7, 8, 9, 10

These series are all arithmetical, and any attempt to arrange a geometrical series between 1 and 10 leads immediately to complicated, or at least inconvenient, decimal fractions.

Above 10, conditions are somewhat better in that there are numerous geometrical series yielding simple numbers, such as—

10, 20, 40, 80, 160, 320, etc.
10, 30, 90, 270, 810, etc.
10, 40, 160, 640, etc.
10, 50, 250, 1250, etc.

but it is obvious that the increase of value in the first series, which is characterized by the slowest rate of increase, is exceedingly rapid.

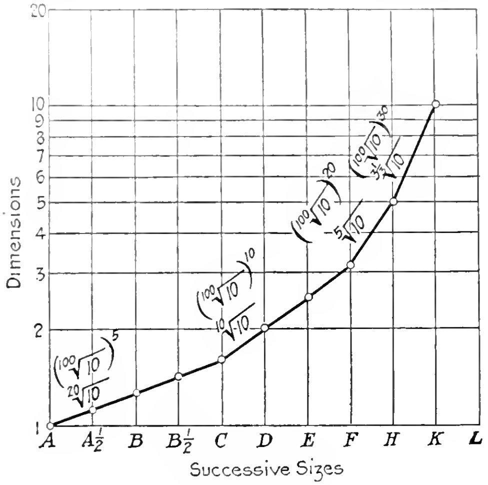


Fig. 17 Dimensions from Fig. 16 Plotted with Nominal Sizes Evenly Spaced

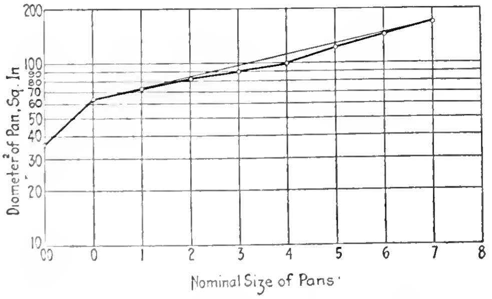


Fig. 18 Squares of Diameters of Frying Pans Plotted against Nominal Sizes

With the exception of such geometrical series one is limited to arithmetical series in developing steps of such character as to yield simple even numerals. One may progress by ones, twos, threes, fours, fives, etc., up to any desired value and thus develop any number of arithmetical series. But any attempt to develop geometrical series other than those just indicated leads immediately to fractional numbers.

These are the facts with which we are confronted, and, even if it be assumed that we can and possibly may change our system of measurement, it seems foolish to suppose that we will ever change our system of numbers. It looks, therefore, as though we may as well make up our minds to do the best we can with what we have.

The Germans have an official system of measurement which coincides in arrangement with the system of numbers. They therefore seem to have only one problem to solve where we have two. The truth of the matter is that in many cases they also have two, but there are enough cases in which they have only the one so that they can confine their attention largely to those cases for the time being. The movement to adopt preferred numbers may be regarded as an effort to evolve a number system better suited to our technical needs than the present system. Of necessity it is expressed in terms of our present system and as a result it appears at a disadvantage.

The Germans have two sets of preferred numbers and, the authors are informed, these numbers are now in use to a limited extent. The first is a set of "standard diameters," and was adopted before the recent development of the more general "preferred numbers." The second is built up on the 80th root of 10, and is like the one discussed in connection with Figs. 12 to 17. The method of construction is best illustrated by writing down the numerical terms of such series. These values are given in Table 4 for all series between that with ratio $\sqrt[5]{10}$ and that with ratio $\sqrt[80]{10}$.

TABLE 4 PREFERRED-NUMBER SYSTEM ADOPTED IN GERMANY—EXACT VALUES

Ratio = $\sqrt[5]{10}=1.585$		Ratio = $\sqrt[10]{10}=1.259$		Ratio = $\sqrt[20]{10}=1.122$		Ratio = $\sqrt[40]{10}=1.059$		Ratio = $\sqrt[80]{10}=1.029$	
Term	Numerical Value	Term	Numerical Value	Term	Numerical Value	Term	Numerical Value	Term	Numerical Value
0	1.000	0	1.000	0	1.000	0	1.000	0	1.000
..	....	..	....	..	....	..	....	1	1.029
..	....	..	....	..	....	1	1.059	2	1.059
..	....	..	....	..	....	..	....	3	1.090
..	....	..	....	1	1.122	2	1.122	4	1.122
..	....	..	....	..	....	..	....	5	1.155
..	....	..	....	..	....	3	1.189	6	1.189
..	....	..	....	..	....	..	....	7	1.123
..	....	1	1.259	2	1.259	4	1.259	8	1.259
..	....	..	....	..	....	..	....	9	1.296
..	....	..	....	..	....	5	1.334	10	1.334
..	....	..	....	..	....	..	....	11	1.373
..	....	..	....	3	1.413	6	1.413	12	1.413
..	....	..	....	..	....	..	....	13	1.454
..	....	..	....	..	....	7	1.496	14	1.496
..	....	..	....	..	....	..	....	15	1.540
1	1.585	2	1.585	4	1.585	8	1.585	16	1.585
..	....	..	....	..	....	..	....	17	1.631
..	....	..	....	..	....	9	1.679	18	1.679
..	....	..	....	..	....	..	....	19	1.728
..	....	..	....	5	1.778	10	1.778	20	1.778
..	....	..	....	..	....	..	....	21	1.830
..	....	..	....	..	....	11	1.884	22	1.884
..	....	..	....	..	....	..	....	23	1.939
..	....	3	1.995	6	1.995	12	1.995	24	1.995
..	....	..	....	..	....	..	....	25	2.054
..	....	..	....	..	....	13	2.113	26	2.113
..	....	..	....	..	....	..	....	27	2.175
..	....	..	....	7	2.239	14	2.239	28	2.239
..	....	..	....	..	....	..	....	29	2.304
..	....	..	....	..	....	15	2.371	30	2.371
..	....	..	....	..	....	..	....	31	2.441
2	2.512	4	2.512	8	2.512	16	2.512	32	2.512
..	....	..	....	..	....	..	....	33	2.585
..	....	..	....	..	....	17	2.661	34	2.661
..	....	..	....	..	....	..	....	35	2.738
..	....	..	....	9	2.818	18	2.818	36	2.818
..	....	..	....	..	....	..	....	37	2.901
..	....	..	....	..	....	19	2.985	38	2.985
..	....	..	....	..	....	..	....	39	3.073
..	....	5	3.162	10	3.162	20	3.162	40	3.162
..	....	..	....	..	....	..	....	41	3.255
..	....	..	....	..	....	21	3.350	42	3.350
..	....	..	....	..	....	..	....	43	3.447
..	....	..	....	11	3.548	22	3.548	44	3.548
..	....	..	....	..	....	..	....	45	3.652
..	....	..	....	..	....	23	3.758	46	3.758
..	....	..	....	..	....	..	....	47	3.868
3	3.981	6	3.981	12	3.981	24	3.981	48	3.981
..	....	..	....	..	....	..	....	49	4.097
..	....	..	....	..	....	25	4.217	50	4.217
..	....	..	....	..	....	..	....	51	4.340
..	....	..	....	13	4.467	26	4.467	52	4.467
..	....	..	....	..	....	..	....	53	4.597
..	....	..	....	..	....	27	4.732	54	4.732
..	....	..	....	..	....	..	....	55	4.870
..	....	7	2.015	14	5.012	28	5.012	56	5.012
..	....	..	....	..	....	..	....	57	5.158
..	....	..	....	..	....	29	5.309	58	5.309
..	....	..	....	..	....	..	....	59	5.464
..	....	..	....	15	5.623	30	5.623	60	5.623
..	....	..	....	..	....	..	....	61	5.788
..	....	..	....	..	....	31	5.957	62	5.957
..	....	..	....	..	....	..	....	63	6.131
4	6.310	8	6.310	16	6.310	32	6.310	64	6.310
..	....	..	....	..	....	..	....	65	6.494
..	....	..	....	..	....	33	6.683	66	6.683
..	....	..	....	..	....	..	....	67	6.879
..	....	..	....	17	7.079	34	7.079	68	7.079
..	....	..	....	..	....	..	....	69	7.286
..	....	..	....	..	....	35	7.499	70	7.499
..	....	..	....	..	....	..	....	71	7.718
..	....	9	7.943	18	7.943	36	7.943	72	7.943
..	....	..	....	..	....	..	....	73	8.175
..	....	..	....	..	....	37	8.414	74	8.414
..	....	..	....	..	....	..	....	75	8.660
..	....	..	....	19	8.913	38	8.913	76	8.913
..	....	..	....	..	....	..	....	77	9.173
..	....	..	....	..	....	39	9.441	78	9.441
..	....	..	....	..	....	..	....	79	9.716
5	10.000	10	10.000	20	10.000	40	10.000	80	10.000

A casual inspection of Table 4 shows that the series with ratio $\sqrt[10]{10}$ contains all the terms comprised in the series with ratio $\sqrt[5]{10}$ and in addition one term which is the geometrical mean between every two of those in the simpler series. Similarly, the series with ratio $\sqrt[20]{10}$ contains all those in the series with ratio $\sqrt[10]{10}$ with one additional term between every two of those occurring in

the latter series. The same sort of thing must hold, no matter how far one carries the construction of such series.

Obviously, if one wished to construct a set of models with a small number of steps or sizes, he would use some or all of the values in the $\sqrt[10]{10}$ series, or possibly even drop back to the $\sqrt[5]{10}$ series. If more sizes were wanted the $\sqrt[20]{10}$ series or the $\sqrt[40]{10}$ or the $\sqrt[80]{10}$ would be used as required.

This gives several sets of preferred numbers, all of which, however, belong to one family.

The Germans then take one further step and round off these preferred numbers, making 1.259 into 1.2; 1.585 into 1.6; etc. This gives the final set or sets of preferred numbers. Such sets are illustrated in Table 5, from which the method of construction will be obvious when studied in connection with Table 4.

TABLE 5 PREFERRED-NUMBER SYSTEM ADOPTED IN GERMANY—SIMPLIFIED VALUES

Values from 1 to 48				Values from 50 to 500			
Series 1	Series 2	Series 3	Series 4	Series 1	Series 2	Series 3	Series 4
1	1	1	1	..	50	50	50
	1.2	1.2	1.2		...	...	52
1.6	1.6	1.6	1.6		...	56	56
	2	2	2			...	60
2.5	2.5	2.5	2.5	64	64	64	64
	3	3	3			...	68
		3.5	3.5			72	72
4	4	4	4			...	75
		4.5	4.5		80	80	80
	5	5	5		...	...	85
		5.5	5.5		...	90	90
6	6	6	6			...	95
		7	7	100	100	100	100
	8	8	8		...	...	105
		9	9	.	...	112	112
10	10	10	10	.		...	118
		11	11	..	125	125	125
	12	12	12	.	.	...	132
			13		.	140	140
		14	14			...	150
			15	160	160	160	160
16	16	16	16		...	...	170
			17	.	..	180	180
		18	18			...	190
			19		200	200	200
	20	20	20		...	...	210
			21		...	225	225
		22	22		...	...	240
			24	250	250	250	250
25	25	25	25	...	...	...	265
			26	...	...	280	280
		28	28	...	...	...	300
			30	...	320	320	320
	32	32	32	...	...	...	340
			34	...	...	360	360
		36	36	...		...	380
			38	400	400	400	400
40	40	40	40	...	...	...	420
		...	42	...	...	450	450
		45	45	...	...	...	480
. .	...	...	48	...	500	500	500

The authors believe that it may be a mistake to round out the numbers in these tables instead of preserving the original values. The original values are the exact values, and the extent of rounding in some cases is so great as to entirely mask the original value. If one regards the adoption of preferred numbers as the adoption of a new number system, much can be said in favor of preserving the peculiar decimal fractions. However, only experience can prove the correctness or incorrectness of such practice.

Application of Preferred-Numbers System to Units of Measurement

Any attempt to apply such a system of numbers to our units of measurement immediately introduces a complication. The decimal fractions do not lend themselves readily to use with feet and inches in the way in which we now use, or think we use, those dimensions. However, it has been shown already that in many cases we are now dealing with decimal fractions in some of our most common articles of commerce, and there is no reason to suppose that we could not extend this practice if the results to be achieved warranted it. If we adopted the inch as a standard of length, for instance, and used decimal fractions of inches and multiples by tens we should have a system with many of the conveniences of the metric system.

After all, commerce is actually conducted as much in terms of nominal sizes as in terms of actual or approximate dimensions, so that no difficulty need be anticipated in that direction. Production at the present time is effected largely in terms of gages, and it is certainly just as easy to produce gages to check a dimension equal to, say, 1.585 as it is to construct a gage to check a dimension equal to 1.750, that is, $1^3/_4$ in. or 1 ft. 9 in. It would seem as though no great difficulties would be introduced into production or manufacture by the adoption of such decimal fractions. The only other function needing consideration is that of design. The designer in most cases works in terms of decimal fractions anyway, and with our present system is confronted with the necessity of converting his final results into the conventional fractions of an inch. Certainly he ought not to complain if a system of measurement expressed in decimal fractions is adopted.

Let us now return to the graphs of actual sizes of commercial products as given in Figs. 1 to 11, 18, and 19. Study of such graphs will show that those products which are largely used as components of manufactured or fabricated articles, such as bar steel, bolts, structural shapes, wire, etc., are generally made in such sizes that the graph to semi-logarithmic coördinates is concave toward the horizontal axis. This means that in the larger sizes such materials are made to finer sizes (smaller steps) in a geometrical sense than they are in the smaller sizes. On the other hand, in the case of finished articles, such as household utensils, containers, machines of various sorts, etc., there is a greater tendency for the graph to flatten out or to become convex toward the horizontal axis. This indicates a tendency toward more uniform spacing throughout the line and in some cases toward wider spacing, in a geometrical sense, in the larger sizes.

Such tendencies as these may not be lost sight of in any effort to rationalize sizes by the adoption of preferred numbers. It may be that we now produce an excessive number of sizes in certain products and that we would actually save in the long run by producing fewer, but such matters require long and detailed study before conclusions can be drawn.

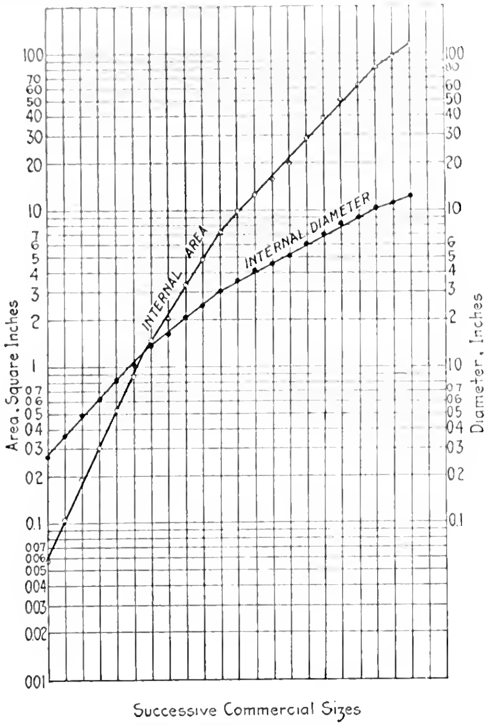


Fig. 19 Standard Wrought-Iron Pipe
(Points represent actual diameters and areas as now made.)

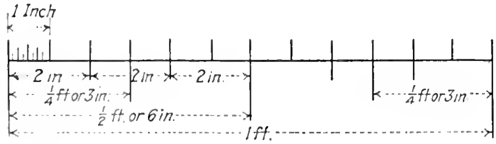


Fig. 20 Length of One Foot so Subdivided That Lengths of Division Lines Represent Order of Preference

There is a further thought which should be kept in mind during all efforts to adopt preferred numbers. Materials as used in production are basically dimensioned to meet certain loading requirements. It happens that physical dimensions appear in several different ways in the formulas which are involved, particularly with reference to their exponents.

As an illustration of the significance of this, strength in tension or compression varies with the square of the diameter in the case of a solid circular section, but strength with respect to bending varies as the cube of the diameter. If we imagine a set of preferred numbers in use and further imagine that round steel stock is rolled to preferred diameters, it hardly seems possible that one set of preferred diameters can give equally desirable variations of its squares and its cubes. When one considers the further complications which are introduced when other types of loading are brought into consideration, the case appears complex indeed.

Such difficulties may prove to be more apparent than real, but the underlying ideas should be borne in mind in any detailed study of this subject.

Possibilities in Simplification of Design

Attention thus far has been concentrated largely on size as a finished or completed proposition with little reference to the mechanism of design. No small part of the saving to be expected should accrue from simplification of design. This matter has been sparingly treated in the rather meager literature of this subject and a few very interesting studies have been recorded. In particular, a paper by Erich Hoffman published in *Mitteilungen des Normenausschuss der Deutschen Industrie*, February, 1920, contains two very interesting examples, one of these being a set of eyebolts.

The collar diameter of the smallest eyebolt is taken as the basic dimension, and for successively larger bolts this is increased in the ratio $\sqrt[10]{10}$ for the smaller range of sizes, and in the ratio $\sqrt[20]{10}$ for the larger range of sizes. Other dimensions of each eyebolt are obtained by taking its collar diameter as a starting point and multiplying by factors differing with the dimension sought. The factor used for a given dimension (such as internal diameter of eye), however, is the same for all sizes of bolt, and the result is therefore a set of geometrically similar eyebolts. As a matter of fact, the Germans have gone one step further, in that, for the set of eyebolts in question, each dimensional multiplying factor is taken as one term in the series with the ratio $\sqrt[80]{10}$, and thus each of these factors is itself a preferred number.

This sounds like a very pretty piece of mathematical juggling in connection with machine design, but it really has a very deep practical significance. A designer need design and draw only one size of eyebolt if he is sure that a certain series can be applied. All other desired sizes can then be obtained by the simplest form of calculation or directly from a table. If there is doubt as to the applicability of one series, he may design and draw the two extreme sizes and the middle size, determine the applicability of any chosen geometrical series, and proceed by simple interpolation to tabulate dimensions for all sizes. A certain amount of caution is necessary in such proceedings and it is always best to draw at least the two extremes if one is in doubt as to the applicability of a given series. Hoffman points out a case in which certain handwheels were under consideration. A satisfactory result was obtained by grading the outer diameter according to the $\sqrt[20]{10}$, the thickness of the rim and spokes according to the $\sqrt[40]{10}$, and the diameter of the hub according to the $(\sqrt[80]{10})^3$. This looks extremely complicated, but if one draws the largest and smallest handwheels, plots the points on semi-logarithmic paper and draws straight lines between, the job is finished.

German authors have been quite enthusiastic over the fact that geometrical series, and particularly geometrical series with ratios equal to roots of 10, have proved widely applicable to design and sizing as now carried out. They seem to emphasize the ease with which the series based on $\sqrt[80]{10}$ can be fitted into existing designs. At first sight it seems as though such applicability represented a most remarkable coincidence, but there is really much behind the phenomenon.

In the first place, human beings accept geometrical ratios in preference to arithmetical when the results are presented in such fashion that the mathematical construction is not in evidence. This is a phenomenon well known to psychologists and one which has been extensively tested. Examples could be cited from many different human activities, but consideration of size is sufficient for the present purpose. The normal human being, in developing a series of sizes, starts out with small increments, enlarging them as he increases the sizes. He thus unconsciously approximates some geometrical series or some combination of geometrical series.

In the second place, one can obtain practical approximations to all the numbers there are by using a sufficiently great number of series based on roots of ten.

The preference for the series with the $\sqrt[80]{10}$ ratio is probably due to the large number of terms in the series, and to the binary structure of the number 80, which contains 2 as a factor four times. This last feature makes this series fit in with many existing sizes since, as has been pointed out, the binary principle (successive division or multiplication by 2) has been extensively used in fractional and in many other series of "preferred numbers" which have been developed and used more or less unconsciously through a long period of time. This feature also makes it possible, if changing industrial conditions make such a development desirable, to double the number of terms in a 5-, a 10-, a 20-, or a 40-series, or in any part of such a series. Furthermore, it may happen that this series represents approximately the path chosen by an uninfluenced human being and is therefore mathematically located in accordance with the theory of probability.

In presenting this paper the authors have attempted to picture the present status of the preferred-number idea and to do it in such a way as to point out its advantages and also its complications and dangers. The authors themselves hold no brief for preferred numbers, but they do believe that the idea indicates possibilities of simplification and elimination of waste of such magnitude that thorough investigation is justified.

The American Engineering Standards Committee is very much interested in the subject of preferred numbers, or Standard Numbers, as the tendency is now to term them, on account of the very generalized way in which the proposal affects many standardization projects. If after study and wide discussion the preferred-numbers method proves to be a sound and rational scheme, it will provide a systematic and flexible tool for settling the question of standard sizes for many component parts, if not for complete structures and machines.

The Committee is coöperating in the current phase of this topic by getting in touch with engineers and industrial experts in diverse fields to which the subject is related, and arranging discussions by leading representatives of some of the following fields: Electrical manufacturing and construction; building design and construction; manual and automatic telephony and telegraphy; governmental research and development work; railway construction and manufacturing practice; hardware; the lumber trade; bolts, nuts and rivets; military ordnance; machine tools; gages; automotive products; structural-steel sections; illuminating practice; and management.

The American Engineering Standards Committee has conducted an inquiry as to the use of the preferred-numbers method abroad. Not all the returns are in, but it is known that the system is already in use in Germany. A general preferred-numbers standard is up for adoption by the Commission Permanente de Standardisation in France, and the system has been used in two French detail standards, one on tool holders for lathes and other machine tools, and the other for aluminum plates, strips, rolled sections, and tubes. The Dutch have the subject up for consideration by their main committee, and may issue a standard; the Austrians expect to adopt the German Standard on the subject, and consider the plan to be very important in its relation to international standardization, in improving the exchangeability of products. The Swedes also think the subject should be considered internationally, and feel that their past work could have been guided and facilitated by some sort of rational preferred-number series. The Swiss are awaiting further manufacturing opinion before proceeding to the development of a standard. The Norwegians express themselves as definitely interested. Everything considered, the coming year is likely to see developments of great importance in this relation.

Steam Distribution in the Locomotive

By GEORGE H. HARTMAN,[1] CLEVELAND, OHIO

This paper gives particulars regarding a new sleeve-valve arrangement for locomotives, designed by Charles J. Pilliod, that can be applied to old engines, either simple or compound. Among other things, it is claimed that the new arrangement –

(1) Makes it possible to effect in the locomotive a steam distribution and economy superior to that obtained in the Corliss stationary engine, along with a reduction in the degree of superheat now carried;

(2) Eliminates causes producing lame engines, as well as lubrication troubles now experienced with plain valves; and –

(3) Makes it impossible for the engineer to cause the cut-off to occur earlier than at its most economical running position.

THIS paper deals primarily with the research work of Charles J. Pilliod, one of the pioneers in locomotive valve and valve-gear design. Mr. Pilliod has recently designed a new valve that has much merit, and one that will, in the opinion of the author, establish many new precedents. While final tests have not yet been made, it is nevertheless believed that the ideas involved are of such importance to the railroad world that they should be disclosed and made the subject of discussion.

In stating the claims that are made for the new valve and analyzing them as to the theory involved, the author has no intention of discrediting any other device that he may find it necessary to mention. It has been thought desirable, however, to raise as many pertinent points as possible in order to stimulate friendly criticism of the conclusions which he reaches, and also to emphasize the fact that there is need in the locomotive field for economy-increasing factors.

A fairly complete analysis of the results produced by the three leading types of valve gears has been found necessary, inasmuch as the use of the new valve arrangement does away with the use of the valve gear as a cut-off-producing medium.

TRUE EFFICIENCY

After the steam is in the cylinder there is but one way to increase the utilization of the heat units it contains, and that is to lower its terminal temperature by expansion. The locomotive in cutting off the steam at 25 per cent of the stroke and releasing at 60 per cent produces 2.4 expansions, neglecting clearance. If the expansion is carried to the end of the stroke there will be four expansions for the same point of cut-off, or an approximate increase of 33 per cent in the utilization of the heat units. This percentage of increase, minus the gain due to maintaining the steam line past the point of release, on account of the back pressure, would be the gain that we could expect to obtain from the increased expansion, other conditions being equal.

Running non-condensing, the simple Corliss engine shows a saving of 25 to 30 per cent over the simple automatic engine, and a saving of 40 per cent over the simple throttling engine. This economy is due entirely to the fact that the release point is made to occur at from 85 to 90 per cent of the stroke at all points of cut-off. It is not possible, however, to use the Corliss design in locomotive practice due to its limitations as to speed, but it does point out the path that must be followed if we ever expect to utilize more of the energy that is available.

OPERATION OF THE PILLIOD SLEEVE VALVE

The Pilliod locomotive sleeve-valve arrangement consists of two moving sleeves, or rather a plug and a sleeve, together with a cut-off-controlling bushing. The inside sleeve or plug is moved through a certain constant travel, the amount of which depends upon the valve events that are desired. This plug is actuated by the reversing mechanism, being driven by the radius rod of the valve gear. For application to old power it is never necessary to exceed 4 in. of valve travel. Either the travel of the lever in the cab can be limited or the throw of the return crank reduced to accomplish this result. The outside sleeve is driven from the lap-and-lead lever of the engine, which imparts to it a travel generally around $2^1/_2$ in.

The operation is as follows: The plug and the sleeve moving thereon, by receiving constant travels at all of the points of cut-off, produce at all times constant valve events, including that of the maximum point of cut-off. All valve events are exactly equal on both ends and the same in the forward as in the back motion, as will be brought out in detail later. Changing of the point of cut-off is effected by moving the cut-off-controlling bushing, which is a sliding bushing manually or air-controlled by the engineer. This bushing together with its control linking is shown in Fig. 1.

It should be emphasized in this connection that the events of release and exhaust closure are not effected by the operation of the cut-off-controlling bushing, and also that they can be made to occur at any point that may be desired, up to and including the end of the stroke.

The sleeves are always in a perfect state of balance, even remaining so should ring leakage develop. The cut-off-controlling bushing is not only balanced as to steam pressure, but also against the sliding friction of the sleeves moving therein. This is made possible by linking up the control levers so that equal and contrary reactions are produced at all positions. By referring to Fig. 1 it will be seen that when the lever that controls this cut-off bushing is moved by the engineer, the two sections comprising it are either moved toward or away from each other, as the case may be. This opposing movement changes the port line on which the variable cut-off is effected. Exact balance is produced by reason of this contrary movement, as the sleeve imparts a push to one of the cut-off-controlling bushings and a pull to the other or vice versa. It will be seen that the reach-rod connection in the cab could in theory be disconnected and no movement of the cut-off bushing would result. Due to this exact balance it is possible for the engineer to unlatch the controlling lever in the cab, for it cannot move until he actuates it.

Referring to Figs. 1 and 2, it will be seen that the Pilliod sleeve valve can be applied to existing piston-valve engines by placing an adapter bushing in the chest that carries the new port lines required for the sleeve valve. This reduces the diameter of the valve slightly, but as the port opening that can be obtained is practically unlimited, no disadvantage results. It is possible to get $^5/_8$ in. admission opening and $1^3/_4$ in. exhaust opening at 25 per cent cut-off with only $3^1/_2$ in. valve travel. Increased valve travel will give a corresponding increase in the port openings that can be obtained. Where the sleeve valve is applied to new saddles or to old slide-valve engines that have been converted with a new piston-valve chest, this adapter bushing is not needed.

RESULTS PRODUCED BY THE PILLIOD SLEEVE VALVE

The following advantages are claimed for the Pilliod sleeve valve:

a Elimination of the valve gear as a means for producing variable cut-off. This does away with the distortion now present in all valve gears, and in particular when the sleeve valve is driven by the Walschaerts, Baker, and other gears that receive their accelerated travel from a connection to the crank; as the rise and fall of the engine on its springs will not cause a change in the valve events. All causes producing lame engines are eliminated

b Unlimited amounts of port opening, both admission and exhaust, at any point of cut-off

c Elimination of lubrication troubles now experienced with plain valves

d Full expansion of the steam to the end of the stroke, regardless of the point of cut-off

---

[1] Chief Engineer, Cleveland Vending Machine Co. Assoc-Mem. Am. Soc.M.E.

For presentation at the Annual Meeting, New York, December 4 to 7, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. Slightly abridged. Copies of the paper may be obtained gratis upon application. All papers are subject to revision.

e All the compression eliminated; or all the compression desired obtained at any point of cut-off and independently thereof

f No preadmission noticed, regardless of the amount of lead

g Reduction in the degree of superheat now carried is possible with the new arrangement, with an increase in the economy effected and with a large reduction in the present maintenance expense

h Proper balancing of the Mallet compound is made possible, together with other advantages where the new arrangement is applied to compounds

i The new arrangement aids combustion, due to better draft, softer blasts, etc.

j Decreased reciprocating weights. The inside plug on a 14-in. by 46-in. chest weighs 154 lb. and the outside sleeve 146 lb., or a total of only 300 lb.

k The placing of all engineers on a basis of equality. The proper minimum point of cut-off cannot be exceeded. The engine cannot be worked against itself

l When applied to existing piston-valve engines it is not necessary to make radical changes in the existing engine structure. When applied to most slide-valve engines, a specially designed piston-valve chest can be used that is also applicable for use with the standard inside-admission plug valve.

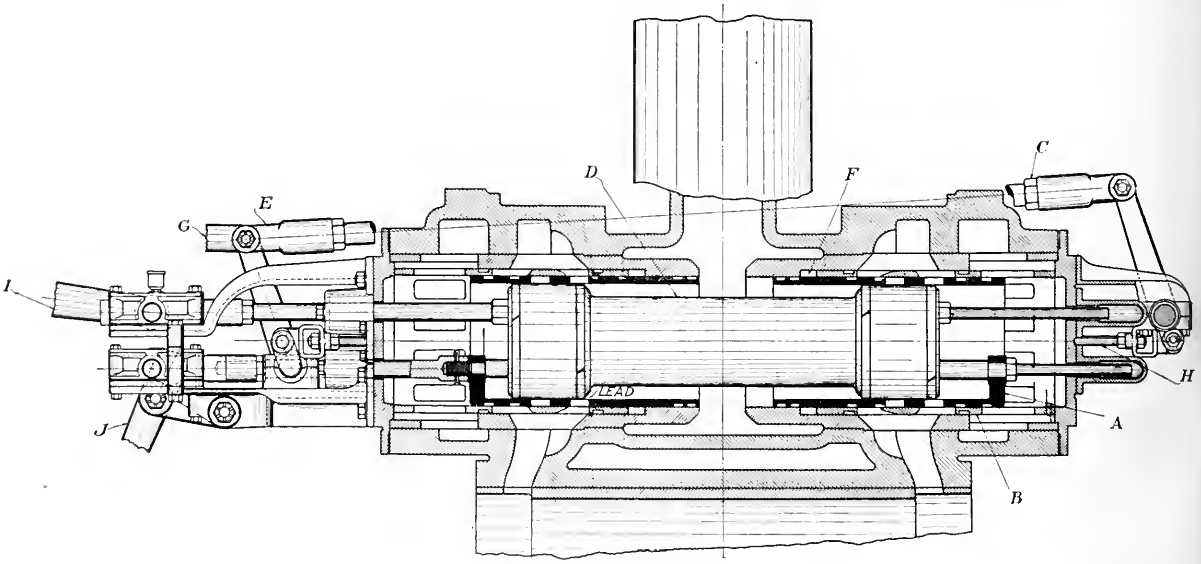


Fig. 1 The Pilliod Locomotive Sleeve Valve

A—Moving sleeve traveling a constant distance of $2\frac{1}{2}$ in. and driven by combination lever *J*. Shaft connecting the two halves of this sleeve works through the inside plug valve *D*. Cut-off and release are produced entirely by this sleeve driven by the crosshead.

B—Cut-off is controlled by moving this bushing. A movement of $1\frac{1}{2}$ in. changes cut-off from 85 per cent to 25 per cent. Control either from reach rod or air cylinder.

C—Control rod by which cut-off-controlling bushing is adjusted.

D—Inside plug or spool driven by radius rod of valve gear. Has a constant travel of 4 in. for all events given below. This plug performs function of reverse; it does not effect the cut-off.

E—Due to the opposing travels of the cut-off-controlling bushings at each end, all ring-friction loads, etc., produce tension in this rod between the pins at either end No stresses are carried to air cylinder or hand control (if latter is used).

F—Holes are drilled through the bridges into the exhaust that prevent pressure backing up into this pocket.

G—Connection to air-control cylinder or to reach rod and reverse lever in cab.

H—Two of these $\frac{7}{8}$-in. rods connect to each cut-off-controlling bushing on the outer edge.

I—Radius rod of valve gear driving plug *D* through its 4 in. of travel.

J—Combination lever of valve gear driving the sleeve *A* through its $2\frac{1}{2}$ in of travel.

Valve Events:

85 per cent cut-off; 96 per cent constant release; 85 per cent constant exhaust closure.

Full $1\frac{3}{4}$ in. port opening at 85 per cent cut-off in 17 per cent of stroke.

Full $\frac{7}{8}$ in. port opening at 50 per cent cut-off in 4 per cent of stroke.

Full $\frac{6}{8}$ in. port opening at 25 per cent cut-off in 2 per cent of stroke.

Full $1\frac{3}{4}$ in. exhaust opening, dwelling full open between 5 per cent and 60 per cent of stroke on the return travel of the piston at *all* points of travel.

Constant $\frac{1}{16}$ in. preadmission at all points of cut-off with $\frac{3}{8}$ in. lead.

Note: These valve events can be changed so that they will give any release at any point of cut-off.

A study[1] of modern locomotive valve gears will lead one to doubt that there is any mechanical reason why any one gear will give more expansion, permit of more rapid opening of the ports, give wider port openings, or better steam distribution than any other, provided that the valve travel, lap, lead, etc., are the same in both cases. One gear might, under different conditions from those mentioned, produce a slightly better steam distribution, but the author is convinced that any outside valve gear can be designed to give any steam distribution that can be obtained by using any other valve gear. If this be true, how can any claim be made by the maker of a given valve gear for efficiency increases over any other? Possibly the Walschaerts types might give slightly better results along the full range of cut-off than the designs with the Randel reverse, on account of the more complete dissipation of the angularities. Further, it is the general opinion that the old Stephenson motion will produce a slightly better steam distribution than the outside valve gears now used.

To bring out the slight difference in the results obtained with various valve gears, the charts of Figs. 3 and 4 have been prepared. From these it will be noted that with equal valve travels the results do not vary to any considerable extent.

The question might be raised as to why these gears are so extensively used if greater economy is obtainable from the older forms of valve motion. The main reason is that the Walschaerts and the Baker designs permit of repairs being made more easily and of better designs being made than would be possible with the heavy type of inside gears, which cannot be easily used with the heavy modern power that we now have. Other factors, such as piston valves for superheated engines—requiring outside valve gears—must also have consideration. It is claimed by some that the Baker gear, by making use of the Marshall reverse, is possibly easier to build than the Walschaerts, which employs the expensive curved link.

Radical improvements in the maintenance of the initial valve settings are possible by changing the valve gear so that the accelerated travel, as well as the lap-and-lead travel, can be obtained from the crosshead. The crosshead-connected valve gears show great increase in economy, due to maintaining the efficiency that the engine had when new.

---

[1] The complete paper discusses the matter fully.

Analysis of the Claims Made for the Pilliod Sleeve-Valve Arrangement

There are no limitations of any kind in the events produced by the new sleeve arrangement. This arrangement also eliminates all of the distortive features connected with valve gears regardless of what type of valve gear is used to drive the sleeve valve.

No Distortion of Valve Events Possible in the Sleeve-Valve Arrangement. The reasons why the new valve arrangement cannot be distorted and why it will remain square after any period of use, can be made the subject of an interesting analysis. If it could do no more than maintain the same valve events that are now obtained by the plain piston valve, its use would probably warrant the cost of application. The 8 to 21 per cent loss resulting from lame engines is a condition recognized by all who have given valve-motion design any attention whatsoever.

When the new sleeve-valve arrangement is applied to an old locomotive the same valve gear is used to drive it that was used with the valve removed (see Fig. 2). In the case of the sleeve arrangement, however, the valve gear ceases to be a valve gear in the strict sense of the word and becomes only a plain reversing device. The lap-and-lead motion of any outside valve gear of the Walschaerts or Baker types can never be distorted by the changing conditions in the setting of the engine

Referring to Fig. 1, it will be seen that the event of cut-off is accomplished by the action of the outer sleeve closing in on the edge of the cut-off-controlling bushing. It will also be seen that the plug valve driven by the reversing device performs no part of this cut-off function. This condition makes the cut-off at all points purely one of a fixed relation between the combination lever-driven sleeve and the manually or air-controlled cut-off-controlling bushing. This being true, the cut-off can never be anything but in the 100 per cent square condition that the engine had when new. Even pin wear in the combination lever and the other connections will not cause a variance, as the lost motion due to pin clearance will be the same at both ends of the stroke.

The release will also always remain square, as the opening of the port is being accomplished through the fact that the plug valve is traveling at a high rate of speed when the piston, by reason of its being at the end of the stroke, is closely approaching a state of rest. The valve travel being constant at all points of cut-off, the action of the opening of the exhaust port is also constant. This permits of the correct setting being obtained, and the feet-per-minute travel of the valve being much greater than that of the piston, makes it possible for the accelerated travel to be greatly distorted without the ear being able to detect unequal exhausts. Another condition that practically eliminates the unequal exhausts due to distortion is that the release by occurring at 95 per cent of the stroke and upward so reduces the terminal pressure that even if exhaust lameness were present there would be little if any loss of efficiency.

The foregoing analysis shows that long periods of maintenance are possible when the sleeve-valve arrangement is applied to engines in which the accelerated travel is obtained from a connection to the crank. In the case of the crosshead-connected valve gears the maintenance conditions would not be increased over those now obtained by the use of such gears. But when we consider that of all the locomotives now in use, less than one hundred are equipped with crosshead-connected valve gears, we can appreciate the gain that will be derived from this feature of freedom from lameness when the new valve arrangement is applied to old power.

Unlimited Port Opening At Any Point of Cut-off. The new valve arrangement, consisting as it does of a pair of sleeves, each driven from a different source and each moving a greater or less distance, produces this form of travel. First the sleeves move as a unit and in the same direction, then one will follow with a retarding movement and the other will accelerate, then both will dwell; and finally they will move as a unit in the reverse direction, producing a period of maximum opening and then a rapid shearing closure by the sleeves again moving in the first direction. This means that the port opening at the working point of 25 per cent cut-off is obtained almost before the piston can be seen to move, and that by changing the valve travel this port opening can be made any amount desired. For instance, with $2^1/_2$ in. travel of the sleeve connected to the combination lever, we get $^5/_8$ in. port opening at 25 per cent cut-off, which is 100 per cent more than is now obtained. With an additional $^1/_2$ in. of sleeve travel we get $^3/_4$ in. port opening at 25 per cent cut-off. At full gear, with the $2^1/_2$-in. travel, the width of opening will equal that now obtained with the plain piston valve.

This excess port opening and the extreme rapidity with which the opening is effected means that one of the principal arguments in favor of early exhaust closure has been shattered, as the steam admission line can be maintained straight, even with the almost total absence of compression and preadmission. The restriction of the present valve design, in which never more than $^1/_{32}$ in. to $^1/_{16}$ in. acceleration is obtained with $^1/_4$ in. lead and 1 in. lap, produces a wire drawing effect at high speeds, and if the clearance space had to depend on the boiler for steam, the steam line of the indicator card would show a material dropping off. This wire-drawing, moreover, causes excessive initial condensation, which will not occur where the port opening is unlimited.

Unlimited Release Opening. The events produced by the constant-travel valve are all constant except that of cut-off. As the valve travel is not changed in proceeding from one point of cut-off to another, the same release that is given for full gear will be had at all of the working points of cut-off. With the plain variable-travel piston valve, when the travel is shortened in order to get the earlier cut-off the release opening is at the same time restricted. A comparison of the events of the plain valve with those of the new Pilliod arrangement can be seen in Figs. 5 and 6. With the sleeve action above mentioned, full opening is obtained at the end of the stroke and within $1^1/_2$ in. travel of the piston, which opening is caused to persist up to 60 per cent of the return travel of the piston, at which point the closure starts and by the shearing action of the sleeves the valve rapidly closes at 95 per cent of the stroke, provided this is the point of release for which it is designed. This means that back pressure can be entirely eliminated if desired and all of the force produced applied to the crank as a turning moment.

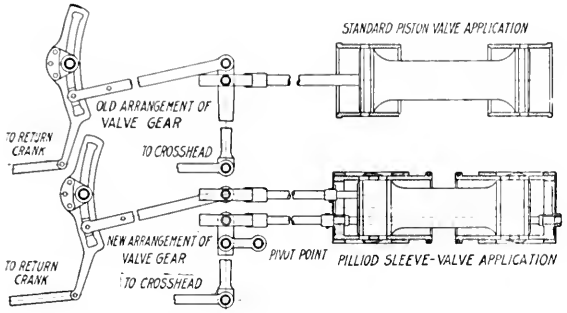
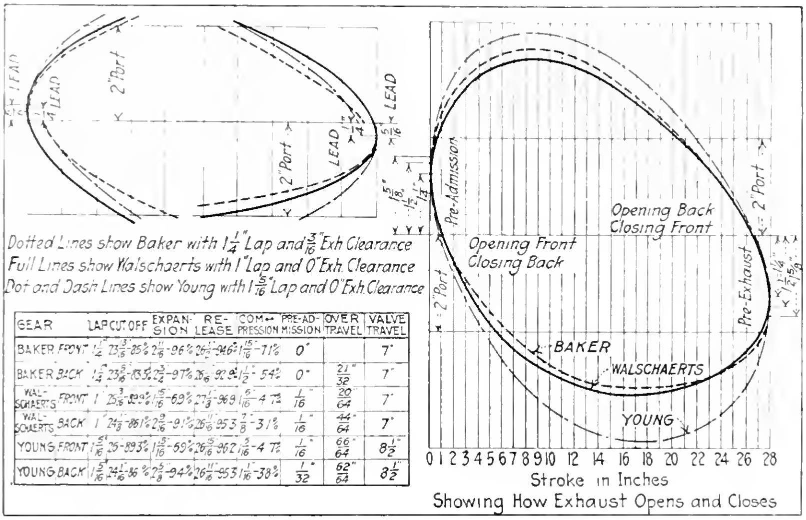


Fig. 2 Changes Required When Old Locomotives Are Fitted with Pilliod Sleeve Valves

Variable Relation of the Release to the Closure. A defect in the present design of plain variable-travel piston valves is that, with the exhaust line and line, exhaust closure must occur diametrically opposite to the point of release. As before stated, if the release is made to take place later by the addition of exhaust lap, then the closure will occur earlier. In the case of the Pilliod arrangement, anything desired can be given. If designed with the exhaust line and line, release and closure will be diametrically opposite up to 100 per cent release and closure. The difference comes from the fact that if we design for 85 per cent closure and 85 per cent release, with a line-and-line valve, and then add exhaust lap to get 95 per cent release, we shall, on the return of the piston, get a 75 per cent closure. This feature makes the Pilliod a design without limitations, as it could also be designed for 90 per cent line-and-line release and closure and, by adding lap for 95 per cent release, 85 per cent closure be obtained. This earlier closing feature is brought out to show that if the arrangement were applied to old power where the clearance space was extremely excessive, it would still be possible to get the long expansion, and



Dotted Lines show Baker with $1\frac{1}{4}$" Lap and $\frac{3}{16}$" Exh Clearance
Full Lines show Walschaerts with 1" Lap and 0" Exh. Clearance
Dot and Dash Lines show Young with $1\frac{5}{16}$" Lap and 0" Exh. Clearance

GEAR		LAP	CUT OFF	EXPANSION	RELEASE	COMPRESSION	PRE-ADMISSION	OVER TRAVEL	VALVE TRAVEL
BAKER	FRONT	$1\frac{1}{4}$"	$23\frac{3}{16}$-85%	$2\frac{11}{16}$-96%	$26\frac{1}{2}$-94.6%	$1\frac{15}{16}$-7.1%	0"		7"
BAKER	BACK	$1\frac{1}{4}$"	$23\frac{5}{16}$-83.5%	$2\frac{3}{4}$-97%	$26\frac{1}{16}$-92.9%	$1\frac{1}{2}$-5.4%	0"	$\frac{21}{32}$"	7"
WALSCHAERTS	FRONT	1"	$25\frac{3}{16}$-89.9%	$1\frac{15}{16}$-6.9%	$27\frac{1}{8}$-96.9	$1\frac{5}{16}$-4.7%	$\frac{1}{16}$"	$\frac{20}{64}$"	7"
WALSCHAERTS	BACK	1"	$24\frac{1}{8}$-86.1%	$2\frac{9}{16}$-9.1%	$26\frac{11}{16}$-95.3	$\frac{7}{8}$-3.1%	$\frac{1}{16}$"	$\frac{44}{64}$"	7"
YOUNG	FRONT	$1\frac{5}{16}$"	25-89.3%	$1\frac{5}{16}$-5.9%	$26\frac{15}{16}$-96.2	$1\frac{5}{16}$-4.7%	$\frac{1}{16}$"	$\frac{66}{64}$"	$8\frac{1}{2}$"
YOUNG	BACK	$1\frac{5}{16}$"	$24\frac{1}{16}$-86%	$2\frac{5}{8}$-9.4%	$26\frac{11}{16}$-95.3	$1\frac{1}{16}$-3.8%	$\frac{1}{32}$"	$\frac{62}{64}$"	$8\frac{1}{2}$"

Fig. 3 Comparison of Forward Motions of Baker, Walschaerts, and Young Valve Gears—Full Gear

still enough compression to avoid too much loss of live steam in the clearance space.

Lead and Preadmission. With the present-day design of the single-piston, variable-travel valve we must use excessive lead (the amount that the port is open at the beginning of the stroke) in order to get enough port opening in the shorter cut-offs. The lead, together with the lap travel, is obtained from the fixed travel on the lap-and-lead lever of the valve gear in the case of outside-connected valve gears, or from the advance of the eccentric in the case of the Stephenson gear. In the former case this travel is constant, as it is not changed when the reversing lever is hooked up in shortening the cut-off.

A condition prevailing in all outside constant-lead gears is that the lead is obtained at full gear with the minimum of preadmission, the latter being measured from the point where the valve starts to open before the piston has completed its stroke.

In the plain valve this preadmission varies in amount, depending on the point of cut-off. In the case of the Pilliod arrangement it will never be more than $^1/_{16}$ in., and this amount will remain constant because of the constant travel of the plug and sleeve and the fact that the sleeve which is opening the lead is traveling much faster at this point than the piston. This means that the Pilliod arrangement will eliminate almost all of the preadmission, in addition to doing away with early closure, and thereby still further reduce the negative work. All of the force produced can then be applied to the crank, creating the drawbar pull which is the primary function of the locomotive.

Compression. Compression cannot be eliminated in the locomotive when existing valve gears are employed to operate the common variable-travel slide or piston valve. This fact has been made the subject of many an argument by textbook authors, and many of them have been led to reason out advantages that are presumably to be derived from its presence.

The losses caused by high compression are great and represent a large percentage of the excessive loss incurred in the utilization of the heat units in the steam engine. Professor Dwelshauvers-Dery of Liége, Belgium, states that as the compression is increased from 10 to 30 per cent, the increase in fuel consumption is 21 per cent; and that for a further rise of 40 per cent the amount of steam used increases 50 per cent. Part of this loss might be compensated for, it is true, in the decrease of the amount of live steam needed to fill the clearance space, but this saving would not be as great as some might think.

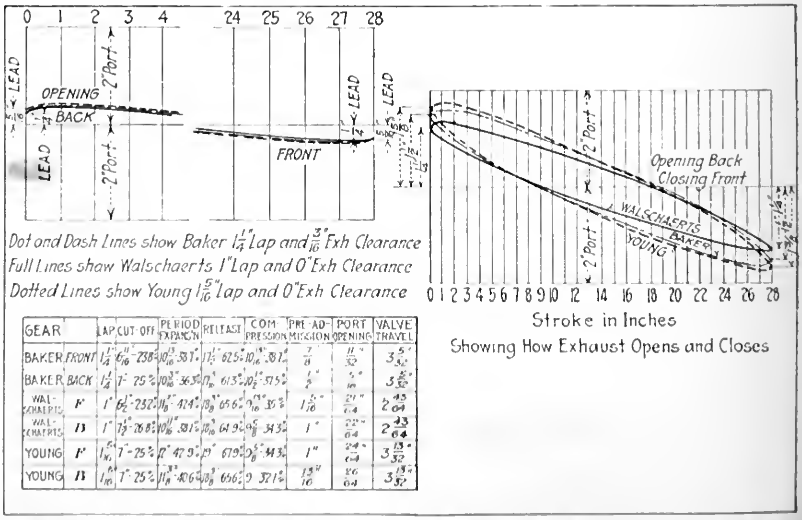
The author believes that from the point on the return of the stroke at which the piston commences to be retarded by the compression to the end of the return stroke, any compression of steam into the clearance space is a detriment.

Locomotive design at the present time is limited by the events that can be obtained from the combination of the plain plug and slide valve with the standard valve gears. At the working points of 25 per cent cut-off and 60 per cent release and with the exhaust line and line, the compression obtained is approximately 40 per cent.

The bad effects of this compression will be plainly seen when we consider that the engineer will have to drop the reverse lever down to a later point of cut-off if the throttle is closed and the engine is allowed to drift down grade while going at a high rate of speed. If the engine is kept set at a short working point of cut-off and the throttle is closed, the nosing action due to the heavy compression will nearly cause the engine to leave the track if the speed of the train is high enough. Many a main rod has broken under the stresses imposed by heavy compression, and it is not making too broad a statement to say that if the compression were reduced the life of the main rods would be much greater than it now is.

With the present-day valve events which are obtained with the plain piston or slide valve and the variable-travel variable-cut-off valve gear, compression is useful to a certain degree. If it were all eliminated the restriction of the admission port at the 25 per cent cut-off would be such that the clearance would not be filled with pressure steam by the time that the piston was ready to start back. This would mean a drooping steam line on the indicator card, and the loss in mean effective pressure would partly offset the added gain in the turning moment due to a complete elimination of the compression.

With the present-day valve designs, complete elimination of the compression would also increase the initial condensation of the steam as it enters the cylinder, in the plain saturated type



Dot and Dash Lines show Baker $1\frac{1}{4}$" Lap and $\frac{3}{16}$" Exh Clearance
Full Lines show Walschaerts 1" Lap and 0" Exh Clearance
Dotted Lines show Young $1\frac{5}{16}$" Lap and 0" Exh Clearance

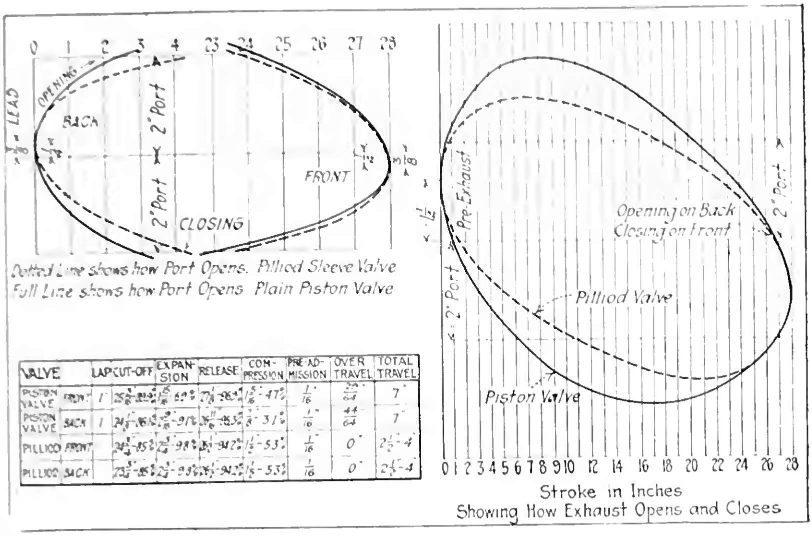
GEAR		LAP	CUT-OFF	PERIOD EXPANS'N	RELEASE	COMPRESSION	PRE-ADMISSION	PORT OPENING	VALVE TRAVEL
BAKER	FRONT	$1\frac{1}{4}$"	$6\frac{11}{16}$"-23.8%	$10\frac{13}{16}$-38.7%	$17\frac{1}{2}$"-62.5%	$10\frac{13}{16}$"-38.7%	$\frac{7}{8}$	$\frac{11}{32}$"	$3\frac{5}{32}$"
BAKER	BACK	$1\frac{1}{4}$	7"-25%	$10\frac{3}{16}$"-36.5%	$17\frac{1}{16}$-61.3%	$10\frac{1}{2}$"-37.5%	$\frac{1}{2}$"	$\frac{5}{16}$"	$3\frac{5}{32}$"
WALSCHAERTS	F	1"	$6\frac{1}{2}$"-23.2%	$11\frac{7}{8}$"-42.4%	$18\frac{3}{8}$"-65.6%	$9\frac{13}{16}$"-35%	$1\frac{1}{16}$"	$\frac{21}{64}$"	$2\frac{43}{64}$
WALSCHAERTS	B	1"	$7\frac{1}{2}$"-26.8%	$10\frac{11}{16}$"-38.1%	$18\frac{3}{16}$-64.9%	$9\frac{5}{8}$"-34.3%	1"	$\frac{22}{64}$"	$2\frac{43}{64}$
YOUNG	F	$1\frac{5}{16}$"	7"-25%	12"-42.9%	19"-67.9%	$9\frac{5}{8}$"-34.3%	1"	$\frac{24}{64}$"	$3\frac{13}{32}$"
YOUNG	B	$1\frac{5}{16}$"	7"-25%	$11\frac{3}{8}$"-40.6%	$18\frac{3}{8}$"-65.6%	9-32.1%	$\frac{13}{16}$"	$\frac{26}{64}$	$3\frac{13}{32}$"

Fig. 4 Comparison of Forward Motions of Baker, Walschaerts, and Young Valve Gears—25 Per Cent Cut-off

of engine. Initial condensation is increased to a certain degree by increasing the range of temperature in the cylinder. It also increases as the ratio of the area of the cylinder walls to the volume of the cylinder increases. Time is also an important factor and, other conditions being equal, the slower the speed of the engine, the greater the initial condensation. But reëvaporation is a deciding factor in the elimination of part of the initial condensation and is one element that must be considered in determining the amount of superheat that will show the greatest economy. In the plain variable-travel-valve engine now in use this initial condensation is increased by the wiredrawing of the steam at the point of admission (25 per cent cut-off) through the restricted port opening.

A factor that increases the negative work due to defects in the valve events is that of preadmission. Excessive preadmission, acting in the same manner as the excessive compression, tends to absorb the stored-up momentum in the engine that by right should go to the crank and be used as a turning moment.

Summing up, the author feels that the compression due to early exhaust closure should never go beyond the point of a balanced ratio between the utilization of the energy stored in the moving parts of the engine and the cost of initially filling the clearance space with the live fluid; and that preadmission should be eliminated.



VALVE		LAP	CUT-OFF	EXPANSION	RELEASE	COMPRESSION	PRE-ADMISSION	OVER TRAVEL	TOTAL TRAVEL
PISTON VALVE	FRONT	1"	[illegible]	[illegible]	[illegible]	1 5/16-47%	1/16"	[illegible]	7"
PISTON VALVE	BACK	1	[illegible]	[illegible]	[illegible]	[illegible]-31%	1/16"	44/64	7"
PILLIOD	FRONT		[illegible]-85%	[illegible]-98%	[illegible]-94.2%	1 1/2-53%	1/16"	0"	2 1/2"-4
PILLIOD	BACK		[illegible]-85%	[illegible]-99%	[illegible]-94.2%	1 1/2-53%	1/16	0"	2 1/2"-4

Fig. 6 Comparison of Forward Motions of Plain Piston Valve and Pilliod Sleeve Valve—Full Gear

(Walschaerts gear used in both cases.)

Curing the Effects and Neglecting the Cause. Trying to save part of the heat lost by reason of poor valve design seems to have been the best that has thus far been accomplished. We have the feedwater heater that endeavors to save at least a portion of the heat which otherwise would escape through the stack. Another remedial device is the brick arch. Brick arches do all that is claimed for them and they do save coal, but would they be able to effect the same percentage of saving on a compound that they can accomplish on the plain simple engine? It would hardly be possible. The saving of fuel by the arch is made possible through the fact that it prevents the unconsumed carbon from being drawn through the tubes by the heavy pull of the exhaust. We know that in the case of the compound with its increased number of expansions, the terminal temperature and the pressure of the exhaust are lower, with a resultant softer blast. The tendency of the exhaust to pull the fire is much reduced, even though the steaming efficiency of the nozzle is not impaired.

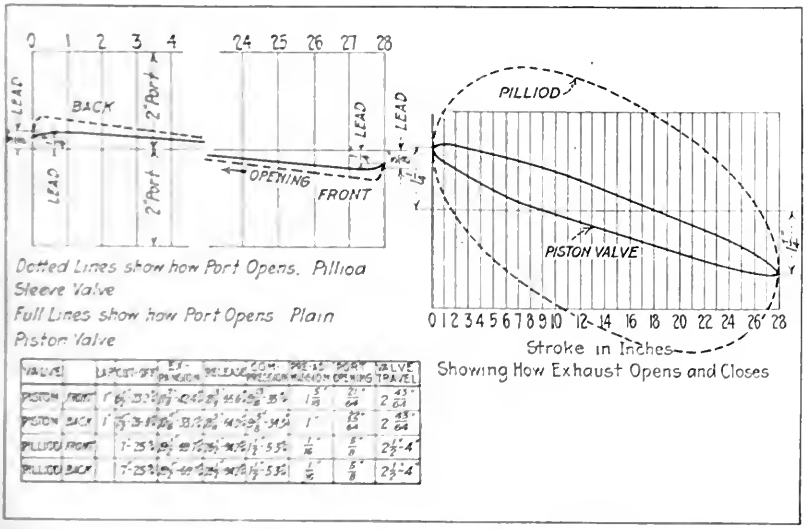
In reducing the terminal temperature of the exhaust the Pilliod sleeve-valve arrangement is a decided stride forward, as the proper utilization of the heat units is primarily a function of the valve in its permitting the piston to create turning moments on the crank, and the main function of the locomotive—that of production of drawbar pull—is thereby effectually increased.

The addition of arches and feedwater heaters to an engine equipped with the new sleeve-valve arrangement will result in further savings of heat units, although their respective efficiencies may not be as high as when these devices are applied to plain piston or slide-valve engines.

Superheating. A tendency to decrease the utilization of the heat units has been noticeable in later years with the advent of the superheater, even though its application to present equipment does show economy. We can assume that if superheat is employed only in the amount required to insure dry steam at the point of cut-off, we shall have accomplished all that is possible by its use, neglecting the value of its increased volume; this because the reëvaporation that will occur during the expansion period between the point of cut-off and the point of release will guarantee that we get dry steam throughout the entire range. This analysis would also seem to indicate that with increased expansion in any engine the effectiveness of superheating will decrease in direct ratio to the amount of expansion.

It is an accepted fact that the loss due to condensation on the cylinder wall diminishes with a rise in the initial temperature and pressure, the ratio of expansion remaining constant, this law holding without regard to the speed of the engine. Therefore the economy to be gained decreases with a rise in the pressure.

Advocates of a high degree of superheat have been presenting from time to time arguments showing that, due to the increased volume the steam receives when it is superheated, less steam is required per



VALVE		LAP	CUT-OFF	EXPANSION	RELEASE	COMPRESSION	PRE-ADMISSION	PORT OPENING	VALVE TRAVEL
PISTON	FRONT	1"	[illegible]-25%	[illegible]	[illegible]	[illegible]-35%	1 5/16"	21/64"	2 43/64"
PISTON	BACK	1"	[illegible]	[illegible]	[illegible]	[illegible]	1"	15/64"	2 43/64"
PILLIOD	FRONT		7-25%	[illegible]	[illegible]	1 1/2-55%	1/16"	5/8"	2 1/2"-4"
PILLIOD	BACK		7-25%	[illegible]	[illegible]	1 1/2-55%	1/16"	5/8"	2 1/2"-4"

Fig. 5 Comparison of Forward Motions of Plain Piston Valve and Pilliod Sleeve Valve—25 Per Cent Cut-off

(Walschaerts gear used in both cases.)

stroke of the engine. Is this a true condition of economy? Addition of heat in the form of superheat does expand the steam in the boiler, it is true. With 200 deg. superheat and with steam at 200 lb. boiler pressure we do get approximately a 32 per cent increase in the volume. But in so doing, it becomes necessary to use 15 per cent more fuel, and in addition the cost of maintenance is higher. However, the economy obtained on locomotives with the present old type of valve design and on other engines where expansion is not a large enough percentage of the total stroke, warrants its use.

It is the opinion of the author that a superheated engine equipped with the Pilliod valve arrangement could have its superheater removed, or at least have the degree of superheat lowered considerably, without affecting its coal consumption per ton-mile. This is due to the fact that the sleeve-valve-equipped engine gives at a very much shorter cut-off a mean effective pressure only possible on the conventional locomotive at a much longer cut-off. This last condition is true on a saturated engine, and much more so on a superheated engine.

Increased Expansion. A practical proof of the advantages to be derived from the use of the new valve arrangement can be seen when we compare its valve events with those of the Corliss engine. This engine is 30 per cent more economical than the standard automatic stationary engine, but is limited in the release, which cannot be made to occur past 85 or 90 per cent of the stroke, as the travel of the rocker arm would be too great. With the Pilliod arrangement, which gives any amount of expansion wanted, from any point of cut-off to the end of the stroke, even a better result should be obtained since no new or untried mechanical devices are involved. The addition of the extra moving sleeve will not cause a greater leakage, as the valve will not be subject to the wear that now takes place on the variable-travel valve. This matter of wear will be discussed in detail in the following paragraph.

Effect of Superheat on the Variable-Travel, Variable-Cut-off Valve—Elimination of This Defect in the Pilliod Constant-Travel Valve Arrangement. A defect not so noticeable in the days of saturated steam is that brought about by the action of the high temperature of the exhaust steam due to superheat on the exposed portions of the valve seat at the working points of cut-off. In time the seat will become scored and the rings plugged, resulting in excessive leakage of the steam past the valve. This leakage assumes very serious proportions at times. The Pilliod arrangement, in which the valves have constant fixed travels at all points of cut-off, will overcome this scoring, and the economy due to tight valves can thus be much longer maintained. The valve can also be operated longer without lubrication, due to the fixed travel and the elimination of much of the oil loss. It is also possible to liken the sleeve and the plug valve to a moving piston which is also traveling in a constant path at all times. The cylinder walls can never become carbonized or coked up, regardless of the degree of heat. In the case of the variable-travel piston valve, even without superheat the variable travel creates variable wear, and the leakage amounts to from 4 per cent to 20 per cent of the amount of steam used. Possibly the engine is not overhauled any oftener, but the loss remains, and a higher consumption of steam per hour can be the only result. In giving constant travel to the valve the new Pilliod arrangement thus eliminates one of the chief defects of the superheated engine and also makes possible a longer time between shoppings, even for saturated engines.

Setting the Valves. The plain variable-travel piston or slide valve presents difficult problems in setting, and to be able properly to square a valve gear one must deal with all of the detrimental angular influences that are present. In the case of the new sleeve-valve arrangement the matter is one of extreme simplicity. The design, as has been brought out, dissipates within itself all of the angular defects that have been heretofore considered as impossible of elimination.

Placing Limits on the Engineer. A big factor in the proper utilization of the available heat units would naturally be that the engine should never be run at any but the most economical point of cut-off. With the present variable-travel piston or slide valve and the conventional valve gear we know that the engineer can cause the cut-off to occur at a point too early in the stroke. The new sleeve-valve arrangement can be set at will in the shop for any point of minimum cut-off, and this minimum point cannot be changed by the engineer on the road. If it has been decided that the minimum point of cut-off should be 25 per cent, the cut-off-control bushing will be made so that it cannot be moved in past the point that will give 25 per cent cut-off.

Compounding. In the variable-travel valve as applied to the existing compound engines, steam is admitted to the high-pressure cylinder at, say, 25 per cent cut-off and exhausted into the receiver at around the conventional 60 per cent point of release. This means that there is more of a varying pressure in the receiver than if the steam were constantly released at the end of the stroke. Also, the high-pressure cylinder loses the chance to produce the additional work that is accomplished when the release is carried to the end of the stroke as in the Pilliod arrangement. When the conventional valve events are applied to the compound, there is also a loss due to the early exhaust closure in the high-pressure cylinder at the working points of cut-off. This back pressure means loss of steam, which would better be applied to the receiver for additional work than to oppose compression. In the Pilliod arrangement the steam as it is expanded to the end of the stroke is also all driven to the receiver on the exhaust stroke, as the valve does not close the exhaust until the piston has reached the end of its stroke and all of the exhaust steam has been passed into the receiver. This means a slightly higher consumption of steam, due to the amount required to fill the clearance, but the increased work performed will more than compensate for this, and a smaller steam consumption per horsepower-hour can be the only result.

Another condition prevailing in the compound is that of the ratio that must be maintained between the low-pressure and the high-pressure cylinders. This has never been accomplished in the compound, due to the fact that it has never been possible to get two sets of valve gears that could be linked to produce it at all points of cut-off.

In the new valve arrangement we are dealing with an auxiliary cut-off-controlling bushing which operates in a straight line and, as has been brought out, it effects at all times equidistant closing of the admission ports. The bushing is also controlled independently from the valve. From this it will be seen that it is only a matter of simple proportion to obtain any ratio that is desired between the two valve arrangements of the compound. Also, once these ratios are fixed, they cannot be changed but will always, through the entire period between shoppings, bear the same relations to each other that they had when new.

Continuous Torque Condition. With the present plain valve cutting off at 25 per cent and releasing and closing at 60 per cent, a very uneven torque is obtained. With the new valve arrangement it is possible to bring about a condition whereby at all points of the stroke the piston will receive some impulse and whereby none of the power thus generated will be dissipated in the negative work of compression and preadmission. The crank will therefore at all times have imparted to it a turning moment and the engine will be working in an extremely free condition. These strains now created by excessive unbalance will be eliminated, wear and tear will be greatly reduced and the lengths of the periods between shoppings increased.

CONCLUSION

In what has gone before the author has endeavored to show that by employing a combination of time-tried devices for controlling fluid events, Mr. Pilliod has made it possible to effect in the locomotive a steam distribution superior to that obtained in the Corliss stationary engine, and in addition has made it impossible for the engineer to cause the cut-off to occur earlier than at its now considered most economical running position. While some, no doubt, will disagree with certain of the conclusions arrived at, it is nevertheless believed that the analysis from which they are drawn is logical; and if the paper shall prove of service in stimulating thought on the subject, he will feel that the work required for its preparation has not been wasted, but has been well worth the effort.

Machining and Lapping Very Deep Holes

By MAJ JOHN B. ROSE,[1] FORT LEAVENWORTH, KAN.

The purpose of this paper is to give in as much detail as practicable at this time a discussion of the shop operations in the forming of very accurate and highly finished cylindrical holes. Work of this kind carried on during the war in the manufacture of recuperators for gun carriages led to very extensive study and experiment, and the processes followed are believed to possess many points of interest to engineers. The drilling, boring, reaming and lapping operations are discussed in order, especial emphasis being laid on the lapping as this was the operation which gave the greatest difficulty and was most closely studied.

DURING the period of our war activities it is probable that no one manufacturing process called for the expenditure of more thought and skill by engineers and machinists than the production of the long and very accurately formed cylindrical holes in the forgings from which gun-recoil mechanisms were made.

These cylinders or long holes varied in size from 1.575 in. to 7.875 in. in diameter and from 5 to 8 ft. in length. To insure good performance it was required that the several cylinders have unusual accuracy of form, size, and position. While extreme accuracy of relative position was not demanded, it was largely obtained as a result of the care necessary to secure accuracy of the first two kinds.

It is believed the operations in producing these cylinders are without precedent in the United States, and certainly not on any scale of like magnitude. For this reason it is felt a record of certain of the machine set-ups and details of the processes should be of interest to shop engineers. It has very frequently occurred that devices or processes which were originally military in nature have found a more useful application in the arts of industry.

Mr. A. L. De Leeuw, Mem. Am.Soc.M.E., has contributed a series of articles to the *American Machinist*,[2] which very ably discuss the manufacturing operations carried on at the Singer Manufacturing Company, including the series of operations in the manufacture of the complete recuperator body. His articles should be read to obtain a comprehensive view where this is desired, and for a comparison of methods. It is here proposed to limit the discussion to the drilling, boring, reaming, lapping, and polishing of the holes.

Even with this restriction it will not be practicable to cover within suitable limits more than one job which will illustrate production of the cylinders up to 2.6 in. in diameter.

It is proposed to discuss these operations not in their connection with the building of a mechanism but in their relation to the pure art of such operations wherever they may be used. This paper then will avoid any technical discussion of recuperators or the history of their war production. It will record only the shop operations and to the extent that these may be of general industrial interest.

The problem is to produce approximately parallel holes 5 to 6 ft. long in a steel forging; the holes to be straight and round to a high degree of accuracy, free from visible scratches, and with a mirror-like finish.

DRILLING

Figs. 1 and 2 show the shape of the forging ready for drilling the small hole (1.338 in. diameter and 63 in. long). The drill leaves the hole 0.236 in. under the final size. The average time for set-ups and through drilling was three hours.

The surfaces *A* and *B* (Fig. 2) were milled and on these the forging rested in the fixture shown in Fig. 3. This fixture was made to insure correct centering of the drill and is mounted rigidly on the carriage of a 25-in. heavy-duty LeBlond lathe. The bearing or guiding surfaces of the fixture were ground to correct location after trial on the lathe with which it was used.

Incorrect drilling was caused at first by the method of securing the piece. By means of two bolts attached to the tail end of the fixture and pulling on the piece, the latter was pressed so hard against the drill guide as to force it out of line and the drill ran at an angle. This was easily overcome by holding the piece against the drill guide by two bolts attached to the latter itself. The original error is obvious and should, of course, never have been made.

On account of depth of the hole the drill was run in half-way, and the piece then reversed either on the same or on a second machine. Good results were obtained by both methods.

It is very desirable that the drilled holes meet. If they do not, the accuracy of each following operation, even to the lapping, is affected, since each tool naturally tends to follow the hole it is enlarging. The correction of inaccurate drilling will be dealt with when considering later operations. In approximately 33 per cent of all drilling the drills did not meet accurately, the maximum variation being $^1/_{16}$ in.

FIG. 1 FORGING READY FOR DRILLING SMALL HOLE

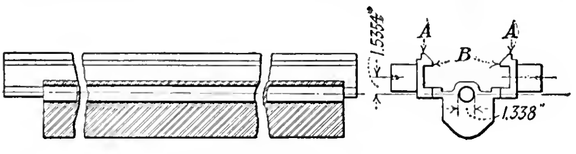


FIG. 2 LONGITUDINAL SECTION AND END ELEVATION OF FORGING

To secure speed it is necessary to provide efficient cooling and prompt removal of chips. Figs. 4, 5 and 6 show the hollow-shank drills used for this purpose.

A mixture of 1 qt. of soluble oil with 3 gal. of water was boiled for half an hour and about a pint of sal soda added. This solution was forced under about 70 lb. pressure into the hole through the drill shank, along the oil clearance, over the end of drill and back through the flutes and hollow shank. Chips were reduced to narrow strips by cutting grooves $^1/_{16}$ in. by $^1/_{32}$ in. as shown at *N*, Fig. 4. The chips pass out with the oil through the hollow drill tube. In the earlier efforts the chips were not expelled satisfactorily, and it is probable that one of the principal causes of this was insufficient pump pressure. It was not practicable to increase the pump capacity and the remedy was effected by forcing air in with the oil. The small pipe in Fig. 3 carries the air at a pressure of 90 lb. This greatly improved expulsion of the chips and permitted continuous drilling. It is also necessary that the grooves in the drill be sharp-cornered and the passages leading to the interior or drill have polished round corners to avoid congestion of chips.

Figs. 5 and 6 show the characteristics of the drills used. In addition to features already noted, it was found very necessary to taper the drill 0.004 in. on a side. Some of the earlier drills used were not tapered and frequently broke due to seizing in the hole.

---

[1] U. S. Army. Mem. Am.Soc.M.E.

[2] Vol. 52 (1920), pp. 595, 937, 1049 and 1094.

Contributed by the Ordnance Division for presentation at the Annual Meeting, New York, December 4 to 7, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. Abridged. All papers are subject to revision.

The life of the drill depended largely on the forgings. The quality of these varied greatly, as shown by Brinell tests. In some cases a drill might finish three holes before regrinding, while again it would go only a few inches. With forgings of uniform proper machinability one drill should complete a hundred or more holes in its life.

It may be noted that the method of drilling used by the Singer Manufacturing Company was quite different from the Rock Island method described. At this Company's shops the forging was mounted in a revolving steady rest and the drill run in a counter direction. No air was used. The drill itself was similar but 0.021 in. larger. It was run in half-way and then the entire fixture and forging reversed as a unit. In drilling the large hole next described, Singer held the drill stationary. It was desired to rotate the drill also, but delivery of suitable machines was delayed.

Fig. 3 Forging Mounted in Lathe for Rough-Drilling Operation

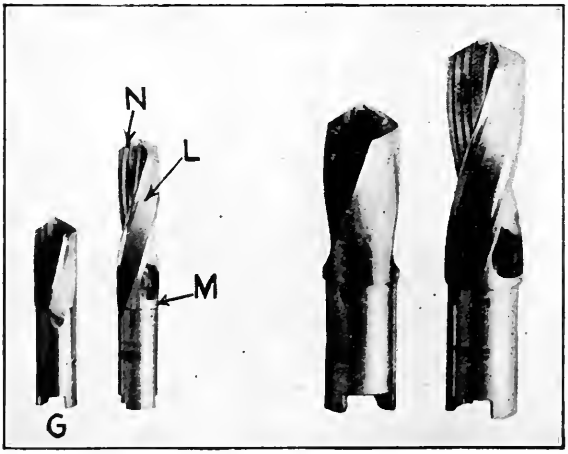


Fig. 4 Hollow-Shank Drills Used in Drilling Operation

In drilling the large hole, all features of the operation were essentially identical with those in drilling the small hole, except that the hole being off the axis of the forging, the latter could not be reversed in the same fixture, but went to the next machine. The drill for this operation is shown in Figs. 4 and 6, the characteristics of operation being as follows:

	Small hole	Large hole
Drill size, in	1 338	2 362
Speed, r p m	248	70
Feed per revolution, in	0 0016	0 008

Speed and feed were varied to suit the character of the forging, those here given being among those generally used.

While probably a little more power is required when work is rotated, this method holds the axis of hole true, even though the hole itself may be conical.

Boring

Fig. 7 shows the forging ready for the boring operation in holes after drilling, and also cross-sections at subsequent stages. In the shop this was sometimes called "roughing-reaming." The most important feature of this operation is to get the hole as nearly straight as practicable. When the drills have not met exactly or within a few hundredths this is difficult to do, especially in the small hole, for which the bar is but 1 in. in diameter and not stiff enough to keep the cutter running true.

The forging was held in a fixture very much like that used for drilling and secured to the carriage of the lathe, but the cutting tool was drawn instead of being pushed. The set-up for the large hole is shown in Fig. 8, the view being from the head end and the forging not in position. The double-end fly cutter is guided into the hole by the follower shown half-way out of the guide of the fixture. This follower does not leave the guide until its end next to the cutter has passed into the hole and is able to force the cutter to cut very nearly along the true axis. The outer sleeve on the follower is free to turn and is hardened and has a diameter across the lands 0.0008 in. less than that of the cutter. It was found that in spite of this follower, one roughing cutter would not true up the small hole very well when the drills did not meet. This led to the use of a leading cutter 1.375 in. in diameter and placed at right angles to the second cutter, and a better hole resulted.

Figs. 9 and 10 show the bars, cutters, and followers respectively used in the small and large holes. The boring leaves the large hole 0.118 in. below final size, and the small hole 0.123 in. Mineral lard oil was forced through from the head end and carried the chips out through the grooves in the follower. In early efforts a cast-steel follower shown in Fig. 8 was used which had a series of hardened studs ground to the size of the hole, but this type of follower was soon discarded as it did not hold its size so well as the one with longitudinal ribs.

At first a reamer cutter was used of the form also shown in Fig. 8, this being a foreign type. It did not work so well due to the breaking down of the outer point on the cutting edge which led to seizing in the hole, as the original tool did not have proper relief back of the cutting edge. The preference abroad for this cutter is most probably due to the softer steel used.

	First Bore	
	Small hole	Large hole
Size, in.	(2 cutters) 1.375, 1.456	2.48
Stock removed on diameter, in.	0.037, 0.081	0.118
Average time of operation, including set-up, hours.	2	2
Feed per rev., in.	0.015	0.015
Speed, r.p.m.	60	60

At the end of the boring operations the holes are neither straight nor parallel. It will be noted that so far the piece has been set in two fixtures for drilling each hole and in one fixture for boring each hole, a total of six fixtures. The relation of the guiding surfaces of these fixtures to the center of the drill rest and lathe spindle was made correct to about 0.001 in. for each machine by special fitting, but the clearance of the drill tube in the guide and deflection in working, plus the summation of machine differences, may easily amount to several thousandths of an inch; or the errors may compensate, leaving a smaller resultant error.

It is permissible to admit these errors in position up to this point. Their total will seldom exceed 0.05 in. and is ordinarily very much less. As will be shown, the reaming fixture is designed to correct or improve parallelism and straightness.

It is well to note here that after the set-up has been made on the

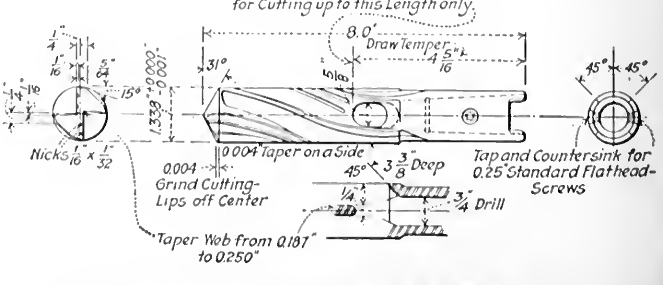


Fig. 5 Details of 1.338-in. Hollow-Shank High-Speed Steel Drill

machine for reaming about to be described, a second boring cut is made in each hole. For this 1.540-in. and 2.560-in. fly cutters are used, these removing respectively 0.074 in. and 0.08 in. of stock on the diameter. These cuts may be considered as either finish boring or rough reaming. They are not considered in the discussion of reaming below.

REAMING

Reaming is the first operation that approaches precision, and the quality of the reaming affects very much the accuracy of lapping. After the rough-boring the piece is planed or milled practically all over; the surfaces being measured from the center of the bored small hole. After reaming both holes, these surfaces are for the most part finish-planed or milled, being again located from the center of small hole. In the reaming it is not necessary that the holes be located with extreme accuracy with respect to the planed surfaces as enough stock is left on these to finish up, but the reamer should leave the holes parallel, round, straight, and smooth.

Fig. 11 shows the set-up for reaming the large hole. The small hole has been finish-reamed and the piece is now trued up on centering plugs which are expanded to fit snugly in each end of the small hole. The piece is supported and held in the fixture below it, which has adjustable bearing surfaces so that the plugs merely align the work but carry no weight. The axis of the bushing in the steady rest for the reamer, and the lathe spindle must be correctly and accurately located with respect to the center line of the two plugs. In reaming the small hole the set-up is identical with that described for the large hole, the centering plugs being adjusted to fit in the bored large hole. It is evident, therefore, that the exact relative positions of the holes and their degree of parallelism must depend on the parallelism of the reamer bar with respect to the center lines of both sets of plugs. The piece being aligned on the plugs parallel to the reamer bar, the reamer is constrained by the packed head to cut on its proper axis, but not entirely so, since after the head leaves the guide it is not controlled except by the hole itself.

Two or more cuts are taken with wood-packed reamers of the kind shown in Figs. 12 and 13. The greatest care was taken with this reamer to see that it left a smooth finish free of all but the finest scratches. If defects were found in the steel, as frequently occurred, or if the reamer left scratches, one or more oversize reamers were passed. The first packed reamer leaves the large hole 2.584 in. or 0.018 in. under size, and the second or finish reamer cuts from 2.595 in. to 2.599 in. or 0.005 in. to 0.001 in. under the nominal maximum. In actual practice the character of steel in the forgings varied so greatly that it was found necessary to allow several oversizes, as this permitted rereaming to remove defects.

The importance of a uniform and clean steel cannot be overemphasized where it is necessary to produce all holes to the same size. Lapping, as practiced, did not straighten a crooked hole except to the extent later indicated, and as it is also a very slow operation it is highly important that the hole come from the reamer true and smooth. If it is not true it can only be partly straightened under the lap, and if scratched or rough more metal must be left for lapping or it must be lapped oversize.

In Fig. 11 the packed reamer head is seen leaving the guide and the cutter has not yet entered the hole. The plug is shown at *A* not fully entered into the small hole. The piece has been moved about 2 in. toward the lathe headstock in order to show these parts. In operation it is forced to the rear until the bushing of the guide, which has a lead-packed end, is in contact with the rear end of the piece and closes the hole, thus forming the oil channel. Pure lard oil is fed through the pipe at *B* and passes through the bushing thence into and through the hole and out the front end around the tool.

	Small hole		Large hole	
	Rough	Finish	Rough	Finish
Size, in.	1.56	1.575	2.584	2.599
Feed per rev., in.	0.025	0.025	0.025	0.025
Speed, ft. per min.	30–40	30–40	30–40	30–40
Stock removed, in.	0.02	0.015	0.024	0.015
Oil used	pure lard	pure lard	pure lard	pure lard

The wood-packed reamers were kept soaked in pure lard oil. The packing was turned to 0.002 in. above diameter of the cutter. The guides in the steady rest were hardened and ground to 0.001 in. above the diameter of the steel followers and were a snug fit over the packed reamer heads. Fig. 14 shows some of the more detailed characteristics of one of the reamer blades.

Attention has already been called to the importance of good reaming. It is necessary to select a steel for the reamer which holds its edge and does not chip off, as this may destroy a hole.

The blades must be ground with clearance and rake on the cutting edge, which are determined by experiment on the work, and the angles first given on the tool drawings may be used only as a preliminary guide. It was the practice to have one man specialize on grinding the blades and it cannot be said the practice was standardized. The cutting edge was usually given a taper of 30 deg., but this angle was varied to suit depth of cut or hardness of steel.

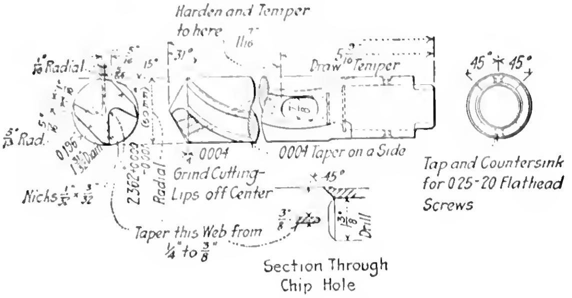


Fig. 6 Details of 2.362-in. Hollow-Shank High-Speed Steel Drill

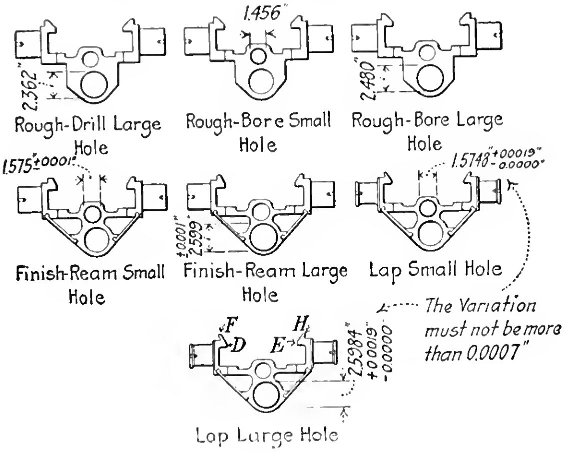


Fig. 7 Boring and Subsequent Operations on Forging

An experienced man can usually tell by holding his hand on the reamer bar whether the tool is cutting well, and chips should be smooth and well formed. If these indicate the cutting edge has broken down it must be immediately reground, and the cutting edge at the beginning of the taper carefully stoned.

Reaming should be continuous since a mark is invariably left after stopping, due to contraction of wood or other parts or substitution of a new reamer. The reamer must never be drawn out while the machine is running as this leaves a spiral line. The reamer blades should be set by a specialist, who also sees to correct grinding and to oil stoning after grinding.

Slag pockets are serious for several reasons: they may be too deep to remove, or they may destroy the finish by breaking down the cutting edge and cause scratches.

At the Singer Company's shops the large and small holes were bored and reamed in two settings of the work, one for each hole. For work on the small hole the piece was set in a fixture mounted on a 24-in. heavy-duty Pond lathe in somewhat the manner of the Rock Island method, and the boring and reaming tools drawn through in succession. They were guided at the beginning of the

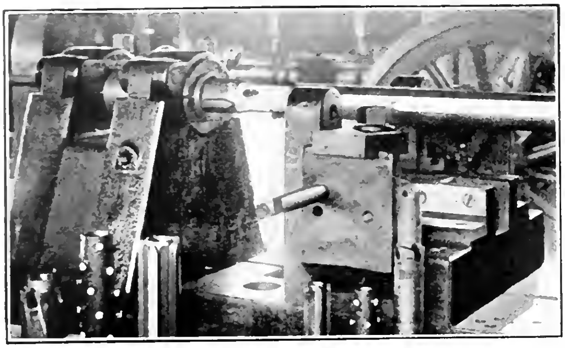


Fig. 8 Fixture for Rough-Reaming Operation

cut in a manner also similar. These features, however, were different: (*a*) No fly cutters were used, but the boring or rough-reaming was done with a reamer which required oil flow in a reverse direction. This is the type of reamer above referred to as having been discarded by the arsenal, but it is here used with success. (*b*) The holes were finish-reamed in two fixtures and the relative location of the holes with respect to each other would not seem to be so well controlled as by the Rock Island method, which mounts the piece on the locating plugs in the same fixture, but there are no data available to show whether this is true.

At the Singer Company's shops the large hole was bored and reamed in a revolving fixture like that used for drilling. It was proposed to do this drilling in the same manner as for the small hole, but fixtures were never completed.

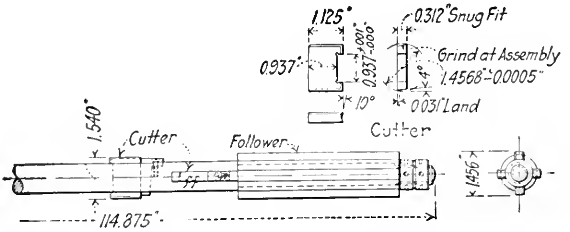


Fig. 9 Bar, Cutter, and Follower for the Small Hole

Lapping

A proper appreciation of the art of producing these holes with mirror-like surface cannot be obtained without some consideration of the steel characteristics. The ordinary run of steel, such, for example, as S.A.E. No. 1035, will, after rough-machining and reduction to a cross-section suitable to take treatment, take a fine finish in a bored hole from reamer, broach, or grinding wheel. Whether it can be lapped and polished free from scratches is altogether another matter, as this depends upon its condition.

If a mirror-like finish free from scratches is required at the end, it is clear we have a different problem. The utmost cleanness and homogeneity is necessary. Slag inclusions or oxides will show up in the final operations and the entire work be lost. Machinability must be good, as a small tear may be disastrous.

The first problem thus appears in the selection of the steel. Ordnance gun steel is clean and quite machinable, but unless very carefully made it is not clean enough to give a mirror finish in lapping. It is probable that our steel makers during the war were somewhat skeptical as to the necessity of delivering a perfectly clean, soft steel. We know, however, that excellent and satisfactory steel can be produced by American processes when the requirements are understood and fully accepted.

Since for the lapping operation clean steel is fundamental, it is necessary to go into this at more length. Slag and other impurities are practically independent of the chemical composition of steels which may be employed, and the amount of inclusions will depend upon furnace and pit practice. It is not so much a question of the kind of steel as it is of the care in manufacture. The electric furnace undoubtedly gives a very superior clean steel, but this is due largely to proper care and it cannot be concluded that the open hearth will not yield a steel equally clean. In fact, we know it can, and it remains for the steel buyer to decide which process is more likely to give him a steel free from inclusions. If the steel makers understand the requirements, either kind can meet them if the necessary precautions are taken, but in the open hearth greater care must be exercised and the electric furnace is probably surer.

Both the Watertown and Rock Island Arsenals have had extended experience in lapping, and have each reached definite conclusions. The Rock Island Arsenal favors a nickel alloy steel made in the electric furnace, and very excellent results have been obtained with a steel of the following percentage composition:

Carbon	0.30 to 0.40
Manganese	0.50 to 0.80
Sulphur	less than 0.045
Phosphorus	less than 0.040
Silicon	0.15 to 0.35
Nickel	3.25 to 3.75

The steel to be free from all slag inclusions, flakes or any lack of homogeneity, and heat-treated to give elastic limit of 65,000 lb. per sq. in. It was found that this steel worked freely under the stone and took a high polish without the appearance of scratches or pockets due to soft spots.

It may be noted here that the initial cost of the steel must not be given too much weight, for unsuitable steel is in the end very expensive, due to eventual rejections. Such rejections were a serious burden in our war manufacture. Too often we blamed the laps for scratches, when in reality the steel itself was the source of trouble, or the entrance of foreign particles of dust and steel.

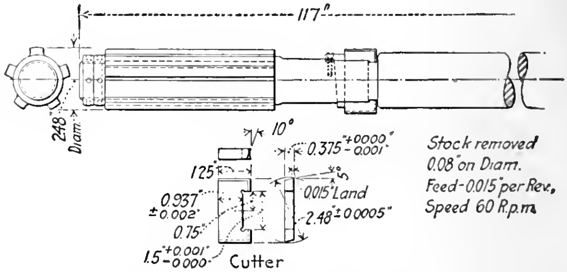


Fig. 10 Bar, Cutter, and Follower for the Large Hole

The Watertown Arsenal feels that the acid open hearth will give steel as free from inclusions as the electric furnace with careful control of melting practice and proper top and bottom discard.

It is not possible in the limits of this paper to discuss all sides of the steel question, nor is it desirable. But we can draw a few conclusions from our experience to date. To secure the best results we are fairly sure that:

a The steel must be produced by the most careful furnace and pit practice
b It must be thoroughly deoxidized, free from slag and inclusions which produce scratches or pit marks in lapping

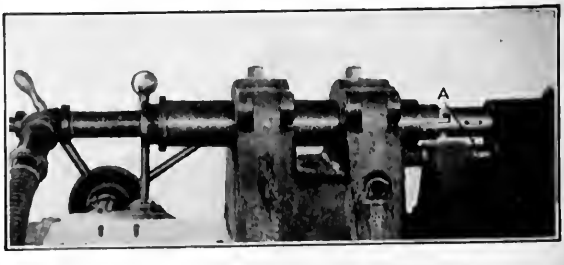


Fig. 11 Set-Up for Finish-Reaming the Large Hole

c The chemical composition may be such as to yield physical qualities desired under the heat treatment permissible

d The heat treatment must be such as to produce great uniformity in hardness and the desired physical properties.

A few words regarding heat treatment are necessary. In dealing with forgings of large cross-section it is evident that the desired qualities can best be secured after rough-machining and boring. During the war it was necessary to heat-treat before rough-machining, due to the lack of machine shops, with heat-treating facilities suitably located or available, to conditions of transportation, distribution of work, and various other influences. Basically it is much better to heat after reduction of the forging to nearly its final shape.

After finish-reaming, finish-planing and milling certain surfaces, the piece goes to the lapping machine. It is not desired to present this machine as ideal; in fact, it has numerous defects. First of all, horizontal lapping of cylinders is believed to be fundamentally wrong, since the gravity forces are constantly changing, as will be shown. In addition, the machines used were noisy and the reciprocating weights unnecessarily large. It can only be said that vertical lapping required too much head room to permit it, and that these machines were the best obtainable at the time.

Fig. 15 shows the machine rigged for lapping. The piece is held stationary in its fixture and the upper bar with the lap is reciprocated by means of the traveling carriage as in a shaper. The lap cuts on both strokes and is rotated 30 deg. at each reversal. As the stone is about 60 deg. wide it overlaps the preceding stroke and no lines are left. The stroke is adjustable in length and the carriage may be set to lap any section of the hole desired.

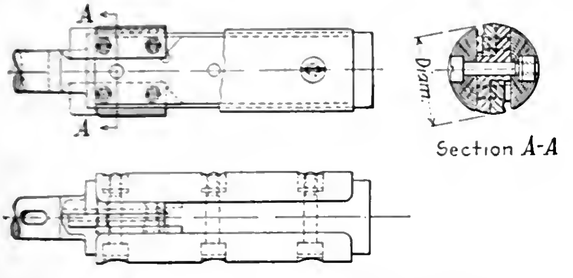


Fig. 12 Wood-Packed Reamer Used in Large Hole

(Ground to 2.584 in. diam. for rough-ream; to 2.599 in. for finish-ream; to 2.610 in. for 1st oversize. Tolerance = 0.0005 in.)

The piece is slid on the fixture, the edges *D* and *E*, Fig. 7, resting against the vertical guiding surfaces of the fixture, and the surfaces *F* and *H* supporting the weight and fixing the holes in proper vertical relation to the center line of the lap bar.

There is a clearance of about 0.01 in. between the guides of the work and the vertical sides of the fixture, so it is manifest the hole is not aligned very accurately with the center line of the lap bar.

It is evident that the hole thus partly guides the lap. In view of the inevitable flexing of the long bar it is of no use to set up the piece with rigid accuracy, and the lap is therefore allowed to float with comparative freedom in the hole, the more so the better.

We must therefore say that the object of lapping is to improve the accuracy and finish of the reamed hole; hence it is obvious that the more accurate the reaming and the better the finish, the less there will be to lap. Working in good steel, 0.004 in. on diameter is enough to allow removal of reamer marks and leave a polished finish, but ordinarily more than this was left for lapping.

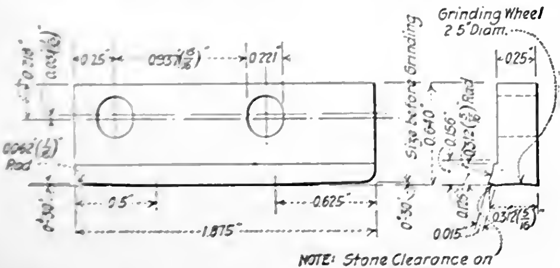


Fig. 14 Details of Finish-Reamer Blade

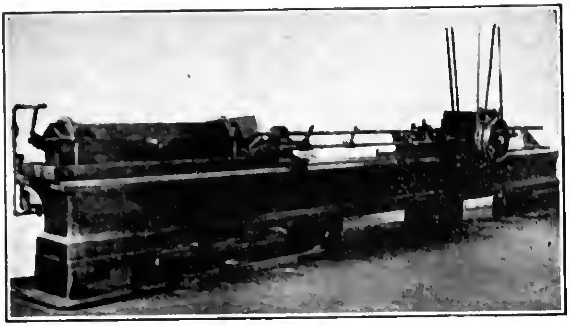


Fig. 15 Rock Island Arsenal Type Lapping Machine

Figs. 16 and 17 show details of the lapping heads and stones used. (In the figures wood lap blocks are shown.) It was originally intended that the stones should be forced out by radial coiled springs, thus securing a uniform pressure in the hole, but this was abandoned for the reason that a uniform pressure does not lap the hole uniformly when the sections are of unequal hardness, and if there are small and large sections these remain respectively small and large. The stones were therefore assembled in the head and shims placed under them until they entered the hole snugly. Shims were also added as the stones wore down. By this method the pressure is least on low spots, or if a spot is soft and wears faster, the pressure is automatically reduced. It was proposed to use heads with a taper adjustment, but these were never actually employed.

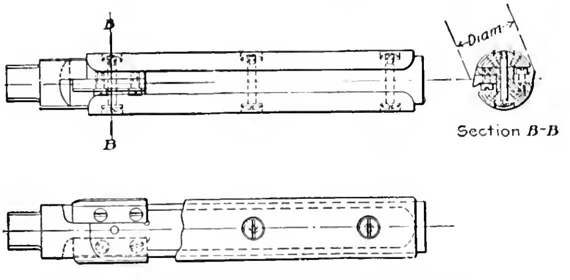


Fig. 13 Wood-Packed Reamer for Small Hole

(Ground to 1.56 in diam. for rough-ream; to 1.575 in. for finish-ream; and to 1.585 in., 1.595 in. and 1.605 in. for 1st, 2d and 3d oversize ream. Tolerance, ± 0.0005 in.)

After finish-reaming the holes were star-gaged to 0.0001 in. and this record went to the lapping machine. By experience it was determined that in a certain time the stones would remove a given amount of material, and it was possible for the gang boss to examine the record of gaging and direct so many minutes' lapping on each piece, based on the amount of metal to be removed. A general rule was not altogether reliable for the final stages of lapping as there was not sufficient uniformity in the steel or in pressure of stones; and it was customary for the gang boss to determine the lapping constant for each piece after a preliminary lapping of about 20 minutes and star gaging. This constant was then used to set the times required for further lapping required.

It was seldom possible to obtain a round hole with a variation in size of less than 0.0005 in. without resorting to spot lapping. Means were provided for frequent star gaging upon call of the gang boss, and if the record showed small or large sections the stroke was adjusted by the gang boss to spot-lap the small diameter. In this way the total variation measured on diamaters would be made 0.0005 in. or less. Ordinarily this required about eight hours or more per piece.

Due to frequent oversize reaming to remove defects or reamer marks the pieces went to the lap with holes varying in size and the amount of lapping therefore varied, the practice being to continue lapping until a regular hole with good finish was obtained.

As already indicated the steel used was not of a suitably uniform character to permit a standardized shop practice with resulting economy in time, and for this reason the question of steel has been emphasized.

The important characteristic of the holes was roundness and this was obtained. They were not accurately straight in the sense of a straight edge. Accurate records have unfortunately not been taken on enough finished recuperators to permit a statement of the variation in straightness. Isolated measurements indicate some of the holes may have been bowed as much as 0.035 in. These were very bad ones and very unusual. An average good hole was straight within an error of 0.005 in. Of course this is far from straight in comparison with a straight edge, but for a small hole 5 ft. long the accuracy is good for quantity production and it probably can be improved under standardized conditions.

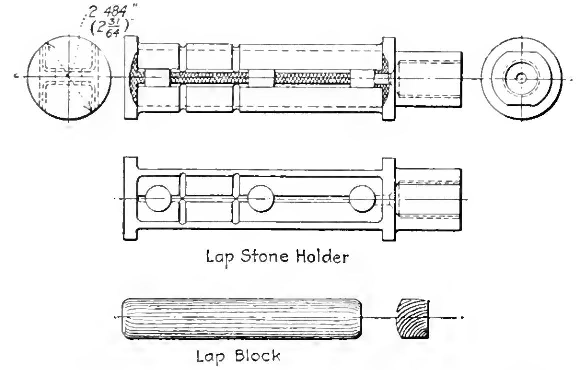


Fig. 16 Details of Lapping Head and Stone Used for Large Hole

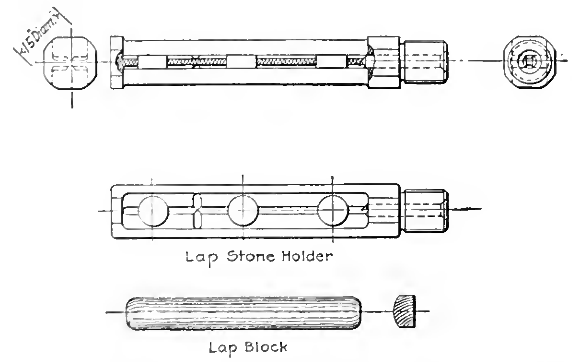


Fig. 17 Details of Lapping Head and Stone Used for Small Hole

The lapping head of type shown gave acceptable results but it is felt that it can be improved. Four stones instead of two might give better results. The method of adjusting the stone is slow. There should be a quick adjustment to suit the hole.' In the end additional vent holes were drilled in the head to allow more free access of oil to the stones.

A mixture of one-half kerosene and one-half pure lard oil was run to the lap through the hollow lap bar. An increase in the amount of kerosene gave greater cutting speed when desired. It is essential to circulate the oil through a filter and keep it very clean.

It is evident that as the lap passes through the hole the pressure on the top and bottom varies as the overhung weight of the lap and bar varies. This actually tended to cause a variation in the size of the hole, but was corrected when necessary by spot-lapping. A nicely reamed hole requiring little lapping could be finished quickly before these variations would appear, but if poorly reamed the lap would in extended use produce variations in diameter. Also in extended lapping there is a tendency to wear spots unequally, due to a difference in hardness. In other words, the lap does not straighten the hole except when spot-lapping is resorted to, and this should not be necessary; therefore the steel must be uniform and good reaming insisted upon.

The pressure on the top and bottom is not the same nor is it the same as on the sides. It may seem that this would produce an elliptical hole, but it does not due to the fact that the diameter across the stones is enlarged by shims as the hole wears and the small diameter of the hole gets the most cutting each time this is done. The effect of this pressure due to weight is, however, to lower the center line of the entire hole, and it is also true that if the center line of the reamed hole is not lined up with the lap stroke, the axis of the hole will be shifted. This again emphasizes the importance of minimum lapping. The lapping speed was about 275 ft. per min. The machine had a lower speed, but this was seldom used.

Lapping Stones

The selection of suitable stones led to many weeks of experiment before the proper grain and grade could be determined. Abrasive stones of all the leading types were tried, with many peculiar results. As a very fine finish was sought, it may seem that the finest grain would be suitable. This was not true. A stone of grain 220 (the finest above the flour) would, for example, not give a finish, but in certain cases would stop cutting and burnish a streak.

Carborundum 180G4 was found the best cutting stone in nearly all cases. This stone cut clean and smooth, and in many cases the finish lap or polish was given with it alone. Again, one stone would be replaced by a hard-maple block and the combination gave a fine polish.

A gang boss was in charge of each six machines and this man learned by experience, from the appearance of the hole, which combination would most likely give the best finish.

When 180G4 would not finish, a FFG4 was used either alone or in combination with a maple block. The two maple blocks were never used together as the tendency was to burnish in streaks and cutting action was necessary up to the end.

It is necessary to keep the stones ground flat on the under side which lies against the shim, and to the correct radius on the curve. This was done by rubbing them on cast-iron lapping blocks, flat or ground to radius, with kerosene and carborundum grit. This was done whenever a stone showed signs of glazing or cutting in spots.

It cannot be assumed that stones in the same lot and grade cut just alike, and although presumably the same, differences in cutting were frequently noted. In this very fine work a variation in the hardness or the least irregularity in grain is quickly revealed by the appearance of the cut.

A broken stone usually ruined the job, and this was the source of some loss. A wire center was used with success, but the stone generally used was not so made. The edges and corners of the stones must be well rounded to prevent chipping or scratching.

It is well known that the appearance of a clean, bright tube—for example, a gun barrel—is deceptive. The repeated reflection of light gives an exaggerated polish. The holes in this case gave the illusion of great brilliance, which was of course increased by bright artificial light or a bright sun. It is only by experience that one can form an idea of the actual condition of a hole. To fix a standard, all holes should be examined under the same kind of light. This is preferably diffused daylight or diffused light from a ground bulb. The latter is more nearly constant.

To examine the hole still more closely, a magnifying mirror set at 45 deg. and mounted so it can be inserted to any point desired will give a very good story of the interior. This should always be used in case of doubt or until the eye has learned to judge correctly.

In closing, it should be stated that the character of the steel on which these observations are all based must be noted, as a change in this alters other conditions. The forgings ran on the average: 0.50 carbon, 0.65 manganese, and 0.30 silicon, with very low phosphorus and sulphur. They were heat-treated to 50,000 lb. elastic limit and about 100,000 lb. tensile strength.

A New Method for Determining the Effect of Speed upon the Strength of Gear Teeth

By WILFRED LEWIS,[1] PHILADELPHIA, PA.

The strength of gear teeth as affected by their speed has been a mooted question for many years and is still awaiting solution. Walker's rules prevailed for fifty years without any known foundation in experiments or analysis, the first analytical treatment of the subject being made by Oscar Lasche in 1899. Since then the experiments of Professor Marx in 1912 pointed to higher values than were given by Walker, but disregarded the analytical work of Lasche which appears to have escaped the attention it deserved until translated and emphasized by Daniel Adamson in 1916.

Impressed by the force of Lasche's analysis, C. H. Logue, in 1920, devised apparatus to measure differentials in velocity ratios and computed increment loads as related to mass and speed. His work was laid before the author at the suggestion of Mr. Adamson in the hope that the gear tester shown and described in the Transactions for 1914 might be utilized in checking up results obtained. The gear tester develops capabilities not originally contemplated in its construction and proves valuable both as an instrument for describing diagrams and as one for measuring exactly the relation of speed to pressure in the loss of initial load.

THE strength of gear teeth as affected by their speed has been a mooted question for many years and various attempts have been made toward its solution, both experimentally and analytically. From a paper on spur gearing by Daniel Adamson, read before the Institution of Mechanical Engineers in 1916, it appears that Reuleaux gave in The Constructor permissible stresses for wood, cast iron, and steel of 2544, 4240, and 14,112 lb. per sq. in., respectively, at speeds not exceeding 100 ft. per min., which stresses he reduced to about half these values for a velocity of 2500 ft. per min.

This work was in the early sixties or thereabouts, and in 1868 E. R. Walker published some data which were embodied in a paper by J. H. Cooper and published in the Journal of the Franklin Institute in 1879. Here factors were given from 3 for slow speed without shock to 14 for a speed of 40 ft. per sec. or 2400 ft. per min.

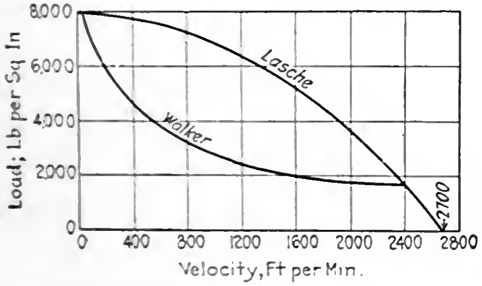


FIG. 1 RATIO OF ALLOWABLE LOAD ON SPUR-GEAR TEETH TO VELOCITY —E. R. WALKER, 1868

Nothing appears to show how these values were determined, and in the author's paper entitled Investigation of the Strength of Gear Teeth—read before the Engineers' Club of Philadelphia in 1892—there was nothing he could find more authoritative than Walker's rules, which are worth restating for their simplicity and directness of application. Letting X = breaking load of tooth, lb. = $2000\,P\,F$; S = working load of tooth, lb.; P = pitch of teeth, in.; F = face of teeth, in., and M = factor of safety = X/S, Walker gave the following values of M:

Speed of wheel rim, ft. per sec.	(a)	3	4	10	15	20	30	40
Values of M	3	4	5	6	8	10	12	14

(a) Very slow speed without shock.

The effect of speed upon strength may then have been recognized as due to irregularities in forming and spacing the teeth, but the first attempt at an analytical solution of the problem appears to have been made by Oscar Lasche, of Berlin, in 1899. He considered the variations in angular momentum caused by these irregularities and demonstrated that the excess loads due to these variations are necessarily proportional to the square of the speed.

To Walker's rules as shown in diagram by Adamson and reproduced in Fig. 1, another line has been added between the same limits to show the variation in load resulting from the use of the principle enunciated and demonstrated by Lasche.

Both lines run from the static load of 8000 lb. to the allowable load of 1700 lb. at 2400 ft. per min., and between these limits it will be seen that Lasche gives much higher values than Walker, whose factors for speed have been followed blindly for fifty years. Instead of showing reductions in strength proportional to the square of the speed, Walker shows greater reductions for small differences at slow speeds than for large differences at high speeds, and his loss in strength grows more nearly as the square root of the speed than as the speed squared.

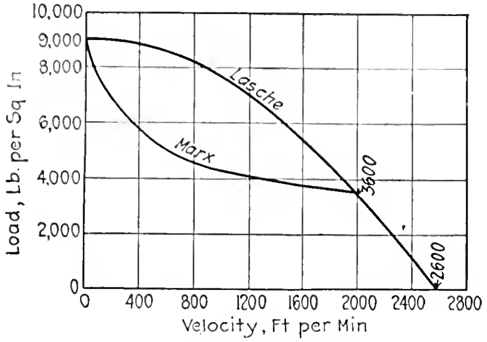


FIG. 2 RATIO OF ALLOWABLE LOAD ON SPUR-GEAR TEETH TO VELOCITY —MARX AND CUTTER, FROM TESTS, 1912

But although Lasche's work in this direction has been generally commended and approved, very little progress has been made in the application of the principles he established. In 1912, however, very elaborate experiments made by Professor Marx of Stanford University were reported, in which gears were broken under various loads and speeds ranging from slow start to 2000 ft. per min. The result of these experiments appear in Fig. 2, also borrowed from Adamson, to which another line has been added showing the working load between the same limits as it would appear for 9000 lb. static and for 3600 lb. at 2000 ft. per min. according to Lasche.

These curves are entirely different in character, that of Walker, which the author adopted reluctantly and tentatively in 1892, and that of Marx running toward the base line as an asymptote while those of Lasche plunge across it and put a definite limit to the speed, depending upon the static load allowable and the accuracy in construction of the teeth. Lasche's curves of strength are parabolic and do not differ essentially from the curve of effective belt pull in the transmission of power, and it is evident that a curve for the power of gears would take the same parabolic form for belt power, reaching its maximum, as for a belt, at a certain speed.

It is also apparent in these diagrams that, according to Lasche, Walker and Marx were not so far apart, Marx starting 1000 lb. higher and crossing the base line at 2600 ft. per min. against 2700 for Walker. In fact, the Lasche lines of strength in Figs. 1 and 2 are almost identical and help to reconcile the differences supposed

---

[1] Pres. Tabor Mfg. Co., Mem. Am.Soc.M.E.

Contributed by the Research Committee for presentation at the Annual Meeting, New York, December 4 to 7, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

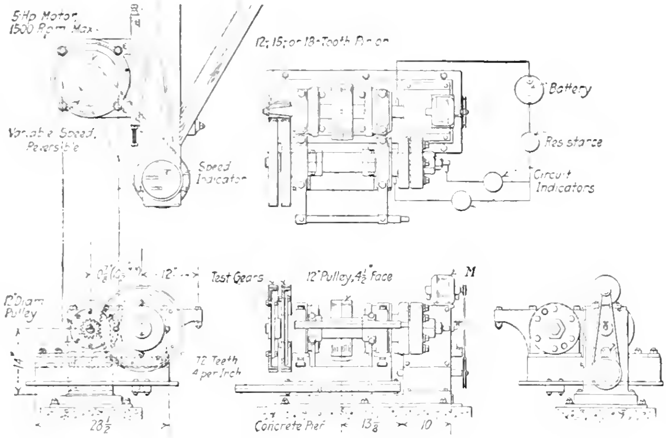


Fig. 3 The Lewis Gear-Testing Machine

to exist between Walker and Marx. If we accept their extreme values and Lasche's principle, we are led to believe that Walker was a close observer and founded his factors upon results obtained under extreme conditions, filling in between as seemed to him reasonable without attempting to prove the intermediate values.

The question may well be asked how such careful experiments as those made by Professor Marx in 1912 seem to sustain, in principle at least, Walker's ancient rule of thumb against the rational conclusions of Lasche; the answer to which calls for further investigation, and it is hoped that the new method here proposed will shed some light upon it. Breaking tests, the author believes, are misleading and should be discouraged for the simple reason that when a gear is broken under any given conditions as to load and speed, it is done for, and it becomes impossible to say what that gear would have shown under some other conditions. So also in regard to inaccuracies in forming and spacing, it is a matter of vital importance that these minute differences be noted in terms of the velocity ratio which they produce, and as nearly as may be under actual working conditions.

In view of the difficulties attending the use of power sufficient to break heavy gears at high speeds, the author was tempted to design a new gear tester as shown and described in the Transactions of the Society for 1914, and afterward built for the University of Illinois in 1916. This was also intended to determine the efficiency and breaking strength of gears under various loads and speeds, but the war intervened and nothing has as yet been reported from its use.

Here again the principle announced by Lasche was overlooked and its was not until the summer of 1920 that the author's interest was revived by a communication from Charles H. Logue, Mem.Am.Soc.M.E., to which attention is here called as being the first step forward in the application of Lasche's principle since its importance was emphasized by Adamson in 1916.

Mr. Logue proposed to produce mechanical diagrams showing in a magnified way the irregularities in velocity ratio for a pair of engaging gears, and from these diagrams to calculate the force of acceleration causing an increment load which, when deducted from the allowable static load, would give the allowable safe load at any speed.

A pair of gears were mounted in bearings and a pair of disks on the gear shaft were connected by a wire, the tension in which caused pressure between the gear teeth. The disks of course bore the same relation to each other as the pitch circles of the gears, and as they turned with the teeth in action, irregularities in velocity ratio would cause more or less slack in the connecting wire, which was multiplied by an index finger. Readings were taken at successive points in the arc of action and the variations in velocity were noted as the data needed in connection with mass to determine the increment load at any speed. This apparatus was modified and improved to give indicator diagrams on paper ribbons or on disks in a closed curve from which the increment load was calculated, and at the suggestion of Mr. Adamson Mr. Logue very freely laid the whole matter before the author to discover if possible whether the gear tester above referred to could be utilized in connection with his problem. So far as the diagrams were concerned, it occurred to the author at once that the gear tester was admirably adapted to their accurate production under conditions that could not be realized so well with any other form of apparatus, but it took all summer to observe that the same machine was equally available for the direct determination of decrement loads rather than increment loads and that it might be materially simplified without detriment as a means for determining the effect of speed upon the strength of gear teeth.

Referring to Fig. 3, the new gear tester is shown to consist as before of a wide-faced pinion mounted in bearings on a swing frame which carries a pair of engaging gears in telescoped shafts, the outer ends of which can be twisted and locked together by a powerful friction clutch. The moment used in twisting is measured by a weighted lever, and this determines the load on the gear teeth acting in equal and opposite directions upon the wide-faced pinion. The friction clutch when tightened secures this load through the resilience of the telescoped shafts, whereas formerly the load on the teeth could be applied or released while running.

A heavy belt pulley on the pinion shaft drives the gears thus loaded and the driving moment can be measured as before by a weigh beam or scales at a certain distance from the turning center of the swing frame in the axis of the pinion shaft. There will be a slight difference in pressure upon the test gears due to this driving moment, which can be easily determined. The belt pulley is driven by a variable-speed motor connected also to a tachometer and revolution counter as may be conveniently arranged, and in this way there is afforded a pair of gears engaging with a wide-faced pinion to run at any desired speed.

Now it is evident that if the teeth are perfectly formed and spaced the gear wheels will run side by side in unison and that such irregularities as may exist will cause them to shift relatively to each other, thus gaining and losing in speed and causing increments and decrements in the load carried on the teeth.

So it occurred to the author, after seeing the results obtained by Mr. Logue, that this shifting of the gears could be made visible by suitable multiplying levers attached to them as shown in Fig. 4 to actuate a scriber moved radially as they turned against a stationary receiving plate. To accomplish this result the scriber is mounted in a link between radius arms so centered as to form a Watt parallel motion and it is made to act under light spring pressure against a plate of smoked glass or photographic film by levers which multiply the differential movement of the test gears about 300 times. Although the Watt parallel motion is not quite perfect, it will be seen that between the limits to which it is here applied it is very simple, effective, and accurate.

The diagrams made in this way require a very slow and steady rotation of the pinion shaft to avoid undesirable momentum in the multiplying levers and this is produced when desired by the small motor *M*, Fig. 3, carried on a gear cover at the end of the pinion shaft. This motor is belted to a light shaft beneath, which engages a train of reduction gears to the heavy pinion shaft. But this train of gearing and all parts used in tracing a diagram are of course disconnected when the test gears are run at speed by the large belt pulley.

If there were no irregularities in the gears the scriber would trace a perfect circle, but since absolute perfection is unattainable, the scriber will move in and out as it turns with the test gears and trace a line indicative of acceleration or retardation, which when interpreted with reference to the masses involved will give the increment or decrement in the load carried on the teeth at any speed. The radial movement of the scriber will show the plus and minus displacements, the mean of which will form the basis for comparisons, and it will be seen that the nearer the curve approaches to a radial line, the greater the intensity of change at that point. Every tooth on both gears will appear for identification in the diagram and a pronounced irregularity can be located at once on the gears.

Here there is no attempt to produce an ideal transmission by means of friction disks or tapes against which irregularities are measured. Each gear forms the basis of comparison for the irregularities of the other, and each is at or near its pitch point when the other is entering or breaking contact. There is nothing to slip or stretch and it is possible by reason of this positive connection to produce diagrams under light or full loads, a comparison of which may reveal the effects of compression and elastic deformations, and it is possible that these effects may modify to some extent Lasche's law of the speed squared. But, however this may be, the results hitherto obtained come from the consideration and manipulation of very minute quantities the multiplication of which may also multiply unsuspected errors, and while working on this mechanism the author endeavored to discover some way of making a direct measurement of the increment load until convinced this was hopeless, and then, reflecting on the decrements entailed by increments as pointed out by Mr. Logue, it occurred to him that when the initial load disappeared with the break in tooth contact there would be a distinct change in the noise, after which he hit upon the better plan now presented of insulating the gears and using an electric circuit to announce through telephone receivers when contact was broken with the pinion by either or both gears.

One or two dry cells as indicated in Fig. 3 are connected by a wire, as shown, to the pinion shaft through which the current passes to the gear wheels in contact and divides in two branches, returning through telephone receivers in each branch to the opposite pole of the battery. The author submitted this suggestion to an electrical expert and was told to rest assured that the breaking of contact between the teeth would be announced by the receivers in no uncertain way, and that variations in pressure might also be expected to make a noticeable change in the sound of the running gears.

So, having set up the desired initial load upon the teeth as explained and taken a diagram on smoked glass to use for printing a permanent record, the idea is to start the motor overhead and watch the tachometer while listening for a change in the sound of the telephone receivers. When this occurs the speed is noted and we know by observation the speed required to reduce the initial load to zero and presumably to increase the speed required to double the initial load. But, while increments and decrements are necessary counterparts in the maintenance of the initial or average load, they are not necessarily of equal intensity, because their durations may be different, and it is thought that the diagram will help to establish the relation between increments and decrements in any given case.

Having determined in this way the increment load for any given speed, it is believed that the result applies to the test gear when running with a flywheel of infinite mass, or very nearly so; because the test gears are substantially equal in mass and flywheel effect, and running as they do with a pinion whose pulley is a massive flywheel, under conditions that impose substantially equal, opposite, and simultaneous reactions upon the pinion, there is no reason to ascribe much if any variation to the movement of the pinion, which runs in consequence as though attached to a flywheel of infinite mass. This may not be strictly true, but it is not far wrong, and it is expected that the increment loads found in this way by experiment can be used to standardize test gears in an absolute way from which the increment loads between any two gears running together may be readily determined. For instance at 1000 ft. per min. we may find in one test gear an increment load of 1000 lb., and in another at the same speed an increment load of 3000 lb.; then when these gears run together the increment load becomes $\frac{1000 \times 3000}{1000 + 3000} = 750$ lb., or, in general $I = \frac{a \times b}{a + b}$ where a and b are the absolute increment loads for two engaging gears at the same speed, and I is the increment load for the same gears running together.

In this way it is proposed to check analysis by experiment and establish upon an indisputable basis the effect of speed upon the strength of gear teeth.

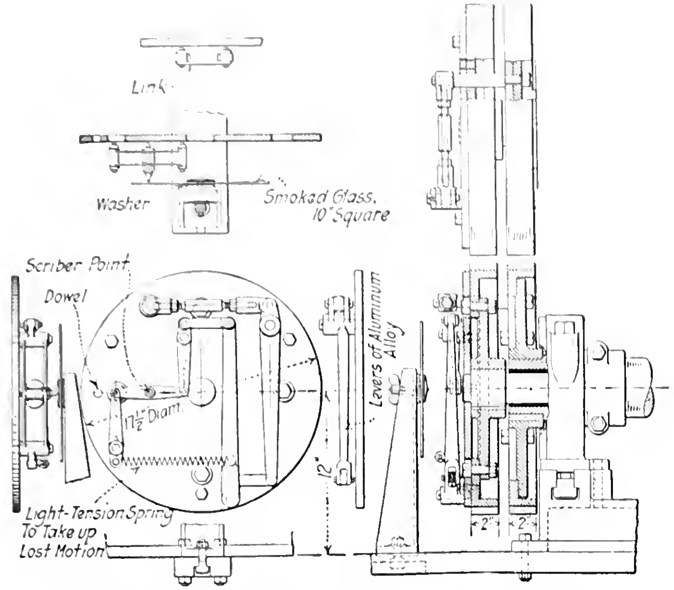


Fig. 4 Recording Mechanism for Use on Gear-Testing Machine

The importance of better knowledge concerning the effect of speed upon the strength of gear teeth was recognized in December, 1921, by the A.S.M.E. Research Committee and a Research Committee on Gears was appointed by the Council of the Society, consisting of Messrs. Wilfred Lewis, *Chairman;* Earle Buckingham, Ralph E. Flanders, Arthur M. Greene, Jr., and Charles H. Logue, to which the following gentlemen have recently been added by the American Gear Manufacturers Association: F. E. McMullen, The Gleason Works, Rochester, N. Y., and E. W. Miller, The Fellows Gear Shaper Co., Springfield, Vt. A critical examination of the gear tester proposed is in progress and when all details have been satisfactorily arranged it is hoped that interest enough will be aroused in the project to provide funds for the construction of a machine with which a valuable series of experiments can be carried out, throwing light not only upon the effect of speed upon strength, but also upon friction and wear and other questions that may arise for solution.

For the control of gear sounds, the prevention of the generation of noise has been found to be the only feasible method. Other methods, absorption and insulation, have met with slight success. Thus far the only way in which gears have been inspected for noise has been by ear. There has been no quantitative physical measurement of sounds. Sound indicators, which are usually resonators responding only to one pitch, are of little service in measuring gear noise. An indicator for this purpose should be of the non-selective type, such as the pressure vane which responds to the air pressure set up by the noise vibrations.

The measurement of noises is not so difficult as the interpretation of the measurements. Surroundings have much to do with sounds. Results obtained with an indicator in one room would be different than those in another room or out in the open, owing to the reflection of sound vibrations from walls and objects. Also, the gears must be stripped, for if this were not done it would be impossible to determine whether the sounds were attributable to the gears, to the shaft in its bearings, to the gear box, or to the supporting framework.

Noise cannot be measured in absolute units but relative measurements are possible, and from a commercial standpoint these are often all that is desired. All gears compared, however, must be tested under identical conditions, and the sound meter must be located in a calibrated room. Prof. Daniel L. Rich, in an address before the American Gear Manufacturers Association, Chicago, October 9-11, 1922.

A New System of Helical Involute Gearing for Use on Metal Planers

By FORREST E. CARDULLO,[1] CINCINNATI, OHIO

In this paper the author gives particulars of a system of helical gearing designed by him for use on metal planers, in which the directions of rotation and the helical angles of the several gears are so chosen as to counterbalance and minimize end thrust, advantage being taken at the same time of the end thrust to counterbalance the side thrust of the cutting tools. The tooth form adopted is an involute having a 14-deg. pressure angle, a pinion addendum of $3/2\ p$ *in. and a pinion dedendum of* $1/2\ p$ *in.,* p *being the normal diametral pitch. The advantages of this form of tooth for the work in question are enumerated at length and dimensions of a pinion, gear and rack design according to the principles set forth in the paper are given in tabular form.*

THIS PAPER presents the engineering features of a system of helical involute gearing of special tooth form developed by The G. A. Gray Company, of Cincinnati, Ohio, to meet the peculiar conditions necessitated by metal-planer service. It is necessary that planer gears should have the following characteristics in order to give satisfactory service:

- *a* The gears must give smooth and uniform motion without impact, vibration, or chatter. If they do not do so, variations in the driving force, or in the speed of driving, will be transmitted to the table, causing it to vibrate, and produce chatter marks on the work
- *b* When the gears wear, they must preserve their correct tooth form so that they will continue to give smooth and uniform motion without chatter
- *c* It is necessary that the gearing have ample strength so that it will transmit the maximum force which can be applied by the source of power, without reaching the elastic limit of the tooth material
- *d* The several gears must have such tooth forms and widths of face that they will run for a reasonable length of time without serious wear
- *e* Should there be wear of the bearings and shafts which would permit the gear centers to separate by a measurable amount, the tooth forms must be such that the gears will still give smooth and uniform motion
- *f* The tooth forms must be such that the teeth can be correctly produced by an efficient and economical machining process.

DISADVANTAGES OF HERRINGBONE GEARS FOR PLANERS

About two years ago it became the duty of the author to design a system of planer gearing embodying the above requirements. On account of requirements *a* and *b*, it was decided to use a complete train of helical or herringbone gearing, and on account of requirements *e* and *f*, to use the involute tooth form. A study of a design using herringbone gearing showed that within the available limits of space this gearing would not have sufficient width of face to meet satisfactory requirements *c* and *d*. The herringbone gear necessitates either that right- and left-hand gears and pinions shall be machined separately and then fastened together in some way, or else that a sufficient space be left between the right- and left-hand teeth to permit the cutters to run out. The first expedient is not only expensive but it gives a weak and unsatisfactory construction of the pinions. Furthermore, the design of a herringbone rack on this plan offers great difficulties. The second expedient makes it necessary to narrow the faces of the gears too much.

A further objection to herringbone gearing for planers is the great practical difficulty of obtaining two helical gears of opposite hand but of exactly equal helical angle, pitch diameter, and pressure angle. A variation in any of these quantities in the two halves of either the gear or the pinion results in an unsatisfactory and "jumpy" action.

Helical gearing having all the desirable qualities of herringbone gearing except freedom from end thrust, it occurred to the writer that the hands and helical angles of the several gears might be so arranged as to counterbalance and minimize the end thrust, and that advantage could be taken of the end thrust to counteract the side thrust of the cutting tools. It is usual in planer work to arrange the tools so that they will feed away from the operating position, commonly called the right-hand side of the planer. Also when a side head is used, it is most convenient and customary to use the right-hand side head. Consequently both the feeding pressure of the rail-head tools and the surfacing pressure of the side-head tool are usually such as to push the table away from the operating side of the machine. These conditions inhere at least 90 per cent of the time in planer work.

It is obvious that if the bull gear be made with a right-hand helix, its rotation during the cut will tend to draw the table toward the operating side of the machine and counteract the feeding pressure of the tools. Since this feeding pressure amounts, with usual forms of tools, to about one-tenth of the cutting pressure, the helix angle of 5 deg. 40 min. was fixed upon as being a suitable helical angle for the bull gear and pinion, the end thrust produced by such a gear being approximately one-tenth of the driving force.

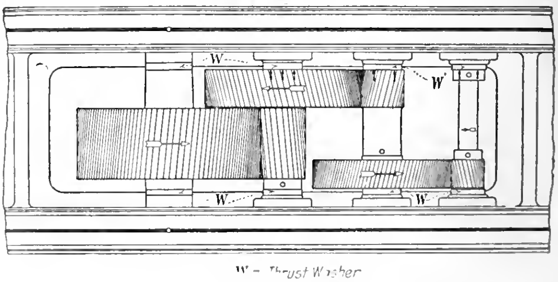


FIG. 1 ARRANGEMENT AND GENERAL PROPORTIONS OF THE GEAR TRAIN DEVISED BY THE AUTHOR FOR PLANER OPERATION

The remaining gears of the train were made with helical angles of about 12 deg., the hands of the helices being so arranged that the end thrust transmitted from the bull gear to its pinion is distributed between the bull-pinion, intermediate, and pulley shafts, being greater in the case of the slow-moving shafts than in the case of the pulley shaft. Bronze thrust washers which are provided with oil by a system of forced lubrication, absorb these end thrusts.

END THRUST OF HELICAL GEARING NOT OBJECTIONABLE IN PLANERS

While there may be objections in certain types of machinery to the end thrust produced by helical gearing, these objections do not apply in the case of planers since the driving pressures and its associate end thrusts are relieved each time that the planer reverses, thus permitting complete reëstablishment of the oil film. That the end thrust in this design is not serious may be inferred from the fact that it is only about one-thirtieth of the end thrust occurring at the end of the worm shaft in the Sellers type of planer drive which the Gray Company have been building for over thirty years and which does not give trouble when working under thrust-bearing pressures of nearly one ton per square inch.

The arrangement and general proportions of the train are shown

---

[1] Chief Engineer, G. A. Gray Co. Mem. Am.Soc.M.E.

Contributed by the Machine Shop Division for presentation at the Annual Meeting, New York, December 4 to 7, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. Slightly abridged. All papers are subject to revision.

diagrammatically in Fig. 1. The feathered arrows show the direction of motion of the tops of the gears during the cutting stroke, while the arrow heads show the pressure exerted by the gears upon the thrust washers.

Imperfections in the action of planer gearing produce a wavy surface on the work known as "gear chatter." If the extreme depth of these waves from crest to trough is not more than 0.0001 in. the planer work will be flatter than can be produced by hand scraping, although the waves can be seen quite plainly under suitable oblique illumination. With improperly designed, poorly cut, or worn gearing, the familiar "washboard finish" appears. The waves may be from 0.0005 in. to 0.0015 in. deep, and the work will have to be hand-scraped to a flat surface if a good job is required. The greater the depth of the waves, the greater the amount of metal which must be scraped away. The cost of this work is properly chargeable against the gearing which makes it necessary.

The Form of Involute Tooth Adopted and Its Advantages

Consequently no portion of our gear design has received more careful attention than the tooth form. The form adopted is a $14^{1}/_{2}$-deg. pressure-angle involute tooth, with a pinion addendum of $3/2p$ in., and a pinion dedendum of $1/2p$ in., where p is the normal diametral pitch.

The advantages of the tooth form adopted are:

- *a* The use of a short dedendum in the pinion teeth eliminates interference, which is a prolific source of trouble in all kinds of machine-tool gearing
- *b* The strength of the pinions is increased about 40 per cent without using stub teeth or increasing the pressure angle. This may be seen by comparing the tooth forms shown in Fig. 2
- *c* The use of long addendum and short dedendum for the driving pinions shortens the angle of approach and lengthens the angle of recess. This type of tooth action is sometimes called "long follow through" and gives great smoothness of motion for the following enumerated reasons:
    1. During the angle of approach, the effect of tooth friction in causing vibration is cumulative, the friction increasing the effective pressure angle and the tooth pressure, which in turn increases the friction. This exaggerates the periodic variation in the amount and direction of the tooth pressures. During the angle of recess the increase in friction reduces the effective pressure angle and the tooth pressure, thus damping any vibrations produced by variations in friction. The effects of these actions are similar in a general way to those obtained by pushing a flexible pole along a rough road in front of one in the case of the angle of approach, and dragging it after one in the case of the angle of recess. In the first of these cases the vibration is very marked. In the second it is scarcely noticeable
    2. The active portion of the tooth profile is removed from the base circle so that the involute curvature changes gradually, giving a smoother action
    3. During the angle of recess there is less relative sliding than during the angle of approach, which reduces tooth wear.
- *d* The diameter of the pinions at the bottom of the teeth is increased, giving stronger pinion bodies
- *e* The short dedendum avoids undercut or radial flanks with their attendant evils.

In order that the advantages of long-addendum drivers shall not be lost in the case of the bull gear working against the rack, the bull pinion, bull gear, and rack are of peculiar kinematic properties. The bull pinion is a long-addendum driver of $14^{1}/_{2}$ deg. pressure angle, and the bull gear, when meshing with the pinion, is a long-dedendum driven gear of the same pressure angle and cut with an exactly similar hob of opposite hand. When the bull gear meshes with the rack, however, it becomes a long-addendum driver, the change being produced by appropriately reducing the pressure angle, the circular pitch, and the helical angle of the rack. The bull gear accordingly has two pitch circles, the larger one associated with the bull pinion and the smaller one with the rack. Each pitch circle has its own circular pitch and helical and pressure angles. Were it not for this design, most of the action of the bull gear and the rack would occur during the angle of approach, when the circumstances are unfavorable to smooth action. By this peculiar construction, however, we achieve the following advantages:

- *a* The bull gear drives the rack mostly during the angle of recess, giving the advantages already described in connection with the long-addendum pinion
- *b* The pressure angle of the bull gear against the rack is theoretically only about $8^{1}/_{2}$ deg., and is practically reduced still lower by the tooth friction, greatly diminishing the tendency to vertical vibration[1] arising from imperfect gear action or variation in tooth friction
- *c* The line of action of the force applied by the bull gear to the table of the planer being more nearly in the direction of the motion of the table, is much more effective and satisfactory

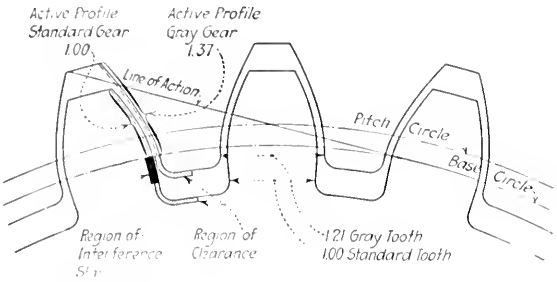


Fig. 2 Comparison of the Gray and Standard Forms of Involute Teeth

- *d* Because of this very low pressure angle the tendency of the bull gear to lift the table is only about half the usual amount,[2] making hold-down gibs and side-thrust bearings unnecessary.
- *e* Because of the low pressure angle the number of teeth in contact is greatly increased, which confers the following advantages:
    1. The load per tooth is reduced in much greater proportion than is the strength of the tooth, so that the construction is actually stronger than would be the case with the larger pressure angle
    2. The effective lineal contact is greatly increased, reducing the specific contact pressure and consequent wear.

Reasons for Employing a Full-Length Tooth and a Low Pressure Angle

A few words of discussion as to the reason for choosing the full-length tooth, that is, a tooth where the working depth is equal to 2 divided by the diametral pitch, and also for choosing the low pressure angle, are in order.

In the case of spur gears which have become slightly worn, some wear occurs at the tips of the teeth and still more on the

(*Continued on page 873*)

---

[1] Gear chatter is caused by periodic variation in the amount and direction of the tooth pressure. Such variations when finally transmitted to the table rack have two components, one in the direction of motion and the other in a vertical direction. The first of these components is harmless, the second produces vertical movements of the table and work. A low pressure angle between the bull gear and table rack tends to eliminate this vertical vibration.

[2] In this connection the author desires to point out that conditions occasionally arise when a left-hand side head is being used or heavy roughing is being done by feeding the tools toward the operating side, that the end thrust of the bull gear adds to instead of counteracting the tool pressure. Under these unusual conditions the bull gear pushes the table against the right-hand surfaces of the ways. This tends to cause the table to lift. However, the pressure angle of the bull gear in the Gray design is such that even under these unusual and unfavorable conditions the tendency of the table to lift is less than the tendency of a spur-geared table to lift under the most favorable circumstances.

The Fuel Element in Energy Production Costs

S. B. FLAGG,[1] NEW YORK, N. Y.

THE executives responsible for the operation of steam-electric public-utility properties have had a troublesome problem in their rising fuel costs during the last few years. Of the total cost of delivering a kilowatt-hour to the switchboard, fuel represents anywhere from 60 to 80 per cent, and this item has consequently been the one upon which has been concentrated the greatest effort to reduce production costs. It will be the purpose of the present discussion to point out some of the most important ways in which this fuel-cost item may be reduced. The opportunities for saving begin with the consideration of the location for the development and do not end until the last unit in the plant is dismantled or placed in reserve.

If the station is to serve a city of some size located far from the source of fuel supply, the selection of site will frequently be determined by the availability of condensing-water supplies. If, however, the community to be served is not at a great distance from these fuel sources, and particularly if the station is to feed into a transmission system distributing energy to several communities, the selection of site may have a marked effect upon fuel costs.

There may be possibility of drawing fuel from two or more competitive coal fields if the proper location is chosen, and in some cases it may be advisable to look forward to shifting from one of these to the other, even though the fuels may be of radically different character. Nowadays, however, freight rates bear little relation to the length of haul, and sometimes the difference in rates applying to two sites only a mile or two apart may increase the cost of delivered fuel by as much as 30 per cent and thus practically preclude the possibility of obtaining competitive fuel bids.

There are cases where advantage may be taken of supplies of waste fuels, such as the so-called "river coal" in the streams flowing from the anthracite coal regions or the refuse from lumbering operations. If the supplies of such fuels are adequate to furnish the requirements of the station for a number of years and they may be purchased on favorable long-term contracts, this condition may prove the deciding factor. When combined with the supplies of waste fuel there is the possibility of eliminating common-carrier transportation from the source to the station, this is a further decided advantage. Occasionally a plant may be built near enough to a coal mine to secure this elimination of freight charges. In the last few years there has been much discussion about the generation of energy in large central stations located in the eastern coal regions, but one of the great obstacles has been to find adequate supplies of condensing water immediately adjacent to the mines. The very important bearing of site selection on fuel costs was well illustrated by a comparative study recently undertaken. Although the sites were only about 25 miles apart, the estimates showed the fuel cost per kilowatt-hour at one plant to be 1.5 mills lower than for a development at the other site. Assuming a peak load of 30,000 kw. and an annual load factor of 60 per cent, this would mean an annual output of approximately 160,000,000 kw-hr., on which a saving of 1.5 mills per kw-hr. would amount to $240,000. Looking at the matter in a different way, the fixed or investment charges on such a station would probably be around 5 mills, so that the estimated difference in fuel costs would, in so far as the effect upon energy cost is concerned, be equivalent to a 30 per cent saving in the investment at one site as compared with the other.

Once the question of station site is settled and the problem is put up to the designing engineer, he, too, must keep fuel costs constantly in mind in developing the general plant layout as well as in determining what equipment shall be installed, for the decision will frequently depend upon the balance between decreased fuel expense and increased fixed charges, or vice versa. This applies to the arrangements for coal and refuse handling, the selection of steam-generating equipment and prime movers, and even to the choosing of auxiliaries. Flexibility in the boiler plant so as to permit taking advantage of changed fuel-market conditions may require careful consideration. This is especially true in some localities in the Middle West where it may pay to change from fuel oil to natural gas or from liquid or gaseous fuels to coal, sometimes for a period of only a number of months.

A number of public-utility companies have decided to acquire and operate their own coal mines as a means of reducing their energy costs, one of the chief inducements being that their exceptionally uniform demand for fuel gives such mines a high "load factor." This is readily apparent when we consider that mines in some sections of the country often average only about 200 working days per year and that coal properties have certain expenses which go on whether or not the mines are operating. Another advantage resulting when the utility company produces its own fuel is that the quality and characteristics of the coal are subject to less variation, and this is a distinct advantage in the plant operation.

If, as in the great majority of cases, the utility company does not control its source of fuel, there is the opportunity to reduce operating costs by the judicious purchase of its supply, and executives have today a much more general realization of this fact than formerly. The comparative values of different fuels as reflected in the fuel cost per kilowatt-hour are now much more carefully studied than formerly. Under some conditions a reduction of 1 per cent in the ash content of the coal may be equivalent to a saving of 25 cents or more per ton in the price of the coal, and this fact justifies not only careful thought in making contracts or purchases, but also in checking deliveries. Further use is made of delivery coal analyses in following up operating performance, for the station economy is now reported in B.t.u. per kw-hr. instead of pounds of coal per unit output.

The marked growth of the plant-betterment work in public-utility organizations is largely on account of the importance of the fuel element in operating costs. As a consequence of these activities and of the availability of improved boiler and stoker-equipment monthly operating reports, the results, being obtained today in some stations are better than were possible formerly under test conditions. For instance, the weekly or monthly boiler-refuse samples from some of the best-operated and most modern installations are showing as low as 10 per cent combustible in the dry refuse, whereas formerly 15 per cent was considered excellent for test conditions. Likewise, gas analyses showing only 15 to 20 per cent excess air are being obtained in daily operation, and monthly average boiler-plant efficiencies close to 80 per cent. By careful study of station heat-balance conditions, of condenser and often of spray-pond operation, as well as the economical loading of equipment, the savings in boiler room and turbine room have in some cases reduced fuel consumption as much as 30 per cent.

Finally the time comes when the boiler or turbine units in the station or even the station as a whole are placed in reserve or superseded by something more efficient and usually of larger capacity. The demand for increased capacity may precipitate such a decision, but if not, the differences in fuel economy will bring it about. In fact, the rapid growth in the electrical loads of our utility plants, necessitating frequent extensions to existing generating facilities or the commencement of new developments, has been due in large part to the unceasing efforts of the executives to improve fuel economy and lower costs of production. As the reward of these efforts we see today the larger and most modern steam-electric stations producing a kilowatt-hour with the consumption of 18,000 to 19,000 B.t.u. in the fuel, where formerly it required 50,000 B.t.u. or more, and the end is not yet. With the continued improvement of efficiency in transmission of electrical energy we may expect greater centralization of energy generation, and far-sighted executives are so shaping plans for development that they will be able to meet the competition which this centralization may make possible. In the struggle to attain to this position the field of fuel economy in its broadest sense offers the greatest single opportunity at the present time.

---

[1] Engineer, Electric Bond & Share Co.

Presented at a meeting of the Washington Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Washington, D. C., March 23, 1922. Abridged.

Relieving Industry of Burden

By WALLACE CLARK,[1] NEW YORK, N. Y.

Many manufacturing plants are today carrying a burden of idleness and waste because their capacity, which was increased during the war and the period of high prices immediately following, is in excess of present demands. This paper presents a general plan for lifting this burden, important features of which are distributing overhead expenses by the machine-rate method, keeping all equipment in use, even though it be necessary to reduce prices to secure orders; reducing manufacturing time, and lowering production costs, particularly by raising production standards and stimulating the interest of the workmen.

AMERICAN industry is at present carrying a heavy burden of unused buildings and equipment and of wasted time. Long before 1919 we had become an exporting nation and had increased the capacity of our manufacturing plants far beyond our domestic needs. When the European nations went to war we added to our factories in order to provide them with munitions and food, and after our entrance into the war, the expansion was even greater. After the armistice the lure of high prices and big profits caused still further additions to plants and equipment, so that we are now greatly overequipped for our own needs, and there is no immediate prospect of a resumption of foreign trade.

How, then, are manufacturing plants to be relieved of this burden of idleness and waste?

First, by using all equipment

Second, by doing work with as little waste as possible.

In attempting to take the first step, it is necessary to begin by separating used from unused equipment. This separation need not be made physically, but it must be clear in the minds of the management, particularly those who have anything to do with costs and prices.

Costs of Work and Idleness

Among manufacturers who are keeping abreast of the times it is generally accepted that the best way to distribute overhead expense is by means of a machine rate.[2] Material which stands on the floor of a shop is not affected by the investment in the equipment or the building, except possibly in the matter of protection from the weather. It is only when that material is worked on by men, machines, chemical processes, or in other ways that the investment in equipment or the expenses have any effect on it. The plant affects material only through machines; therefore the fairest method of distributing the plant expense is according to the time spent on the material by the various machines, that is, by means of machine-hour rates.[3]

From an operating standpoint the overhead expense may be divided into two parts:

1 The cost of keeping equipment and having it ready for use

2 The added cost when equipment is used.

In distributing this expense there are therefore two rates for each machine, an idle rate and a running rate.

These two machine rates provide a means for keeping costs of idleness entirely separate from costs of work done. When a machine is being used, it is obvious that through its running rate the overhead is charged directly to the product; but when the machine is not running the overhead is not being used and cannot be charged to the product because it has no effect on the product. However, it may be charged to accounts which represent the reasons for the idleness. In a machine shop, for instance, there would be such idleness accounts as Lack of Help, Lack of Material, Lack of Orders, Lack of Power, Repairs, and Lack of Tools. These expenses cannot be charged to the product, so they must be kept separate and possibly absorbed in "profit and loss." When the manager, superintendent, and, particularly, the foremen know the amount of out-of-pocket expense due to causes over which they have control, they will invariably so plan their work as to lessen this burden of idle equipment.

Losses Due to Lack of Orders

When the cost of maintaining equipment in idleness due to lack of orders is known, intelligent steps can be taken to reduce that loss. The sales department will examine the situation and see what advertising or soliciting can be done to bring in orders at profitable prices. If satisfactory results are not obtained, the price will be lowered to a point which will secure orders, provided that the price covers the expense incurred for material, direct labor, power, etc., in filling the orders. Whatever is received above the material-labor-power cost will go toward reducing the losses caused by the idleness of machines. It is often possible to wipe out all the burden of idleness expense by quoting prices low enough to keep machines running.

However, if conditions are such that even in normal times there is no prospect of securing orders at a profit, there is no advantage in continuing to quote low prices. There are then two courses open:

1 To develop new products which can be manufactured with this equipment and sold at prices which will produce a profit

2 To sell the equipment and use the space for the manufacture of some other product.

Either course will remove what remains of the burden of unused equipment. During the last two years investors have come to realize that idle capital is frequently unable to secure any return, and they are inquiring into the cost of idle buildings and equipment, fixing the responsibility for their idleness, and insisting that every possible step be taken to make use of them.

Eliminating Waste

Going back to our second step toward relieving the burden—that is, by doing work with as little waste as possible—all waste in industry may be traced to the waste of man's time. But money is our medium of exchange for time, therefore wastes are most easily detected by investigations of costs. A comparison of actual costs of work done with ideal or standard costs will reveal the wastes and lead to their elimination.

Great savings can be secured by simplifying the product, reducing the number of varieties, and manufacturing in quantities wherever possible.

One of the striking wastes in many plants is the unnecessarily large investment in inventories of raw material, work in process, and finished goods. In order to maintain satisfactory control over an inventory, an accurate and up-to-date record of quantities in stores, of receipts, and of issues must be kept in the office of the stores department; order points must be so marked that when they are reached the office can be notified, its records checked, and the necessary orders for additional quantities placed. The amount to be kept in stores will depend on:

1 The time required to replenish the supply, either by manufacture or purchase

2 The amount used during that time.

A reduction in the time required to replenish the supply brings about a corresponding reduction in the inventory. When material moves slowly through a plant or stands on the floor or on shelves waiting for a workman or for additional material, not only is the inventory of work in process increased but also that of finished goods, because a sufficient quantity of finished goods must be carried in stores to meet the sales during the time a new supply is being manufactured. The longer it takes to manufacture, the

---

[1] Industrial Engineer. Mem. Am.Soc.M.E.

[2] Organizing for Work, by H. L. Gantt (Harcourt, Brace & Howe, 1919); Cost Accounting and Burden Application, by Clinton H. Scovell (D. Appleton & Co., 1920); Principles of Factory Cost Keeping, by Edward P. Moxey (Ronald Press, 1920); Proper Distribution of Expense Burden, By A. Hamilton Church; Cost Accounting to Aid Production, by G. Charter Harrison (Engineering Magazine Co., 1921); and Bookkeeping and Cost Accounting for Factories, by William Kent (John Wiley & Sons, 1918)

[3] The term "machine-hour rate" is intended to include rates for floors benches, vats, and, in some cases, men.

Contributed by the Management Division for presentation at the Annual Meeting, New York, December 4 to 7, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

more finished goods must be kept in stores and the heavier will be the burden of inventory.

Reducing Manufacturing Time

In order to reduce the manufacturing time, that is, the time required for the material to move through the plant until it becomes finished goods, the way must be cleared and the material kept moving. However, before the way can be cleared, a decision must be reached as to what work is to be done on this material. A written record must be made of the kind and quantity of material required, the operations to be performed, the machines on which the work can be done, the special tools or fixtures required, and the time which each operation will be reasonably expected to take. This information should be supplemented by detailed instructions as to how the work is to be done, either in the form of blueprinted shop drawings or typewritten instructions.

These instructions should represent the best available knowledge in the plant as to the material and processes which will produce goods of the desired quality, and should be the combined knowledge of the foremen, workmen, engineering department, and the management. When there is a difference of opinion as to methods, it is necessary for all of these departments to agree as to which method is best and rigidly adhere to this agreement until they are all convinced as to the wisdom of a change.

When a decision has been reached as to the work to be done on an order, the way can be cleared through the plant; that is, material, special tools, and fixtures can be ordered, and the necessary time of machines and operators set aside. This, of course, can be done only when the management has a fairly complete knowledge of the capacity of the machines and operators, as well as knowledge of the time required to complete the work already in the plant.

Orders can be then issued to the various foremen telling them what operations are to be done in each department, how, and when. There should not at any time be doubt in a foreman's mind as to the comparative importance of the work ahead of him.

When the foreman has before him the various orders to be worked on, it is necessary for him to so plan his work as to make the best possible use of his machines and men and yet get the orders out at the proper time. He will each day advise the management what he expects to do the following day and also report the things which he had been instructed to do but which he knows he will not be able to do, with the reasons why. In this way he keeps the management informed as to the progress he is making and the obstacles which prevent his progress. (It will be noted that this method places more responsibility on the foremen than has been usual in the strongly centralized organizations often identified with scientific management.)

The plant management compares these records of work done received from the foremen with the plans which it has already made, in order to see that the material moves through the plant at the desired rate of speed. Whenever its progress is checked, the management is enabled to concentrate its attention on overcoming delays, which add a considerable weight to our industrial burden.

Lowering the Cost of Production

The part of the work of management described above, that is, keeping the work moving through the plant at a rapid pace, should be well organized before very much time is devoted to individual production, because the delays under the control of the management are usually much greater in extent than those under the control of individual workmen, and because improvements in the management will have an appreciable effect on the output of the workmen. It is only when the plant is properly organized that satisfactory standards of accomplishment can be formulated with which to compare actual production. Such a comparison, when made by the foreman himself, enables him to give the workman whatever help or instruction he may need in order to do his work in accordance with the best knowledge in the plant. It is then time to investigate the processes themselves, to develop better methods and better equipment, and to teach the workmen how to use these new methods.

Finally, the interest of the workmen themselves must be stimulated. Those who dislike monotony must be provided with a rotation of work and an opportunity to develop their creative abilities; those who dislike learning new methods should have their interest aroused by the constant comparison of their production records with the standards and by receiving extra compensation for doing the work within the standard time.[1]

Lifting the Burden

This burden of idleness and waste can be lifted from the shoulders of manufacturers only by their own efforts. Each one must get at the facts in regard to his own plant, and he can check them up with a general plan such as is here presented.

In order to *use all equipment*, he will—

1 Get costs of idleness
2 Remove causes of idleness under the control of the plant management
3 Reduce idleness due to lack of orders by:
    a Advertising or soliciting
    b Lowering prices
    c Developing new products
    d Selling equipment.

In order to *do work with as little waste as possible*, he will—

1 Simplify his product and reduce varieties
2 Reduce inventories by:
    a Control of stores
    b Reducing manufacturing time.
3 Lower the cost of production by:
    a Getting workmen to use available knowledge as to methods
    b Improving processes
    c Stimulating the interest of his workmen.

When individual manufacturers have solved this problem for themselves, it will be found that the burden has been lifted from American industry.

The executive who aspires to "sell" his institution, as an institution, to the public will concede that it is equally important, if not more so, to sell it to its employees. To make men and women see that they are working not primarily to make dividends for other men and women but for an institution that is recognizedly of universal service; and that through it their labor is promoting that service, is to apply one of the strongest possible antidotes to discontent and strife.

Various efforts are being made to sell concerns to those who work for them. What else are pensions, bonuses and group insurance? These all have their value—and a very practical value.

There is no denying the strength of the appeal made by wages, by hours, by working conditions. But there is another powerful appeal that too seldom is tried—the appeal that lies in the recognition of each person connected with the concern as an individual; not as merely a cog in the machine. It is small wonder that the man who is regarded by his employers as a cog comes to think of himself in the same light and to take no more interest in his work than a cog.

There must be differences in responsibility and authority among those who comprise the personnel of a factory or store force; there need be no difference in the dignity of their positions, nor graduations of the courtesy accorded them. This matter of courtesy is more vital to harmony and loyalty than is sometimes recognized.

That the selling of an institution is no idle dream, but a practical possibility, is proved by practically every newspaper. Newspaper men work overtime when it is necessary simply for the glory and prestige of the paper, which to them is an entity, with a being and soul of its own.

It will take time to put the institutional idea over among industrial organizations. But its success will usher in an era of peace, efficiency and prosperity in the industrial and commercial world that will make the effort more than worth while.—C. P. Bulkley, in *Industrial Management*, November, 1922, p. 279.

---

[1] See Making Work Fascinating as the First Step Toward Reduction of Waste, by Walter N. Polakov, Mechanical Engineering, November, 1921, p. 731.

Influence of Design on Cost of Operating Airplanes

By ARCHIBALD BLACK,[1] GARDEN CITY, N. Y.

The author discusses cost of operating commercial airplanes and endeavors to clear up prevalent misunderstandings. Curves of operating cost for varying duration, speed, reserve horsepower, etc., are developed. Calculations are made to illustrate the impracticability of requiring twin-engined commercial airplanes to fly on one engine, and initial rate of climb of 400 to 500 ft. in the first minute is proposed as the standard of safe performance. Air Mail Service costs are used to show that airplanes designed for commercial use and fully loaded can be operated at a total cost of from 0.030 to 0.032 cent per pound-mile or 6.5 cents per passenger-mile, exclusive of the cost of obtaining the business.

THIS paper has been prepared with the intention of exploding certain widely held fallacies regarding the performance for which commercial airplanes should be designed. It presents the results of a study of the relation between designed performance and unit operating cost for such airplanes. The data were compiled by the former firm of A. & D. R. Black on work for its clients, and should be regarded as forming a qualitative rather than quantitative analysis. That is, the data given, while capable of general application to all types, will be slightly modified in the case of machines radically different from the conventional type considered.

The most generally held erroneous ideas regarding commercial airplanes are probably the following: (1) That duration of flight of eight or even ten hours is practicable; (2) that speeds of 125 to 130 m.p.h. or more are practicable; (3) that a twin-engined machine should be capable of flying with one engine running; (4) that a factor of safety of eight or more is desirable; (5) that comparatively high climbing ability is necessary and practicable; and (6) that very large airplanes are the most suitable for commercial use. While such notions are most common among those without experience in the design or operation of airplanes, they have sometimes been advanced by others who have less excuse. Probably this misunderstanding is due to the frequent practice of using for commercial work machines not suited to this purpose.

The presumption is made here that commercial airplanes are designed primarily for operation at a profit, so that operating cost and safety become the most vital considerations. When this work was started it was found possible to eliminate some duplication by basing many of the calculations upon a British report on the division of total weight of different airplanes.[2] Fig. 1 is reproduced from this report with data on weights and horsepower added.

Weight Division vs. Size, Duration, and Speed

As a preliminary to consideration of the variation of unit operating cost with size, duration, speed, etc., it becomes necessary to study the variation of net pay load with these elements. Figs. 1 to 6 should be regarded merely as furnishing the data necessary for later curves and may be passed over with little comment. They are included here because of their value for reference. Each figure shows the variations of pay load with other elements for a series of airplanes similar in every respect except in the particular feature under consideration. It will be noted that in Fig. 1 the assumption is made that only wing weights vary appreciably with size and factor of safety. While not strictly correct, the error is very slight.

In Figs. 2 and 4 single Liberty-engined airplanes have been considered, while in Figs. 3 and 5 those dealt with are twin Liberty-engined airplanes. Fig. 6 includes the two types. These machines may be regarded as typical of commercial airplanes. All corrections have already been made so that the net pay load can be read directly. The "theoretical number of passengers" scales are so marked because they indicate the number of passengers which the machine can actually lift. Other design considerations, particularly the size of the fuselage, may make it impracticable to accommodate the full number. In Fig. 11, later, the assumption is made that twelve passengers is the limit for a machine of about 420 hp. and that this limit varies directly with the horsepower. This is somewhat arbitrary but is based upon experience and should be regarded as an ultimate limit. For ordinary practice, ten instead of twelve passengers should be taken as the present limit for this size of airplane.

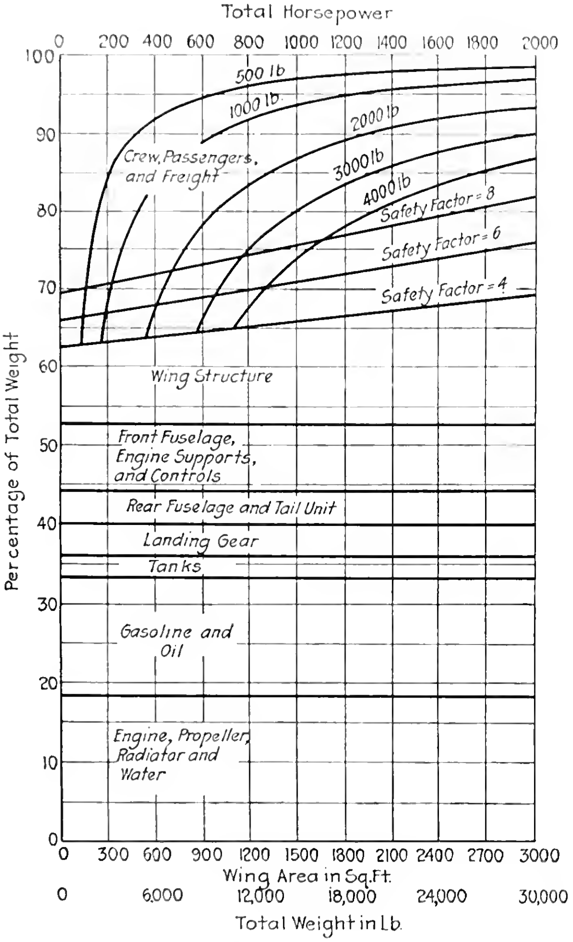


Fig. 1 Division of Weight of Fully Loaded Airplanes

(For condition of 10 lb. per sq. ft., 15 lb. per hp. and 4 hr. duration. Curved lines represent conditions of constant useful loads.)

Operating Cost

Available data on the cost of operating commercial airplanes on a comprehensive scale are very limited and practically confined to the records of the U. S. Air Mail Service. The author's association with this organization as its consulting engineer some time ago gave him an opportunity to study it at close range and he feels satisfied that it may be regarded in every way as a commercial air line. Incidentally, it is incontestably the largest commercial air line in the world. Careful and fairly complete records have been kept of the cost of operating this service and the figures which they give form the most trustworthy information at present available. The allowance which has been made for interest on investment is

---

[1] Consulting Aeronautical Engineer, Garden City, N. Y., Mem. Am. Soc.M.E.

[2] British Advisory Committee for Aeronautics, Reports and Memoranda No. 676.

Contributed by the Aeronautic Division for presentation at the Annual Meeting, New York, December 4 to 7, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

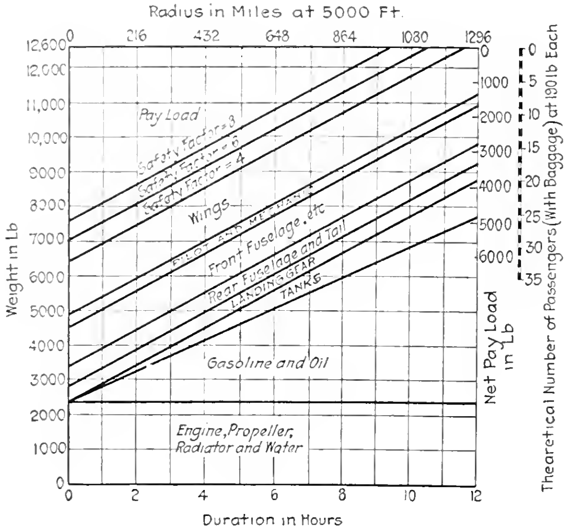


Fig. 2 Variation of Weight Division with Duration—420-Hp. Airplane

(One 420-hp. Liberty engine; total weight, 6300 lb.; wing area, 630 sq. ft.; high speed, 108 m.p.h. at 5000 ft.; minimum speed, 57 m.p.h.—10 lb. per sq. ft.; climb from sea level, 565 ft. in first min.)

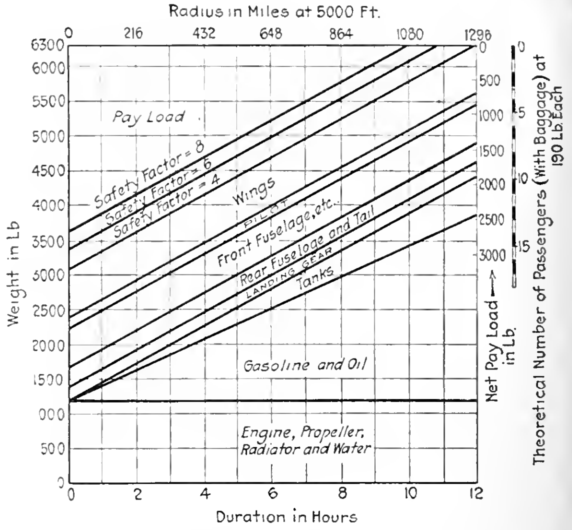


Fig. 3 Variation of Weight Division with Duration—840-Hp. Airplane

(Two 420-hp. Liberty engines, 840 hp.; total weight, 12,600 lb.; wing area, 1260 sq. ft.; high speed, 108 m.p.h. at 5000 ft.; minimum speed, 57 m.p.h.—10 lb. per sq. ft.; climb from sea level, 565 ft. in first min.)

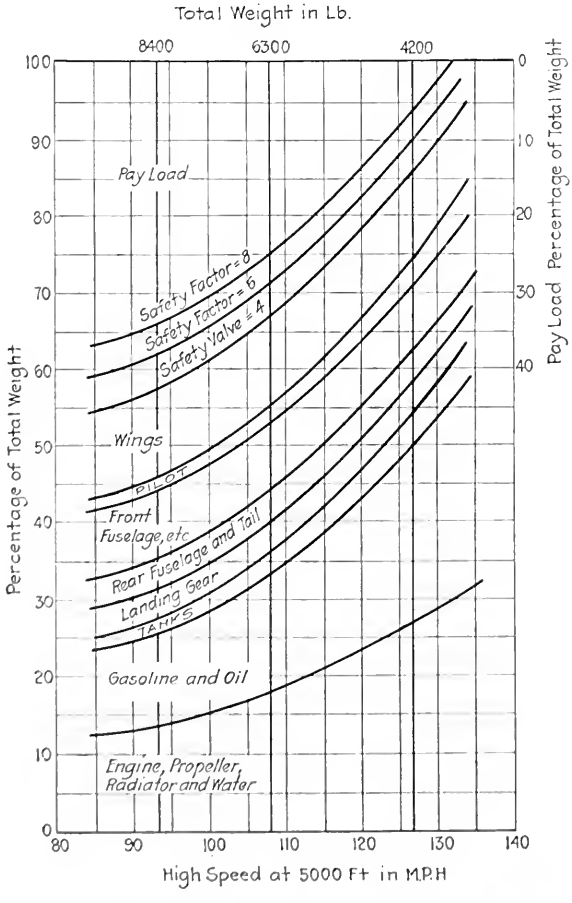


Fig. 4 Variation of Weight Division with Speed—420-Hp. Airplane

(Liberty engine, constant minimum speed, 57 m.p.h.; 4 hr. duration; wing loading, 10 lb. per sq. ft.)

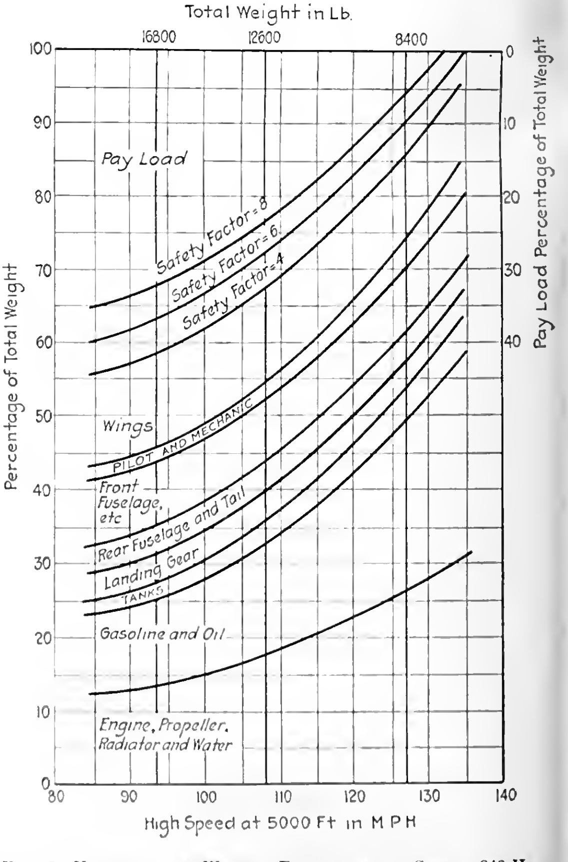


Fig. 5 Variation of Weight Division with Speed—840-Hp. Airplane

(Two Liberty engines, constant minimum speed, 57 m.p.h.; 4 hr. duration wing loading, 10 lb. per sq. ft.)

not complete. However, were it even doubled it would only increase the total cost 3.4 per cent, or, if trebled, 6.8 per cent, so the error is evidently within reasonable limits. It also appears reasonable to assume that this slight increase could be offset by certain economies possible under private operation.

The report of the Air Mail Service for the twelve months ending June 30, 1921, shows the average cost of operating its Liberty 420-hp.-engined airplanes to have been $71.13 per hour of flight.[1] Fig. 7 shows graphically the actual division of this cost over the various items. In estimating cost of operation, in the absence of other data, the assumption has been made that the Air Mail figure is a fair average for 420-hp. machines and that it will vary directly with the engine horsepower.

Operating Cost vs. Duration

We have heard some mention of operating airplanes through from New York to Chicago without an intermediate stop. This distance is about 700 miles in a straight line or 908 miles on the Pennsylvania Railroad. Along the course taken by an airplane it would be 750 to 800 miles owing to the impracticability of flying in a dead, straight line. The great increase in cost of making this flight by eliminating the intermediate stop will be immediately evident from Fig. 8. This figure shows that the operating cost per pound-mile or passenger-mile increases gradually with the duration or distance up to about 4 or 5 hours or 432 to 540 miles. Beyond this the curve takes a rapid upward turn and the cost of operating machines of over 6 hours' duration becomes prohibitive.

If we assume a 420-hp. airplane of the type described under the caption of Fig. 8, having 4 hours' duration and factor of safety of 6, the cost of operation becomes about 0.035 cent per pound-mile. Increasing this duration to 6 hours raises the cost to 0.049 cent or 40 per cent. Doubling the duration, to safely make the New York-Chicago flight without a stop, raises the operating cost to 0.086 cent per pound-mile, an increase of 146 per cent. The general conclusion to be drawn is that commercial airplanes of this size should not be designed for over 4 or 5 hours' duration. Considering now Fig. 9 for larger machines, this effect is more pronounced and it becomes advisable to keep the designed duration even below 4 hours, where possible.

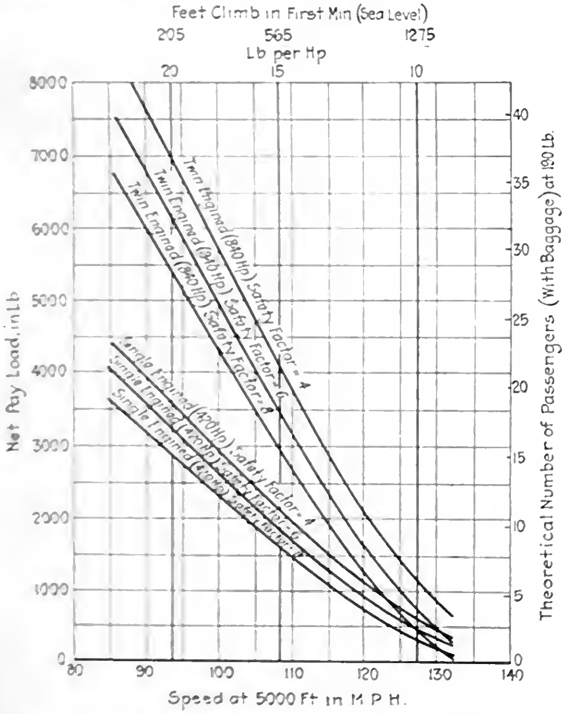


Fig. 6 Variation of Net Pay Load With Speed

(Series of single and twin Liberty-engined airplanes, constant minimum speed 57 m.p.h.; duration, 4 hr.; wing loading, 10 lb. per sq. ft.)

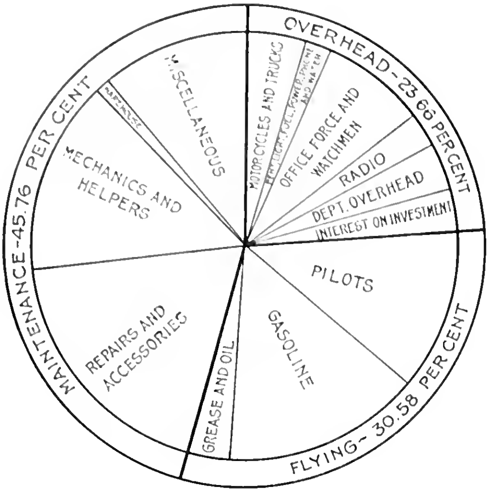


Fig. 7 Division of the Operating Dollar

(U. S. Air Mail Service for twelve months ending June 30, 1921.)

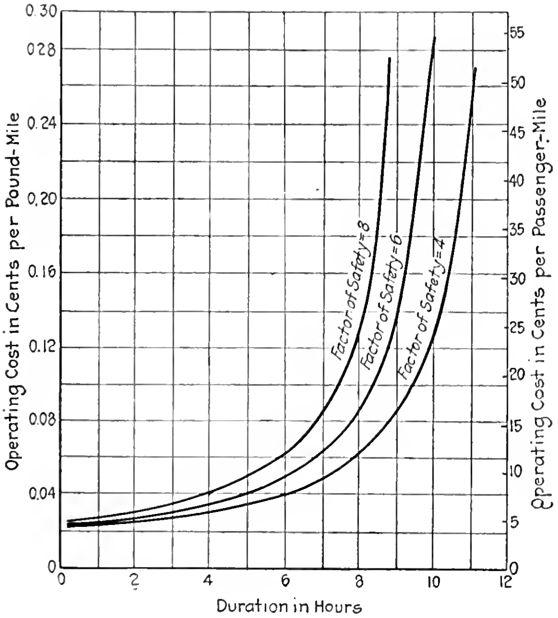


Fig. 8 Variation of Cost with Duration—420-Hp. Airplane

(One 420-hp. Liberty engine; total weight, 6300 lb.; wing area, 630 sq. ft. high speed, 108 m.p.h. at 5000 ft.; minimum speed, 57 m.p.h—10 lb. per sq. ft.; climb from sea level, 565 ft. in first min.)

Operating Cost vs. Factor of Safety

The importance of keeping the factor of safety as low as the conditions warrant is also very evident. Considering Fig. 8 again and increasing from 6 to 8 the factor of safety of the 420-hp., 4-hour-duration machine, the operating cost rises from 0.035 to 0.041 cent per pound-mile or 17 per cent. With the larger machine about the same increase takes place. However, the greater stability and lower maneuverability of the larger airplane permits some slight reduction of the factor of safety. In either case the necessity of keeping factors of safety within limits is apparent.

---

[1] More recent data, which have become available since the study was made, show this figure to have decreased with continued operation.

Operating Cost vs. Speed, Climb, and Reserve Horsepower

The effects on operating cost of speed, climb, and reserve horsepower are considered together, as these factors are inseparable if the low or landing speed remains constant. As landing speed is usually fixed by ground conditions, etc., there appears to be no reason for considering these variations separately. Fig. 10 shows the variation of climb and cost with speed, power loading, and reserve horsepower for two series of freight airplanes. Speeds have been taken as at 5000 ft. altitude to provide a better comparison, as commercial flying will take place at altitudes close to this for safety reasons. With supercharged engines, however, higher altitudes will probably be used because of the higher speeds thus made obtainable.

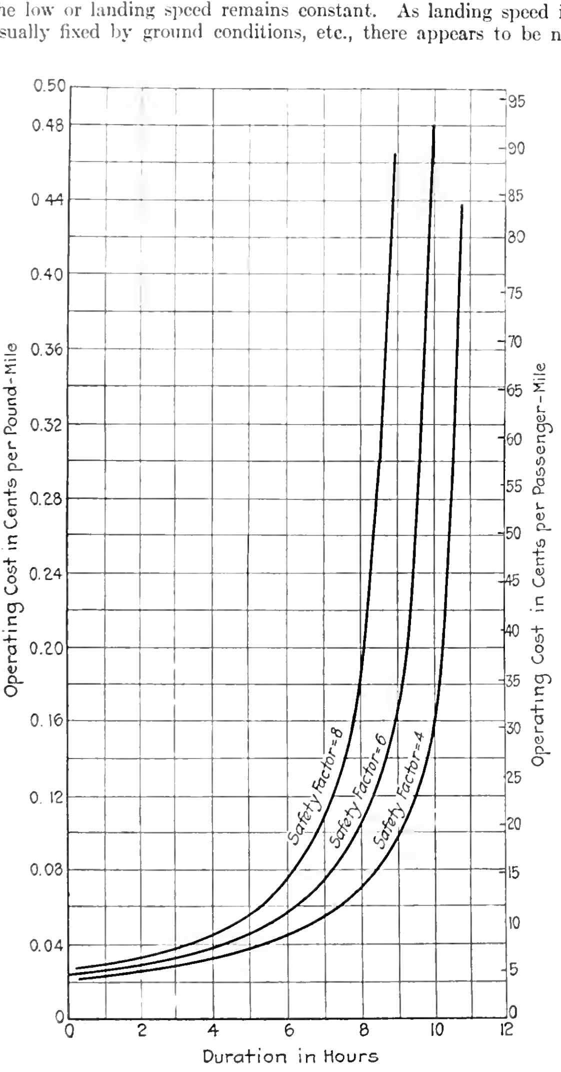


Fig. 9 Variation of Cost with Duration—840-Hp. Airplane

(Two 420-hp. Liberty engines, 840 hp.; total weight, 12,600 lb.; wing area, 1260 sq. ft.; high speed, 108 m.p.h. at 5000 ft.; minimum speed, 57 m.p.h.—10 lb. per sq. ft.; climb from sea level, 565 ft. in first min.)

Starting from the lower speeds the cost of operation rises steadily until about 105 or 110 m.p.h. is reached when a rapid upturn takes place, carrying this cost to prohibitive values for speeds above 110 or 115 m.p.h. The effect of factor of safety is also noticeable, particularly at the higher speeds. It is important to note here that of all the curves presented in this paper, Figs. 10 and 11 are the most susceptible to modification when applied to radically different types of design. At the same time they may be taken to apply to present-day airplanes of good, conventional design. The only effect of extremely fine lines would be to raise slightly the critical speed at which the cost becomes prohibitive. Against this possibility of refinement must be balanced the fact that the large fuselages necessary for commercial work place a limit on the reduction of head resistance.

In determining the best operating speed a compromise must be effected between low speed with its low reserve horsepower and high speed with its high cost. At the top of Fig. 10 a scale of reserve horsepower will be noted. This was obtained by plotting climb against power loading and extending the curve down to the point where climb became negligible. The speed at which this occurred was taken as the speed corresponding to the machine at the lower end of the series and having no reserve horsepower. The reserve horsepower scale was then laid off from the loading. This scale is approximate because, among other items, it does not take propeller efficiency into consideration. However, it is of value in furnishing a fair measure of what can be done with reduced engine speeds.

The necessity of keeping reserve horsepower down to reasonable limits is immediately evident. Experience has shown that an initial climbing speed of 400 to 500 ft. in the first minute is about the lowest consistent with safety, for operation from sea-level territory. To provide a basis for comparison an initial climb of 500 ft. in the first minute is assumed to be satisfactory. This gives a reserve horsepower of about 58 per cent and a high speed at 5000 ft. of 106 m.p.h. while the operating cost for safety factor of 6 is 0.032 cent per pound-mile for a 420-hp. machine or 0.034 cent per pound-mile for the 840-hp. machine.

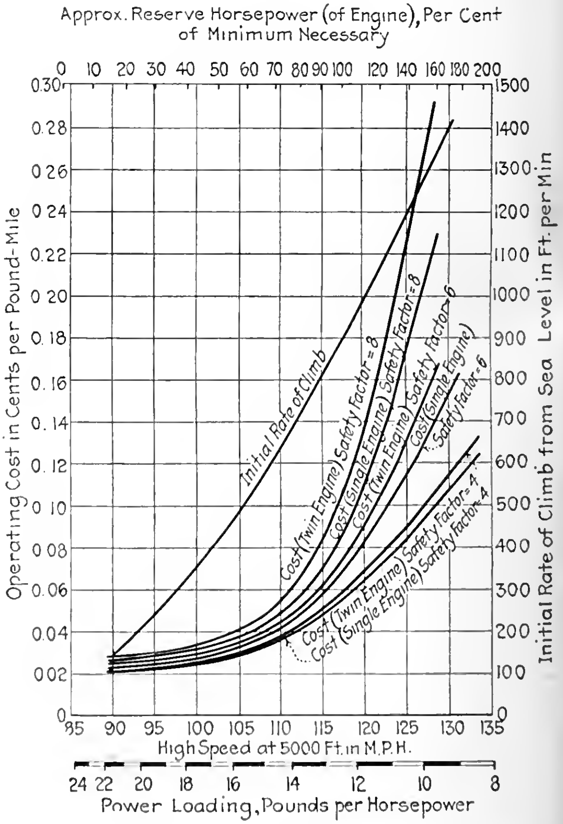


Fig. 10 Variation of Cost and Climb with Speed and Reserve Horsepower

(Series of single and twin Liberty-engined freight airplanes of constant minimum speed of 57 m.p.h.—10 lb. per sq. ft.; duration, 4 hr.)

Flying on One out of Two Engines. Let us assume that the twin-engined machine is required to fly on one of its engines. Reserve propeller horsepower of at least 100 per cent must be provided. With only one engine running the lower speed will cause a drop in

propeller efficiency from 80 per cent to about 70 or 75 per cent. Taking a propeller efficiency of 72.5 per cent, the reserve horsepower required becomes: (80 × 100) ÷ 72.5 = 110 per cent. Consulting Fig. 10 we find that climb has increased to 980 ft. in the first minute, speed at 5000 ft. has increased to 120 m.p.h., and cost of operation to 0.089 cent per pound-mile. In other words, the machine under consideration has been taken right out of the commercial class and put into the military-fighter class, while its cost of operation has increased to 162 per cent over that of a rational commercial design.

Even assuming the possibility of maintaining efficiency at 80 per cent by using a variable-pitch propeller, the increase in operating cost is still 118 per cent over normal. A study of Fig. 11 will show that the same results are obtained with the passenger machines. These figures should be sufficient to demonstrate the utter impracticability of the requirement that twin-engined machines be designed to fly on one of their engines. It seems safe to say that the prohibitive operating cost resulting from enforcement of this requirement would be sufficient to eliminate the possibility of developing commercial airplane transportation.

Flying on Two out of Three Engines. If a three-engined machine is required to fly on two of its engines a minimum reserve propeller horsepower of 50 per cent is necessary. Assuming drop in propeller efficiency from 80 per cent to 75 per cent the required reserve horsepower of the engine becomes: (80 × 50) ÷ 75 = 53.3 per cent. This is about the reserve required to provide the climb necessary for safe operation. It is thus evident that the requirement of flying on two out of three engines is reasonable and practicable.

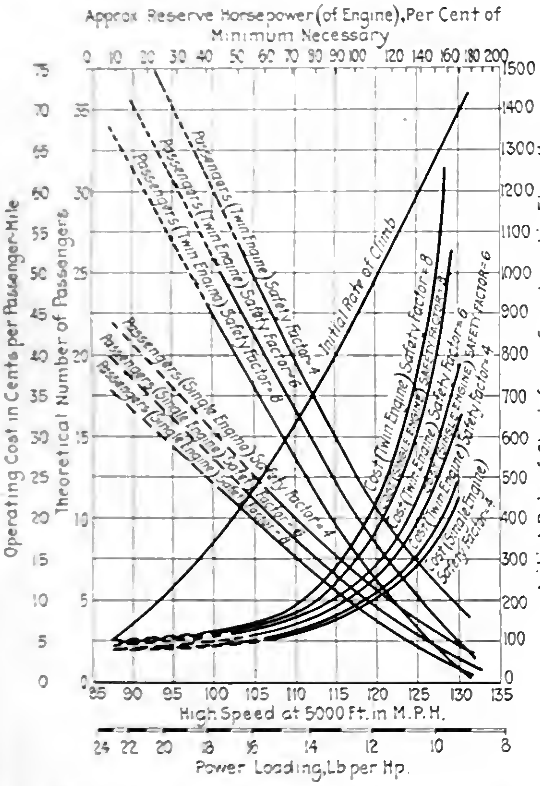


Fig. 11 Variation of Cost, Climb and Passengers with Speed and Reserve Horsepower

(Series of single and twin Liberty-engined passenger airplanes, constant minimum speed, 57 m.p.h.—10 lb. per sq. ft.; duration, 4 hr. Dotted curves indicate capacity above practical limit. Passengers calculated at 190 lb. each including baggage.)

Aside from landing speed the one element of paramount importance in determining the safety of commercial aircraft is its climbing speed, this being a measure of reserve horsepower. As an initial climb rate of 400 to 500 ft. in the first minute has been found to be consistent with safety, no reason for increasing this is apparent. If, therefore, we are to write safety requirements for performance of commercial airplanes, the most logical measure to use would be their climbing speed.

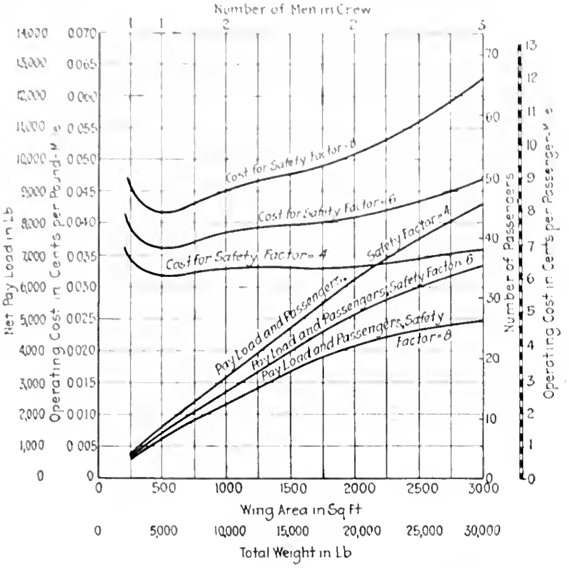


Fig. 12 Variation of Cost, Pay Load, and Passengers with Size

(Series of Airplanes loaded 10 lb. per sq. ft.; 15 lb. per hp.; duration, 4 hr., minimum speed 57 m.p.h.; high speed, 108 m.p.h. at 5000 ft.; climb from sea level 565 ft. in first min. Passengers calculated at 190 lb. each including baggage.)

Operating Cost vs. Size of Machine

The curves of Fig. 12 are based upon calculations of machines of 250, 500, 1000, 2000, and 3000 sq. ft. wing area. Some arbitrary assumptions regarding the number of men in the respective crews were necessary and these numbers appear at the top of the graph.

The form of these curves was a surprise to the author, the economical sizes being much lower than he had anticipated. They show marked economy for machines of the type under consideration in the size in which the wing area is about 500 to 600 sq. ft. This economical size would, of course, be changed somewhat were the performance of the series altered. The quick upturn of the cost curves for small sizes of machines is due to the constant allowance for weight of the pilot crowding out a larger percentage of the net pay load. The slight "hump" in the same curves at about 1000 sq. ft. area is due to the allowance for a crew of two, while the gradual rise toward the larger machines is due to the increased structural weight of the wings and to the allowance of three men for the crew. This increase can be modified somewhat by further refinement in design but an allowance corresponding to existing practice *has already been made.* To avoid the very laborious work of estimating in detail the investment and operating cost for each size the following assumptions have been made: (1) That the Air Mail cost applied directly to the 420-hp., 630-sq-ft. size; and (2) that the operating cost for other sizes varied directly with the size. In considering the question of size, some preference should be given to machines having more than one pilot. The added safety thus obtained makes it worth while to sacrifice some possible savings by reducing size.

Operation Cost vs. Landing Speed

No detailed study of the effect upon operating cost of varying the landing speed or low speed has been included. Landing speed being practically fixed by the field conditions to be met, very little variation is permissible when the design is being made. Consequently it appeared unnecessary to go into this effect as thoroughly as into other features of performance.

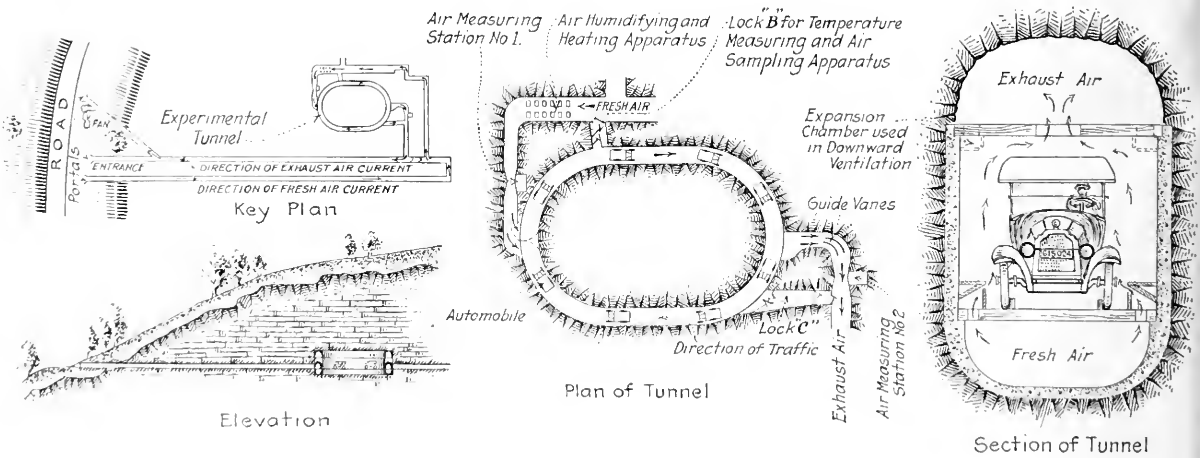
(Continued on page 849)

Research Fundamental for Hudson Tunnel Design

Design of Longest Vehicular Tunnel Requires Exhaustive Research to Determine Physiological Effects of Exhaust Gases and to Proportion Ducts and Orifices in Ventilation System

THE entire development of modern industry with its great achievements in opening up new fields and basically revolutionizing old ones, has shown that the new ways of applying materials have contributed mightily to the changes in modern economics, even more so perhaps than the three formerly well-recognized factors of production: land, labor and capital. Further, modern engineering has shown the absolute need of "knowing how" when an attempt is made to accomplish anything vastly bigger in size than has ever been tried before. Bridges have been built from time immemorial. Iron (latterly, steel) bridges have been common for a century, and yet failure was the result of the first two attempts at building the Quebec Bridge, an unprecedentedly huge structure. Knowledge of the behavior of such enormous masses of material was lacking. There have been many other instances in which an increase in size unaccompanied by accurate knowledge has brought disaster. We recall the early failures of ore-carrying steel boats on the Great Lakes, which continued until proper ways of bracing and reinforcing them were found. There are many other such instances well known to the engineering profession.

In engineering design a lack of knowledge can be met in two ways. One, applied whenever possible, is to introduce what are known as factors of safety. A more proper designation might be factors of doubt or of ignorance. Another way is to analyze the unknown conditions and determine the facts relating to them.



EXPERIMENTAL TUNNEL CONSTRUCTED IN THE ROOM WORKINGS OF A COAL MINE AT BRUCETON, PA.

The method of handling the ventilation problem in the projected Interstate Tunnel under the Hudson River connecting New York and Jersey City is a fine example of the modern way of securing by rigorous research the fundamental facts for the solution of a big engineering problem, difficult not only because of the unusual size of the undertaking but because there was a comparative lack of exact information as to the technical factors involved.

In the first place, the tunnel is much larger than anything of the kind ever undertaken before. The only vehicular tunnels even approximately comparable to the Hudson River Tunnel are the Blackwall and the Rotherhithe tunnels under the Thames River in London. These have, however, an under-river length of only 1221 and 1570 ft., respectively, and carry a traffic of less than 100 motor vehicles each per hour, whereas the Hudson River Tunnel, to be 8300 ft. long, is designed to handle in excess of 2000 motor vehicles per hour, or more than 20 times as many as the London tunnels, where, it may be stated, atmospheric conditions are reported to be bad at times.

There were three elements to be determined before a comprehensive design of the ventilation system could be worked out. First, it became necessary to determine the amount and composition of exhaust gases from the motor-driven vehicles which were to pass through the tunnel at a known rate. The next problem was to find out what quantity, or rather percentage, of these exhaust gases in air would be harmful to persons spending the time in the tunnel necessary to pass from one end to the other, taking into consideration various possible delays. With these two factors known, it became a simple mathematical problem to find out how much fresh air must be introduced into the tunnel to produce the necessary dilution and render the exhaust gases harmless. Finally, it was necessary to determine the complete design for adequate ventilation and, to be on the safe side, actually try it out before an irrevocable commitment was made to its use in the actual structure. It was neither an easy nor a simple matter to obtain information on all these factors, but it was obtained, and American engineering may be justly proud that all the tests were carried out in a scientific manner and with a considerable degree of precision in institutions located in this country, an largely with apparatus developed in America.

A series of tests were carried out at the Pittsburgh Experiment Station of the Bureau of Mines in accordance with the program of the Chief Engineer of the Tunnel Commission. A number of passenger cars and various kinds of trucks and buses were tested both under summer and winter conditions on a level course and over various grades. The exhaust gases were carefully analyzed, and it was found that the percentage of carbon monoxide for all classes of vehicles varies within wide limits and depends on a number of variables. The effect of carburetor adjustment is probably directly or indirectly far greater than that of any other factor. It was also found that because of improper adjustment—something quite common with the average automobile driver—there is an immense waste of gasoline from the resulting excessively rich mixtures.

In the tests the average output of carbon monoxide for each class of motor vehicles under certain conditions was determined, and this together with a knowledge of the vehicle capacity of the tunnel gave

---

Acknowledgment should be made for the assistance given in the preparation of this article to C. M. Holland, chief engineer, and Ole Singstad, assistant chief engineer, of the Interstate Tunnel Commission.

a fairly clear idea as to the maximum volume of toxic gases with which the ventilating engineer must reckon.

Physiological Effects of Exhaust Gases

This part of the investigation was carried out at the Laboratory of the Bureau of Mines at Yale University with Yandell Henderson in charge. The Bureau of Mines had had considerable experience in this kind of work as it had already undertaken studies which dealt with the use of traction engines in coal mines, the vitiation of air in small garages and coal mines, and the determination of standards for the vitiation consistent with safety.

Prior to this investigation the standards of allowable air vitiation with carbon monoxide had not been precisely defined. Dr. J. S. Haldane, in England, had investigated the question chiefly with reference to the safety of miners after mine explosions and fires, and his attention had accordingly been directed to the amount of carbon monoxide which would incapacitate or seriously inconvenience a man, rather than to those amounts which are compatible with complete comfort and efficiency.

The simplest way to deal with this question would be to demand that the air in the tunnel be as pure as that of the city streets, with a standard of, say, not more than one part of carbon monoxide in 10,000 parts of air. This standard would not be economical, however

Carbon monoxide when inhaled produces oxygen deficiency in the body which leads to physiological results that vary with the length of exposure and the concentration of the gas. This latter, it may be stated, is commonly measured and expressed for purposes of ventilation as one or more "parts" of this gas mixed with 10,000 times as much air, one "part" being therefore one-hundredth of one per cent of the atmosphere.

The absorption of carbon monoxide by the hemoglobin of the blood proceeds at first at a very rapid rate but slows down as time goes on, and the more carbon monoxide the blood absorbs the greater becomes the force with which this gas tends to diffuse out again into the air, the condition gradually approaching a state of equilibrium, though it is not certain to what extent it ever reaches it. As a definite quantity for determination may be selected the time required for an attainment of a percentage saturation of one-half the equilibrium values. Thus, in an atmosphere containing two parts of carbon monoxide for which the blood equilibrium is about 28 per cent, the length of time that would be required for the blood to become 14 per cent saturated, and so on for other concentrations and percentages of saturation.

The answer to this question is the principal practical contribution to knowledge that has been made. Experimentally it has been found that the time for attainment of half-equilibrium for persons sitting at rest and breathing concentrations of carbon monoxide up to 7 per cent is never much less than one hour, and what is more, it has been established experimentally and by analysis of reasonable conditions that the vast majority of people who may travel through the tunnel under conditions of actual operation can be safely assumed to fall within these limits.

The method of studying the effects of various concentrations of carbon monoxide which has been found to be the most reliable for establishing standards of permissible vitiation of air is illustrated in Fig. 2, which shows a chamber of 226 cu. ft. capacity. The walls and door of this chamber are made gastight to such an extent that it will hold any concentration of gas for a day without any appreciable loss from diffusion through undiscovered leaks. A small hole in the door allows the hand of the man inside to be thrust out for the withdrawal of blood.

Measured amounts of pure carbon monoxide were introduced into this chamber and in turn the members of the investigating staff and a few other persons spent periods of one hour therein after amounts of carbon monoxide from two to eight, and in one case ten, parts were introduced. While they sat and read most of the time, there were a sufficient number of activities, such as turning on the electric fan, standing up to look out of the window for a moment, opening and closing flasks to take air samples for later analysis, etc., to correspond fairly well with those of the driver of a car. Blood to the amount of 20 or 30 drops was drawn from a finger before the subject entered the chamber and 0.02 cc. were drawn in the middle of the period and at the end, and usually once or twice during the three hours following the subject's leaving the chamber. These blood samples were analyzed for carbon monoxide, in addition to which certain checks were used and other observations taken. Of all signs and tests both in the experiments in the chamber and in other tests, the typical carbon-monoxide or oxygen-deficiency headache proved the most definite and reliable. It is a distinctly localized pain, usually frontal, throbbing, intensified by lying down or by exertion, and accompanied by certain effects, such as nausea, etc.

As a result of these tests it was found that if at any point the concentration exceeds six parts of carbon monoxide in 10,000 of air, men doing hard work for even a short time will be unfavorably affected. A study of the traffic conditions expected to obtain in the tunnel has shown that even slow-moving trucks, allowing for all possible ordinary delays, will pass through the tunnel in less than 45 min. and a degree of concentration has been determined which will provide not only complete safety but also an assurance of freedom from disagreeable effects due to the presence of carbon monoxide. There are, of course, other features of tunnel ventilation, for example, wind velocity, moisture, temperature, etc., which have not been specially investigated in the present instance, but enough is known about them to permit intelligent design of the ventilation apparatus.

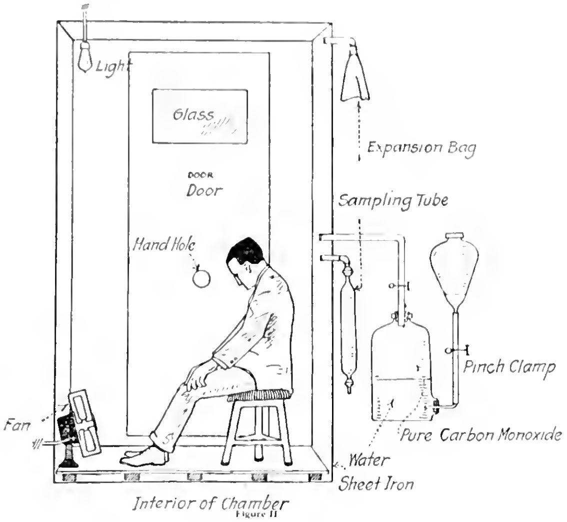


Fig. 2 Chamber of 226 cu. ft. Capacity Used in Studying Effects of Various Concentrations of Carbon Monoxide

One is strongly impressed with the thoroughness of the tests carried out in this connection. For example, in addition to tests in the small chamber described above which involved exact but rather artificial conditions, another series of tests were carried out with actual exhaust gas and under conditions as near as possible to those that will be encountered in the tunnel when completed. For this purpose a hip-roofed brick building 30 ft. by 30 ft. with walls 12 ft. high was erected. Its cubic capacity was approximately 12,000 cu. ft. of air, which is about the volume of the vehicular tunnel required for two cars when the traffic is active. A Ford car was installed near the middle of this chamber with a dynamometer arrangement that permitted the engine of the car to run at a fair load and to expend the power in mixing the air in the chamber.

In this chamber groups of a dozen or more persons at a time sat or moved about for periods of one hour. In addition to the staff of this investigation a number of students of the Yale Medical School, both men and women, served as subjects. After the tests the general condition and feeling of the subjects, particularly the occurrence or absence of headache, were noted and other observations taken, proper gas analysis being carried on all the time. A few observations were also made on two horses, and dogs were subjected to high concentrations of gases, various gases besides carbon monoxide and exhaust gas being used for this purpose in order to obtain as extensive results as possible.

The Mechanism of Ventilation of the Tunnel

With the completion of tests at the Bureau of Mines Laboratory in Pittsburgh and the Physiological Laboratory at Yale University, the tunnel engineers had a fairly clear idea as to the problem that lay before them. From the number of cars for which the tunnel was designed and the volume and composition of gases found in the exhaust, the amount of toxic gases was known, while the Yale University tests established a standard for the permissible content of carbon monoxide and similar constituents in air. From this it was quite simple to determine the amounts of air per unit of time to be supplied to the tunnel in order to maintain the proper ventilation. In a smaller installation this would have ended the necessity for further investigation. In the present case, however, it became necessary to go a step further and determine such things as the coefficient of friction for flow of air in concrete ducts; the laws governing the flow of air in concrete ducts of uniform cross-section with the air leaving or entering in uniform quantities at uniform intervals; and finally the power losses in bends or elbows in concrete air ducts. This part of the work was conducted partly at the Bureau of Mines and partly in a special experimental plant at the University of Illinois, Urbana, Ill., under the direction of the Chief Engineer of the Commission or his representatives.

Extensive tests carried out at the University of Illinois gave sufficient information as to the behavior of the air under the various desired conditions and permitted the derivation of equations for blowing or exhausting air through a duct in uniform quantities at uniform intervals. These made it possible to compute the air horsepower required.

With the conclusion of these tests, what might be called the scientific foundations for the design were laid down. In view of its unusual size and the novelty of some of the elements involved, it was obviously desirable, if possible, to test out the relative merits of various methods of transverse or distributive ventilation, introducing fresh air through the bottom duct and exhausting through the top duct, and vice versa. Experiments were accordingly conducted in an experimental tunnel constructed in the room workings of a coal mine at Bruceton, Pa. (Fig. 2). The reason for constructing the experimental tunnel underground was to secure a location that would be free from atmospheric disturbances and to obtain data on the flow of heat through the walls of the tunnel.

The tunnel had a driveway 8 ft. high by 9 ft. wide with continuous air ducts above the ceiling and below the roadway. The ducts under the roadway and the walls of the driveway were of concrete construction. The tunnel was oval in plan, giving a roadway length of 400 ft.

The quantity of air was measured before entering the tunnel ducts and on leaving at two specially constructed air-measuring stations in the mine passages. Samples of the air were taken at various points in the tunnel driveway and thermocouples were installed to obtain the temperature of the incoming and outgoing air, the temperature of the tunnel atmosphere, and the rate of flow of heat through the tunnel walls. Smoke observations were made by means of an optical instrument and by the Ringlemann chart. Physiological data were taken by various means.

Cars were run in the tunnel so as to give conditions as nearly as possible approaching those that would prevail in the Hudson tunnel and it was found that smoke in the tunnel atmosphere under ordinary operating conditions was not dense enough to interfere in any way with driving or comfort. It was also found that ventilating upward with openings over the center of the roadway gave better results than exhausting through continuous slots in expansion chambers located just under the ceiling at the two sides over the driveway. In downward ventilation better results were obtained by introducing the fresh air horizontally than by introducing it at an angle of about 45 deg. through the expansion chambers. The tests demonstrated that with upward ventilation the exhaust gases crossed the breathing plane of persons using the tunnel but once, while with downward ventilation they crossed this plane twice. The chemical analyses of the tunnel atmosphere also showed a lower concentration of carbon monoxide at the breathing plane with the upward than with the downward ventilation. It was therefore concluded that transverse upward ventilation is the proper method.

Experiments in the concrete model duct and elbows, together with the experiments in the experimental tunnel under actual operating conditions, have given sufficient data to determine the power required to operate the fans for ventilating the tunnel and indicate that the mechanical ventilation of the tunnel as planned is assured of success.

The general plan of ventilation adopted is as follows: Blower fans located in buildings over the four shafts will supply the required amount of fresh air to the main fresh-air duct located under the tunnel roadway. The air will then pass through flues to continuous expansion chambers, one on each side of the roadway, thence through a continuous slot to the roadway. The air remains in the tunnel an average of $1^1/_2$ min., during which time it slowly ascends from the roadway to the ceiling. Exhaust fans located in the same buildings with the blower fans will draw the vitiated air through ports in the ceiling and thence through the upper duct, delivering it through stacks to the outer atmosphere. In this way fresh air will be supplied in the proper amount to all points throughout the tunnel. There will be no discomfort or danger from high-velocity air currents and the exhaust gases will be quickly diluted and removed.

There is one feature in this work which deserves mention and that is the clear realization of the fundamental idea that the safety and even comfort of those riding in the tunnel must be carefully considered.

Smoke and noxious gases, though of different character, have always been present in railroad tunnels, especially those of considerable length, and have made travel in them anything but pleasant. When these tunnels were built, however, the idea of caring for the comfort of passengers to the extent of providing them at all times with clean air had not yet been conceived. Those who had to travel could not avoid riding through the tunnels, and whatever discomfort they experienced did not seem to affect the business of the railroad companies. Had the Hudson Tunnel been built 25 years ago perhaps the same conditions would have prevailed, and the question of ventilation would have been handled in some hurried and ineffective fashion. It is, therefore, with sincere pleasure that one records an enlightened attitude toward the design of public utilities in which an earnest effort is made to provide decent atmospheric conditions.

University Research

From an engineer's point of view it is essential that the universities keep *instruction* as their great work—instruction of matriculated students and instruction of the far greater public outside the cloistered walls.

There are two very good reasons why the faculty of a technical school should engage in research. In the first place, a true teacher is also a student—he is curious about the unknown. In the second place, the schools and their faculties must advance in order to hold their jobs. Abstruse science of yesterday is commonplace technology of today. So if there were not more new things constantly discovered, the engineering and scientific colleges would quickly become trade schools.

It seems agreed that investigation is necessary to the well-being of our schools. But what kind? We believe that the true scientific researcher does not select his problem from a scrap pile. But with a background made up of thorough familiarity with the literature of his specialty, an acquaintance with the principal workers in the field and the useful applications which have so far been made, he selects one of the broader problems that remain to be solved and attacks the matter with a quite disinterested perspective. He throws all the resources he can bring to bear into the search, and in time, perhaps years, reaches a solution—or at any rate it becomes known that he is very well informed in that particular branch. Then with the advantage of this position, he is able to give the public the maximum amount of seasoned, correct advice with the least amount of distraction from his ordered routine. And that's the only kind of advice he will attempt to give. It is more than doubtful that this eminent and influential position could ever be reached by a university faculty that devoted itself to commercial research—which is time-consuming, but rarely broad and never disinterested. (*Chemical and Metallurgical Engineering*, vol. 27, no. 15, Oct. 11, 1922, p. 725)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

The New Paris High-Pressure High-Temperature Central Station

DURING the past few months the technical press in the power field has given much attention to the new Gennevilliers central station which is now in partial operation carrying a portion of the electrical load of the city of Paris. This station, which will have an ultimate capacity of 320,000 kw., is designed with the ruling idea that economy in fuel is imperative. To achieve this the French engineers decided on turbines operating at a pressure of 313 lb. gage and with a superheat of 280 deg. fahr. at the throttle. The design of the plant is accordingly novel and interesting.

A complete description of the plant by Col. Ernest Mercier, was given in a pamphlet published this year by the *Revue Industrielle* of Paris. The illustrations on this and following pages are taken from this account. Other descriptions of this station are given in in the following journals:

The Engineer, vol. 134, nos. 3480, 3481 and 3482, Sept. 8, 15, 22, 1922, pp. 242–243, 270–272, 294.

Génie Civil, vol. 81, no. 1, July 1, 1922, pp. 1–13.

Industrie Electrique, vol. 31, no. 722, July 25, 1922, pp. 265–276.

Power, vol. 56, nos. 5 and 7, Aug. 1 and 15, 1922, pp. 156–162, 232–236.

Electrical World, vol. 80, no. 6, Aug. 5, 1922, pp. 264–270.

COSTS

In the pamphlet referred to, Colonel Mercier, who was responsible for the design of the plant, gives the following statement as to costs:

> Due to the thorough study of all questions and due to the rigorous supervision of all expenditures, including the value of the grounds and that part of the financing charges attributable to the generating station, the cost of the station, based upon the first 200,000 kw. installed, will be slightly under 600 francs per installed kilowatt.
>
> After the installation of units Nos. 6 and 7, the total power then being 280,000 kw., the cost per installed kilowatt will have decreased to 530 francs. This latter figure is based upon the supposition that the price of land, the cost of extensions, docks and labor remain the same as at present, and that the construction of the station, as it is actually built, will allow the placing of the sixth unit without any addition to the present structure.
>
> The goal was to construct a station at the prewar price, regardless of the new and expensive apparatus decided upon.

The following facts regarding the station are taken from the account given in *Power*, of August 1, 1922.

BOILER-ROOM EQUIPMENT

	Double-ended Stirling	Single-ended B. & W.	Total
Number of boilers to be installed at once	5	10	15
Ultimate number of boilers, various possibilities	11	10	21
	8	16	24
	5	22	27
Maximum allowable steam pressure, lb. per sq. in			355
Maximum total steam temperature, deg. fahr			752

Boiler Dimensions and Characteristics

	Stirling	Babcock & Wilcox
Heating surface per boiler, sq. ft.	22,600	14,300
Superheater surface, sq. ft.	10,764	8,190
Economizer surface, sq. ft.	12,915	8,617
Air-preheater surface, sq. ft	19,350	12,060
Overall dimensions:		
Width of face	34 ft., 10 in.	35 ft., 11 in.
Length	37 ft., 9 in.	20 ft., 3 in.
Height from boiler-room floor to C.L. of highest steam drum	28 ft., 7 in.	21 ft., 3 in.
Volume of water at normal water level, cu. ft	2,860	1,288
Volume of steam at normal water level, cu. ft.	705	583
Ratio volume of water to volume of steam	4.05	2.21
Volume of water per sq. ft. of heating surface, cu. ft.	0.127	0.09
Steam guarantees:		
Normal steaming rate, lb. per hour	132,000	88,000
Lb. per hour per sq. ft. heating surface (normal)	5.85	6.15
Maximum two-hour rate, lb. per hour	176,000	116,000
Lb. per hr. per sq. ft. heating surface (maximum)	7.79	8.12

Grate Characteristics

Stirling boilers: Riley underfeed 36-retort mechanical stoker, in two sections of 18 retorts each, fed from two firing aisles, and discharging the ash in the center.

Total grate surface per boiler, 660 sq. ft.

Babcock and Wilcox boilers: B. & W. chain-grate stokers, in four sections, each 15 ft. long by 6 ft. 7 in. wide, equipped for forced draft.

Total grate surface per boiler, 394 sq. ft.

DRAFT EQUIPMENT AND COMBUSTION GUARANTEES

A. Stacks:

Number and type of stacks: 6 convergent-divergent, Pratt type.
3 stacks serving the Stirling boilers, 3 the B. & W.
1 stack for 2 Stirling or 4 B. & W.

Stack dimensions:	Stirling Boilers	B. & W. Boilers
Height (total)	121 ft.	121 ft.
Base (rectangular)	13 ft., 9 in. x 12 ft., 4 in.	15 ft., 1 in. x 13 ft., 9 in.
Throat diameter	6 ft., 3 in.	7 ft., 3 in.

B. Induced-draft fans:

Number of fans per stack: 2
Drive: Direct-current, adjustable-speed motors

Rated capacity of motors:		
	On Stirling boiler stacks	120 hp.
	On B. & W. boiler stacks	150 hp.

Guarantees:

Assuming: Lower heating value of coal, 12,600 B.t.u. per lb. Temperature of outside air, 61 deg. fahr. Barometric pressure, standard. Temperature of gases entering the induced-draft fans, 284 deg. fahr. CO_2 content of gases entering the induced-draft fans, 11 per cent. Forced-draft fans operating at their normal rate.

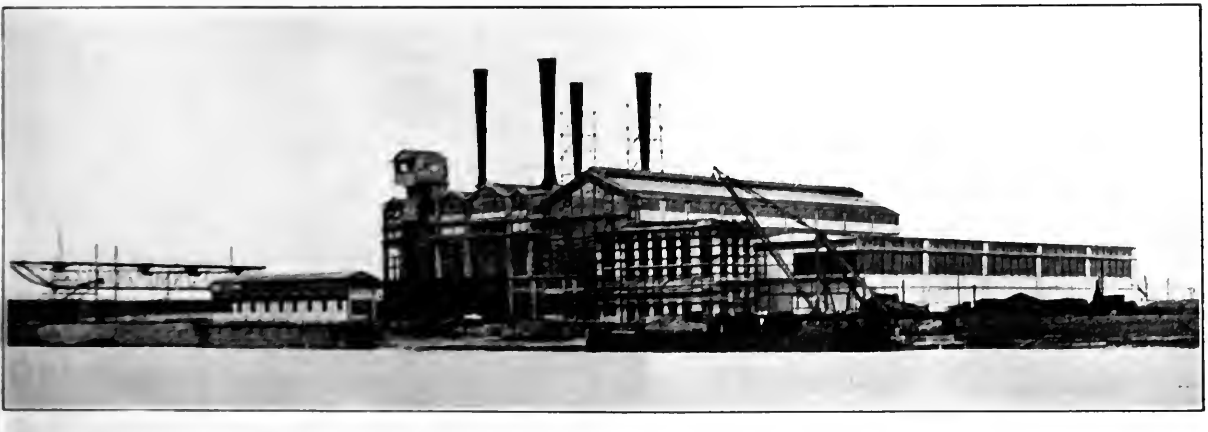


FIG. 1 THE GENNEVILLIERS STATION. VIEW TAKEN FROM THE SEINE, MAY, 1922

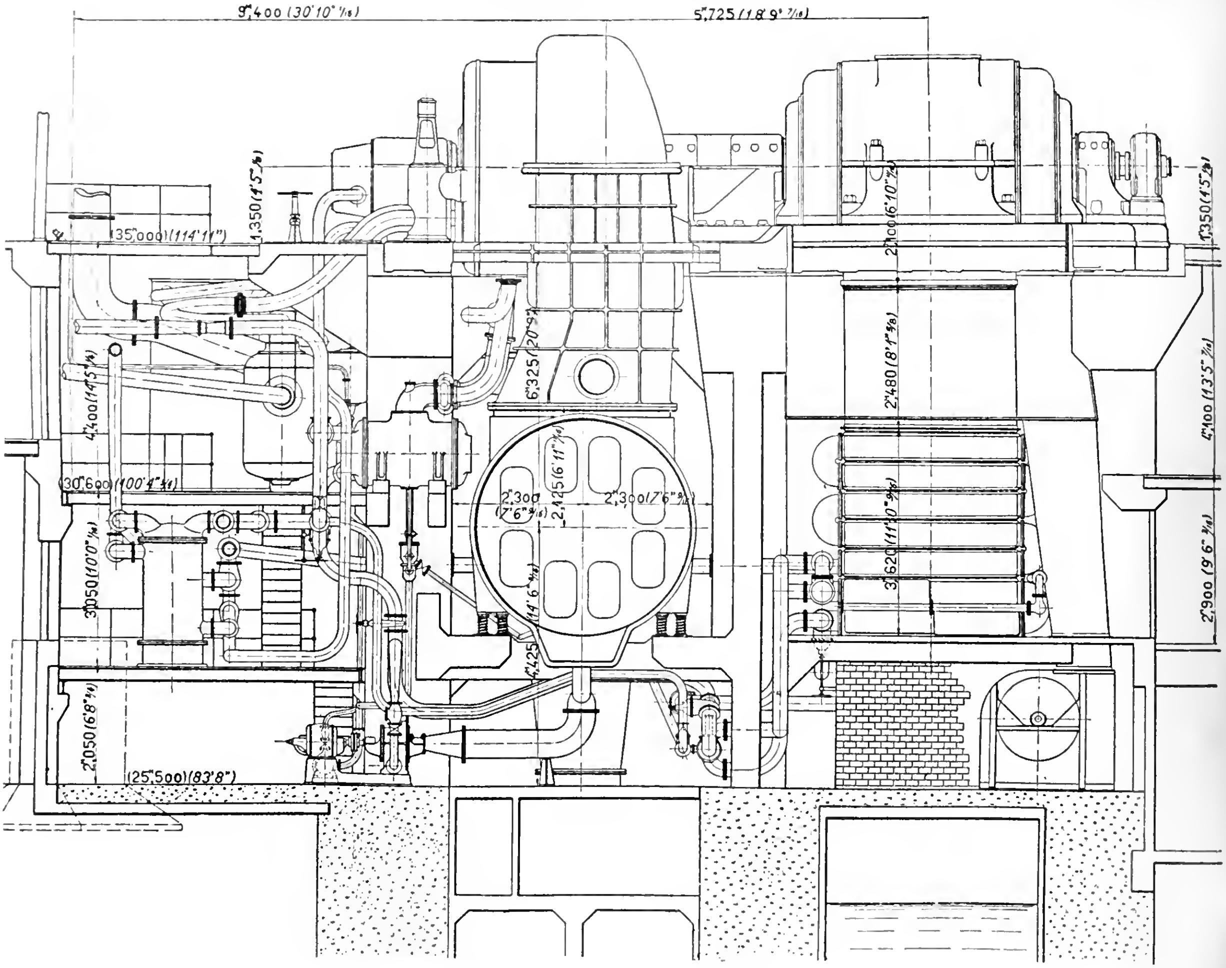


Fig. 2 40,000-kw. Turbo-Generator, Elevation

	Stirling-Boiler Stack Serving 2 Boilers or 1,320 Sq. Ft. of Grate			B. & W.-Boiler Stack Serving 4 Boilers or 1.576 Sq. Ft. of Grate		
Draft at base of stack	Natural	0.9 in.	1.97 in.	Natural	0.9 in.	1.97 in.
Combustion rate:						
Lb. per hour	23,100	31,900	46,200	30,400	41,400	60,700
Lb. per hour per sq. ft. of grate	17.5	24.2	35	19.3	26.3	38.5
Speed of fans, r.p.m.						
No. 1	0	335	430	0	305	385
No. 2	0	0	430	0	0	385
Power consumption of fans.						
No. 1, hp.	0	44	88	0	55	110
No. 2, hp.	0	0	88	0	0	110

Under the foregoing conditions, but with the forced-draft fans shut down, the induced-draft equipment alone will supply a draft of 2.36 in. with the expenditure of 170 hp. on each of the B. & W. stack motors, and 132 hp. on each of the Stirling stack motors.

C. Forced-draft fans:	Stirling Boiler	B. & W. Boiler
Number of fans per boiler	4	2
Drive	Direct current adjustable-speed motors	
Rated capacity of motors	60 hp.	80 hp.

Fan characteristics:	Output, cu. ft. per hr.	Power cons'n, hp.	Speed, r.p.m.	Output, cu. ft. per hr.	Power cons'n, hp.	Speed, r.p.m.
Normal rate—5.9 in. draft.	1,760,000	43	870	2,380,000	58	745
Overload —7.1 in. draft.	1,980,000	60	955	2,650,000	80	820

TURBINE ROOM EQUIPMENT

Number of Generating Units	
In present plant	5
Ultimate number of units	8
Capacity of Generating Units at 80 per cent Power Factor:	
Most efficient load, kw	30,000
Full load (maximum continuous), kw.	40,000
Maximum overload (2 hours), kw.	45,000

All the units are practically identical, and the rotors are interchangeable.

Characteristics of the Units	
Speed, r.p.m.	1,500
Frequency, cycles	50
Terminal voltage	6,000
Throttle pressure, lb.	313
Total steam temperature, deg. fahr.	705

Type of Turbines: Simple impulse Zoelly type, straight single-flow, with 10 pressure stages, each consisting of one velocity stage. Two bleeder connections, one from 7th and one from 8th stages, by which steam is extracted for feedwater heating.

Mean diameter of first 7 wheels, 6 ft., 6¾ in.
Mean diameter of last 3 wheels, 9 ft., 2 in.
Length of blades of last stage, 22½ in.
Lubricating-oil pressure, 10.7 lb. per sq. in.
Oil pressure for valve operation, 55 to 70 lb. per sq. in.
Capacity of lubricating-oil pump, 400 gal. per min.
Turbine regulation, throttling.

GUARANTEED TURBINE STEAM CONSUMPTION WITHOUT BLEEDING

Load, Kilowatts	Consumption, Lb. per Kw-Hr.
40,000	9.62
30,000	9.46
20,000	9.9
10,000	11.0

CONDENSING EQUIPMENT

The main condensers are identical for all units, all single-pass.

Condensing surface, 37,650 sq. ft. 0.94 sq. ft. per kw.

Diameter of tubes:	Inside, in.	0.787
	Outside, in.	0.806

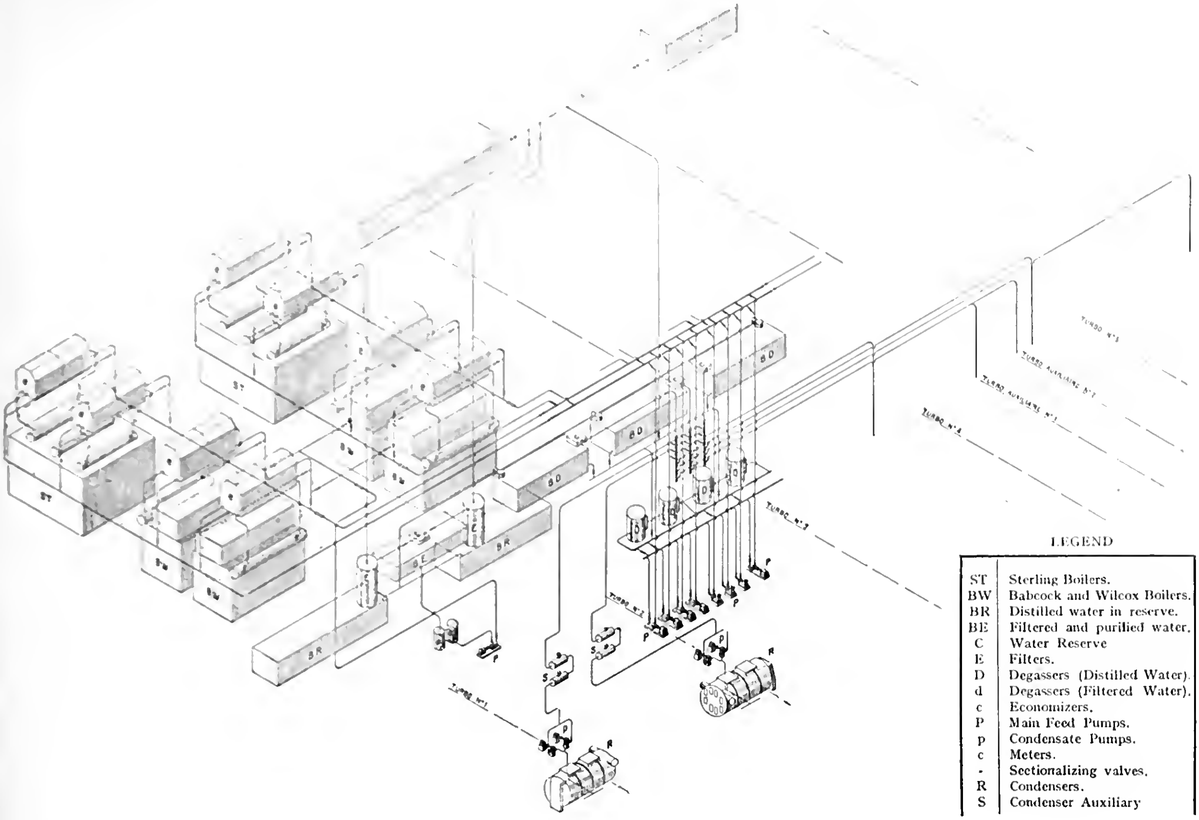
Circulating pumps: 2 per unit, one being a spare;
Capacity 30,000 gal. per min.
Type, single-stage centrifugal
Drive. Electric for regular service; duplex (electric and steam turbine with reduction gears) for the spare.

Condensate pumps: 2 per condenser, one being a spare;
Capacity, 720 gal. per min.
Type, 2-stage centrifugal;
Drive, electric for both sets

Air extraction. 4 ejectors per condenser, 2 being spares.
Rated output at 225 lb. steam pressure.

SUMMARY OF STATION DESIGN CONSTANTS

Steam Conditions at Throttle:	
1. Pressure, pounds gage	313
2. Total temperature, deg. fahr.	705
3. Superheat, deg. fahr.	280
Boiler Room	
4. Sq. ft. of boiler heating surface per kilowatt station capacity	1.28



LEGEND

ST	Sterling Boilers.
BW	Babcock and Wilcox Boilers.
BR	Distilled water in reserve.
BE	Filtered and purified water.
C	Water Reserve
E	Filters.
D	Degassers (Distilled Water).
d	Degassers (Filtered Water).
c	Economizers.
P	Main Feed Pumps.
p	Condensate Pumps.
c	Meters.
•	Sectionalizing valves.
R	Condensers.
S	Condenser Auxiliary

Fig. 3

		Stirling	Babcock & Wilcox
5.	Sq. ft. of heating surface per sq. ft. of grate	34.3	36.3
6.	Cu. ft. of combustion space per sq. ft. of grate	2.08	7.8
7.	Sq. ft. of superheater surface per sq. ft. of heating surface	0.476	0.573
8.	Sq. ft. of economizer surface per sq. ft. of heating surface	0.572	0.602
9.	Sq. ft. of air-preheating surface per sq. ft. of heating surface	0.857	0.844
10.	Cu. ft. of water per cu. ft. steam in boilers	3.24	2.21
11.	Cu. ft. of water in boilers per sq. ft. of heating surface	0.127	0.090
12.	Forced-draft fan-motor output per sq. ft. grate, horsepower; normal rate of firing	0.261	0.294
	Do., 2-hour overload	0.364	0.406
13.	Induced-draft fan-motor output per sq. ft. grate, horsepower; normal rate of firing	0.033	0.035
	Do., 2-hour overload	0.133	0.140
Turbine Room:			
14.	Sq. ft. of condensing surface per kilowatt capacity		941
15.	Ratio of circulating-pump capacity to condensate-pump capacity		42

Fig. 4

Fig. 3 Scheme of Condensate Circuit of the Gennevilliers Station, Paris

Fig. 4 40,000-Kw. Turbo-Generator; View of Turbine End

(*Sol des Machines* = machine floor; *Sol Sous Sol* = basement floor.)

Short Abstracts of the Month

AERONAUTICS

Zeppelin-Dornier Airplane with Inclined Axis. Abstract from a British patent granted to the German Zeppelin Works and Dornier, describing an airplane so designed that it can take off and land in a small space. The axis of the machine forms an angle α of substantially 45 deg. with the horizontal. The axis C of the propeller forms the angle β with the axis A. It has an even greater inclination with regard to the horizontal than the axis of the monoplane. The tail has the usual runner D and, further, a hook-shaped braking spur E, by means of which the tail end of the machine can be retained on the ground at the start or at the landing. The braking spur is adapted to be pulled in from the pilot's seat by means of a pull rope, which is not illustrated. The invention can be applied to any type of airplane, but it is preferably designed to be used with monoplanes. (British patent no. 16,948. *Patent Office Journal*, Aug. 8, 1922. Compare *The Engineer*, vol. 134, no. 3483, Sept. 29, 1922, pp. 341, 1 fig., *d*)

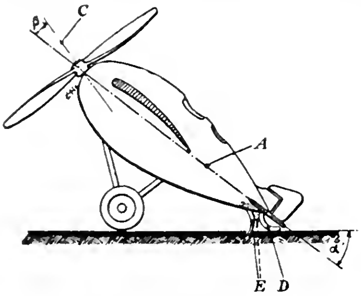


Fig. 1 Zeppelin-Dornier Airplane with Inclined Axis

Airplane Crashes in the U. S. Army Air Service During 1918 and 1919. A total of 1250 reports of crashes were received from the various flying fields covering a period from the beginning of the war up to January 1, 1920, and the present investigation analyzes these reports in various ways. From these reports it would appear that bad landing was responsible for a little more than 45 per cent of the total accidents reported.

On the other hand, as regards the extent of injuries to pilots, a little more than one crash out of ten proved fatal, while in 807 out of the 1250 crashes the pilot was uninjured. To bad judgment are ascribed 47.52 per cent of the total crashes and to engine trouble, 21 per cent.

It would not appear that the age of the flier, hours of dual instruction received or experience in solo flying has any clear bearing on the number of crashes. As regards weather conditions, the figures themselves are not illuminating as 1092 out of a total of 1250 crashes occurred in fair weather, which is, however, probably due to the fact that most of the flying was also done in fair weather.

Taking up the question of age and its possible bearing on the cool judgment and resourcefulness so necessary in the case of a flier, it is interesting to note that the percentage of crashes attributed to bad judgment on the part of the pilot shows a steady decline as the tabulation proceeds from the young pilot of 18 or 20 to the more mature flier of 30 to 35 years of age. In reverse ratio are the percentages of crashes listed as unavoidable, which show that while only 12.08 per cent of all crashes occur among pilots from 18 to 20 years of age, more than twice as many (26.81 per cent) happen to those from 27 to 30 years of age.

In basing a conclusion on a table in the original article that age might have a tendency to promote prudence and carefulness in a pilot, and assuming that the ranking of pilots to a large extent followed their experience and natural ability as fliers, one would expect to find the percentage of crashes due to bad judgment on the part of the pilot steadily decreasing on passing from the lower ranking officers to the higher, and the percentage of unavoidable crashes steadily increasing. This is fully borne out by the statistical data available. (*Air Service Information Circular*, vol. 4, no. 340, May 1, 1922, pp. 1 to 22, *gA*)

AIR MACHINERY

Air Conditioning in Deep Mines—Reduction of Accidents

The Air-Cooling Plant at the Morro Velho Mine of the St. John Del Rey Mining Company, Ltd., Brazil, Eric Davies. The plant is similar in principle to an ordinary cold-storage plant with the brine-circulation system. Since, however, the temperatures do not fall below 32 deg. fahr., ordinary water is used instead of brine and the place of the cold-storage chamber is taken by two large air coolers. Since the wet-bulb temperature of the air entering the plant is liable to vary between 75 and 32 deg. fahr. according to the season and time of day and it was desired to supply the mine with air at a fairly steady temperature, the plant is divided into six stages.

Two air coolers are always acting in parallel so that each handles approximately half the total quantity of the air. The air coolers are of the Heenan type (see Mechanical Engineering, Feb., 1918, p. 190) and consist of a number of cylinders 10 ft. 10 in. in diameter which are built up of galvanized-steel plates 8 in. wide, arranged in a long spiral. These cylinders weigh three tons each.

Each air cooler has nine of these cylinders altogether, all arranged on one common shaft which is revolved at the rate of about 3 r.p.m. The lower parts of the revolving cylinders are immersed in six segmental tanks of water (one per stage), the mean temperature of which is maintained considerably below that of the air in that stage, and hence the air passing over the freshly wetted surface of the upper portion of the revolving cylinders has its temperature reduced.

The water tanks for each stage are piped up to the evaporator for that stage. The evaporators consist of large cast-iron tanks kept full of water to be cooled, and in them are immersed the coils of piping containing the ammonia undergoing evaporation. As regards the main ammonia compressors, there is one for each stage—a single-cylinder double-acting machine, $11^5/_8$ in. bore by 21 in. stroke, belt-driven at 81 r.p.m.

The original article gives extensive data as to the results obtained which appear to be very satisfactory, both in the way of stabilization of temperature and of keeping it at a desirable level.

General improvement in underground conditions due to the cooling plant has also been reflected in the fall of the accident rate. In the sixteen months (August, 1919 to November, 1920, inclusive) previous to the starting up of the plant there occurred twenty deaths through underground accidents and four cases of disablement, the total liability for compensation involved in connection with these accidents being 80,675 milreis. In the following sixteen months (December, 1920 to March, 1922, inclusive) there were six fatal accidents underground and four cases of disablement, the amount of compensation involved being 35,820 milreis. These figures speak for themselves; they show that, owing to the more bracing condition of the underground atmosphere, the men are more alert and can perceive and avoid danger with greater celerity. There can be no doubt that the old trying and enervating conditions induced a sort of mental sluggishness, and where this state exists in the case of men who, as not infrequently occurs with the native labor at Morro Velho, are none too intelligent in the first place, disaster is all too often the result. There can also be no doubt that the frequent recurrence of fatal accidents during 1919 and 1920 was not only giving the mine a bad name among the natives (thus rendering it increasingly difficult to attract labor), but was also causing experienced and valuable miners to leave the company's service. This tendency has now been stopped to a great extent.

Another indication of the improved conditions is to be seen in the output returns. In the company's financial year ending February 28, 1921, the tonnage raised from the mine was 151,200, whereas the corresponding figure for the year ending February 28, 1922, was 169,234 tons, an increase of 17,935 tons, or nearly 12 per cent. Taking the value of the gold contained in each ton of ore as £ 3, which is approximately correct, it will be seen that the increased output in a single year's working has gone a long way toward paying for the company's total outlay in connection with the plant. (*Transactions of the Institution of Mining Engineers*, vol. 63, pt. 5, Aug., 1922, pp. 326–336, and discussion pp. 336–341, 2 plates, *dA*)

BUREAU OF STANDARDS (See Metallurgy)

ENGINEERING MATERIALS (See also Metallurgy; Testing and Measurements)

Laws of Failure of Solid Bodies Due to Stress, Chido Sunatani. The author's theory is that the failure of a solid body subjected to stress is due to the occurrence of separated surfaces in its grains or throughout the body. He assumes the possibility of occurrence of three kinds of separation: namely, sliding separation, tensile separation, and a combination of the two. As regards sliding failure, the author propounds the following hypothesis: The shearing resistance of materials on the plane within a solid body decreases when the normal component of the stress acting on the plane increases algebraically, tensile strength being taken to be positive. The difference between this hypothesis and a similar one stated by Mohr lies in the fact that Mohr considers all failures to occur when shearing resistance is overcome, while the author of this paper considers that there are two kinds of resistance—shearing and tensile—and that failures due to either kind can occur in any material.

After a mathematical treatment of his hypothesis the author describes some tests made on sliding failure, by means of which he claims to have proved that his hypothesis is correct and that Mohr's theory cannot be a general law of failure of a solid body. He then proceeds to a consideration of tensile failure and the general conclusions of the paper are as follows:

1 There are two ways in which materials start to fail: by sliding and tensile separations; and two simple laws bearing thereon, which are now for the first time proposed by the author: namely, (*a*) True shearing strength increases or decreases proportionally with the normal component of the stress, as it is tensile or compressive, and may be expressed by the equation—

$$R_s = R_{so} - kN$$

where

R_s = shearing strength per unit area of a plane on which there exists a certain amount of normal component of stress, N

R_{so} = shearing strength of the plane where there is no normal component of stress, and which may be called the "true shearing strength" along the plane

k = a coefficient

and (*b*) True tensile strength decreases proportionally with the tangential component of stress, and may be expressed by the equation—

$$R_t = R_{to} - kS$$

where

R_t = tensile strength per unit area of a plane on which there exists a certain amount of the tangential component of stress, S

R_{to} = tensile strength of the plane when there is no amount of tangential component of stress, and which may be called the "true tensile strength" of the materials on the plane

k = a coefficient in a similar sense as in the case of sliding failure, and also assumed to be a constant for a given material

In both cases the proportional constant k is about 0.364 or ϕ about 20 deg.

2 In an isotropic body sliding or tensile failure occurs according as—

$$\frac{1}{2\cos\phi}\left\{T_1 - T_3 + (T_1 + T_3)\sin\phi\right\}$$

or

$$\frac{1}{2\cos\phi}\left\{T_1 - T_3 + (T_1 + T_3)\cos\phi\right\}$$

is greater than R_{so} or R_{to}, respectively, and the normal of the plane of failure lies in the plane perpendicular to the middle principal stress T_2, and makes an angle of $(\pi/4 - \phi/2)$ or $\phi/2$ with the greatest principal stress, according as it is a sliding failure or a tensile one. Consequently, we may anticipate the elastic or the breaking stress of a solid body under a certain state of stress if we know the corresponding value of R_{so} or R_{to} for its material, which is determined in any other state of stress of the material, and in some cases even if the value of R_{so} or R_{to} is not known.

3 New design formulas are derived as follows:

$$\frac{1}{2\cos\phi}\left\{T_1 - T_3 + (T_1 + T_3)\sin\phi\right\} \ngtr R_{so}$$

and

$$\frac{1}{2\cos\phi}\left\{T_1 - T_3 + (T_1 + T_3)\cos\phi\right\} \ngtr R_{to}$$

where T_1 and T_3 are the greatest and the least principal stresses at any point of the element in its working conditions.

From these formulas the values R_{so} and R_{to} of a brittle material can be obtained from a simple compression and a simple tension test, respectively, and that of R_{so} of ductile material from a simple tension test, but it seems difficult to find the value of R_{to} of ductile material and it is not necessary in practice. (*Journal of the Society of Mechanical Engineers*, Tokyo, Japan, vol. 25, no. 74, June, 1922, pp. 1–39 and 20 pp. of illustrations and plates, *teA*)

Investigation of Forged and Cast Brass. Tests were made with a view to determining the suitability of forged brass in gasoline pipe-line and tank fittings and to compare the soundness of forged and cast brass fittings. The tests were made on brass forgings submitted by a manufacturer and involved the chemical analysis, metallographic investigation, physical testing, and strain test. The results are as follows:

The chemical analysis shows that the metal used in the forgings is of the muntz metal type and is within the range of composition recommended for hot forgings or stamping by Guillet. Although the manufacturer claims that the forging of brass is a new process, brass has been successfully hot-forged or stamped in England for several years. It is know that there is danger of producing internal strains which result in season or spontaneous cracks. This condition is usually caused by forging at too low a temperature and can be readily detected in either the microstructure or by the mercurous nitrate test. Unless the cold work has been too severe, it may be remedied by annealing at a temperature ranging from 600 to 800 deg. fahr. The twinning of the alpha constituent in the annealed specimen indicates that this material has not been annealed subsequent to the forging operation. Another source of trouble encountered by the use of forged brass is the unequal hardness of different lots of metal, which seriously slows up the speed of machining when the parts are being turned out on a production basis. The variation in hardness is usually contributed to the chemical composition and so can be controlled. The hardness tests and the chemical composition of the forged fittings under test indicate that fittings made of this material could be readily machined.

It may be observed that the fittings cast in the Metals Branch Foundry are of tin bronze and not brass. The reason for this is that although the copper-tin alloy is more expensive, it gives a sounder casting and is more desirable for parts that are to hold water or gasoline. For that reason the gun metal rather than the red brass cast in the Metals Branch Foundry was taken as a basis with which to compare the forged brass. The properties of forged and cast brass are not really comparable, as the effect of either hot or cold work on a metal is well known, and it is to be expected that the forged material would be far superior to the cast. The particular forgings under test were forged from extruded bars so that the product is a result of two processes of hot-working along with the necessary annealing, all of which tends to produce a material more homogeneous and sound than that which is used in the final product as cast. (*Air Service Information Circular*, vol. 4, no. 335, Apr. 1, 1922, Material Section Report no. 158, 2 pp. of text and 2 pp. of photomicrographs, *e*)

The Effect of Superheated Steam on Non-Ferrous Metals Used in Locomotives, Sir Henry Fowler. The author reports on experiences with regard to the chief parts that are subjected to superheated steam in the case of superheated locomotives on the Midland Railway.

In piston tail-rod bushes several compounds were tried. For example, M. R. A. 1 gun metal and cast iron, of which the former was found to break in service and the latter to score the rods. Recourse was then made to a phosphor bronze containing 88 per cent copper, 11 per cent tin, and 1 per cent phosphorus, which gave entire satisfaction.

For piston-rod packing white-metal packing rings are used of

the following composition: lead, 70 per cent; antimony, 30 per cent. During solidification this metal is pressed into the mold by means of a flat piece of wood, as this has been found to give metal of greater soundness. Although this metal has been used for about 12 years and has given excellent satisfaction, apparently the temperatures met with today, say, 340 to 370 deg. cent. (644 to 698 deg. fahr.) are approaching its critical point and an increase above this figure has been found to cause trouble. This was the experience during the coal strike of last year when a number of engines were fired with oil in place of coal, which was found to give a higher degree of superheat, with the temperature rising to 425 deg. cent. (797 deg. fahr.). The trouble experienced was due to the packing rings' fusing.

As regards the by-pass valves, which are arranged in close communication between the ends of the cylinder, when steaming they are subjected not only to the temperature of the steam in the cylinders but also to considerable shock. Cast iron, gun metal, and phosphor bronze were tried and found wanting. A complex nickel brass with 3.33 per cent nickel and 38.05 per cent zinc was tried successfully, but on account of cost was replaced by malleable iron or steel castings. From all of these experiences it would appear that in the case of locomotive parts subjected to superheated steam, a metal which may prove satisfactory when not subjected to friction may be wholly unsuitable when it has a moving part working over it. (Paper presented at the *Institute of Metals*, Sept., 1922, abstracted from advance copy, 4 pp., *ep*)

Stainless Steels—Scaling, Dr. W. H. Hatfield. A general discussion, with data of tests of the properties of stainless steels.

As regards resistance to scaling, the author states that in comparison with ordinary carbon steels, stainless steel resists scaling to a marked degree with increasing temperature. Tests performed up to 1000 deg. cent. (1832 deg. fahr.) on mild steel, alloy steels, tungsten steels, and stainless steel showed that the stainless steel scaled less than any of the others.

The temper colors produced at much lower temperatures form an analogous phenomenon to scaling, and it is well known that when hardened tool steel is tempered, the originally bright surface goes through a series of colors. During this process of color change with increasing temperature the skin of the steel becomes seriously affected when visible red heat is attained. Stainless steel responds in a very different manner, and up to temperatures of 800 deg. cent. (1472 deg. fahr.) the effect on the surface is confined to the color effect only. The same temper colors obtained during tempering, in the case of stainless steel, correspond to much higher temperatures than in the case of carbon steel. (*Transactions of the Institution of Mining Engineers*, vol. 63, pt. 3, May, 1922, pp. 177–191 and discussion pp. 192–195, *g*)

Metallic Tantalum. The Fansteel Products Co., North Chicago, Ill., it is said, has developed a process for the production of metallic tantalum. The metal will necessarily be very high in price because it has to be made in a vacuum.

Its resistance to wet corrosion is its most interesting characteristic. It is unattacked by any acid or alkali solution (except hydrofluoric acid) even at boiling temperature.

Its high melting point—about 2850 deg. cent.—is of no commercial advantage as it oxidizes in air easily long before it reaches that point.

[It might be mentioned in this connection that tantalum was made in Germany for a number of years by a process developed by Dr. Von Bolton. Editor.]

The work for the Fansteel Company has been done by Dr. Clarence W. Balke. Further research work is being conducted by the same company on columbium, with a view to determining what commercial advantages this material may have. (*Chemical and Metallurgical Engineering*, vol. 27, no. 14, Oct. 4, 1922, pp. 704, *d*)

The Marine Borer. Data of work of the San Francisco Bay Marine Piling Committee, affecting particularly views concerning immunity from the teredo. Prof. C. A. Kofoid of the University of California was in charge of the biological work.

In the course of the work of the committee it was determined that the teredo can continue to feed and function in water of a minimum salinity of five parts per thousand; all previous investigations placed the minimum at nine parts per thousand. It was also discovered that the teredo can endure exposure to entirely fresh water for a period of at least twenty days and can live in conditions of putrefaction involving the entire exclusion of dissolved oxygen from the water for at least ten days. The marked winter dying off of teredo in the Carquinez Strait region has been proved to be due not to reduction of salinity, but to be caused by a fungus and bacteria infection.

Based on the biological work, the Marine Piling Committee has worked out tentative specifications for creosoted oil and the treatment of timber with this material for protection from marine borers; also, at the instance of the San Francisco Committee, the National Research Council, Washington, D. C., has appointed a special committee on marine-borer investigation that will explore and correlate the work on this subject through the United States. (*Pacific Marine Review*, vol. 19, no. 8, Aug., 1922, pp. 452–453, *edA*)

FUELS AND FIRING

Conveying Coal Dust Through Gas Mains

Conveying Finely Pulverized Fuels Through Gas Mains, Dr. Engr. Wittfeld. Dust particles of very small grain size fall only very slowly in gases, even when these latter are strongly rarefied. A good indication of the ability of dust to stay in suspension is given by the so-called twilight phenomena occurring after violent eruptions of submarine volcanoes. These phenomena are due to the fact that extremely fine dust is thrown to great heights and forms there clouds which give well-known peculiar lighting effects. That such dust is formed in eruptions of submarine volcanoes is due to the action of steam.

This behavior of fine dust may be utilized in the conveying of finely pulverized fuels to considerable distances by means of gas mains. Conditions are particularly favorable for applying this process to the handling of semi-coke. The process of manufacturing of semi-coke is now only in its infancy, but when it develops the problem will arise of how to deliver it to consumers. This fuel is of a very brittle character and therefore not well suited for shipment in open cars. However, because of its brittleness it is very easy to pulverize, and it can then be used for firing boilers equipped with proper devices. Furthermore, semi-coke plants yield considerable quantities of products of incomplete combustion in the form of gas, and this gas may be used for lighting and house and industrial heating. It would therefore appear logical to pulverize the semi-coke at the plant where it is made, and in the form of fine dust deliver it to the place of consumption together with and carried by the by-product gases.

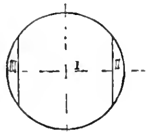


Fig. 2

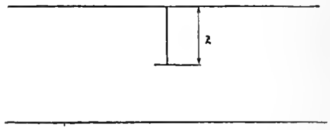


Fig. 3

Fig. 2 Diagram Showing Position of Deflectors in Dust-Gas Mains with Respect to the Cross-Section of Main

Fig. 3 Velocity Diagram Used in Connection with Equation [1]

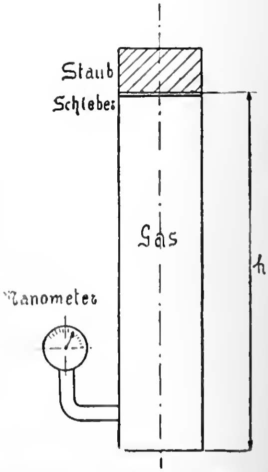


Fig. 4 Device for Determining Velocity of Fall of a Given Dust in a Given Gas
(*Staub* = dust; *Schieber* = valve.)

No special difficulties are involved in separating the dust from the gas. All that it is necessary to do is to pass the gas through a filter which will retain the dust. In fact, where lignite or peat are used as the raw material of gas and semi-coke manufacture, it may be necessary to permit the gas to retain a certain amount of the coke dust in order to increase its heating capacity.

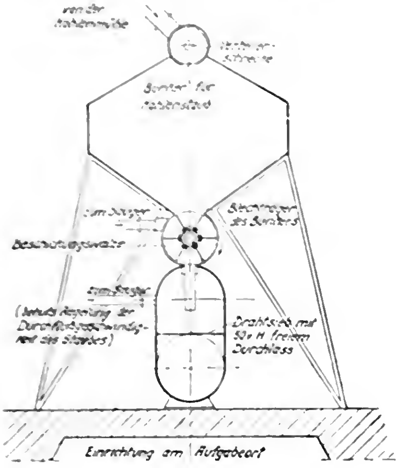


Fig. 5

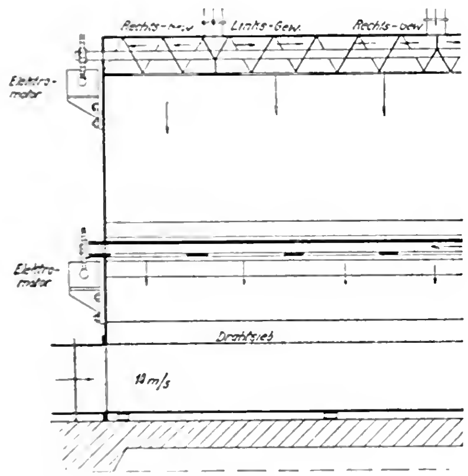


Fig. 6

FIGS. 5 AND 6 DIAGRAMS OF PLANT WHERE THE MIXING OF THE GAS AND COAL DUST IS EFFECTED

(Fig. 5: *von der Kohlenmühle* = from coal crusher; *Verteilerschnecke* = distributor worm; *Bunker für Kohlenstaub* = coal dust bin; *zum Sauger* = to suction fan; *Beschickungswalze* = feed roll; *Blechträger des Bunkers* = bin supports; *Drahtsieb mit 50 v. H. freiem Durchlass* = wire screen 50 per cent mesh; *behufs Regelung der Durchflussgeschwindigkeit des Staubes* = for properly regulating the velocity of flow of the dust; *Einrichtung am Aufgabeort* = equipment at mixing station. Fig. 6: *Rechts-Gew.* = right-hand thread (of worm screw); *Links-Gew.* = left-hand thread; *Drahtsieb* = wire screen; *10 m/s* = 10 meters per sec.)

The gas mains should be equipped with side outlets to permit the supply of local industrial plants with semi-coke dust and gas. It will be advisable to lay them so that they will be horizontal and free of bends along their entire length. In many instances this can be done, but where it is impossible owing to ground conditions, charging stations will have to be installed; this, however, can be done only to a limited extent on account of the increased first cost and cost of operation. Where the mains are on one level and run in a straight line, there is no reason why the cost of delivering the mixture of gas and dust should be much higher than the cost of handling gas alone. Spaced from each other at certain intervals *s*, deflectors (Fig. 2) may have to be installed in the pipe in order to force the gas to flow in an upward direction and thereby give the suspended dust an undulatory path of travel. Such deflectors need to be installed only over the part of the cross-section indicated by *I*. In the remainder of the cross-section (*II*, *II*) the flow of the dust is quite irregular, but this increases the power consumption of the pumps only to a slight extent. The spacing of the deflectors may be determined in the following manner.

Referring to Fig. 3, let *c* be the limiting velocity of flow of the dust and *w* the velocity of flow of the gas, and let it be assumed that there is a simple straight-line relation between the resistance to fall (suspension resistance) of the dust and a certain velocity of fall *v*; then—

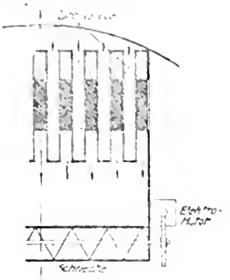


Fig. 7

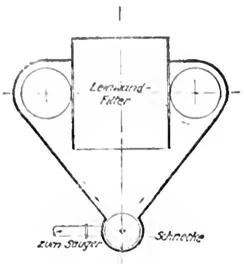


Fig. 8

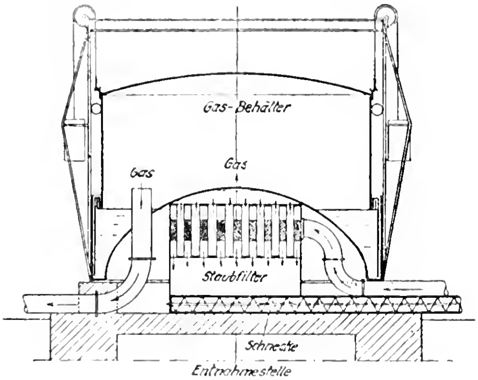


Fig. 9

FIGS. 7, 8 AND 9 VIEWS OF DELIVERY PLANT SHOWING SEPARATION OF COAL DUST FROM GAS

(Fig. 7: *Drahtsiebe* = wire screen; *Schnecke* = conveyor worm. Fig. 8: *Leinwand Filter* = cloth filter; *zum Sauger* = to suction fan; *Schnecke* = conveyor worm. Fig. 9: *Gas Behälter* = gas holder; *Staubfilter* = dust filter; *Schnecke* = conveyor worm; *Entnahmelselle* = coal-dust delivery plant.)

FIG. 10 BAFFLE IN GAS MAIN FOR PRODUCING AN ASCENDING FLOW OF THE COAL-DUST-GAS MIXTURE

(German text under illustration substantially translated in above caption.)

$$\frac{dv}{dt} = \left(1 - \frac{v}{c}\right) g,\; v = c\left(1 - e^{-\frac{gt}{c}}\right),\; z = ct - \frac{c^2}{g}\left(1 - e^{-\frac{gt}{c}}\right) \quad [1]$$

As it passes into the mains the dust enters the gas stream with a vertical velocity v_0. Hence, for the distance s_0 between that point and the nearest deflector,

$$v = c\left(1 - e^{-\frac{gt}{c}}\right) + v_0, \text{ and } z = (c + v_0)\, t - \frac{c^2}{g}\left(1 - e^{-\frac{gt}{c}}\right)$$

The length of pipe traversed by the dust flowing with the gas during the time t is $x = wt$. If D is the diameter of the pipe, the following equations may be used for computing s_0 and s:

$$D = \frac{c + v_0}{w} s_0 - \frac{c^2}{g}\left(1 - e^{-\frac{gs_0}{wc}}\right)$$

and—

$$D = \frac{c}{w}s - \frac{c^2}{g}\left(1 - c^{-\frac{gs}{wc}}\right)$$

In order to determine the limiting velocity c, semi-coke dust may be allowed to fall in a glass tube filled with gas at a known pressure. If T is the time taken by the dust to fall through the distance h (Fig. 4), then the velocity c may be obtained from the equation—

$$h - cT + \frac{c^2}{g}\left(1 - e^{\frac{-gT}{c}}\right) = 0$$

Such combined gas and pulverized-fuel conduit systems may prove to be economically preferable in certain cases to the long-distance transmission of power by electrical means. Figs. 8 to 10 show what is considered to be a workable arrangement for such a transmission, for the dust falling at low velocity is delivered through a wire screen at right angles to the rapidly flowing stream of gas (Figs. 5 and 6) and separated therefrom at its destination by screens and impact action (Figs. 7, 8 and 9). Fig. 10 indicates diagrammatically the motion of the dust in the gas main.

Only by means of tests can the facts regarding the behavior of dust in gas mains of this character and the power requirements be determined, and it would be advisable in view of the importance of the subject to institute such tests. (*Fördertechnik und Frachtverkehr*, vol. 15, no. 9, Sept. 15, 1922, pp. 247–248, 9 figs., *dA*)

The Comparative Merits of Benzol and Gasoline as Engine Fuels, W. O. Hinckley. The author briefly describes the process of manufacturing benzol and gives a specification for motor benzol, which is also compared with the specifications of gasoline.

It is found that the end point of the gasoline sample was 417 deg. fahr. as compared with 275 deg. for the motor benzol. There was a residue of 0.2 per cent with gasoline on distillation and none with motor benzol. The so-called end point is important, as a high end point indicates the presence of poorly volatilized constituents, such as kerosene, which, if present in too great an amount, would reduce the efficiency of the motor fuel. Various methods may be used in demonstrating this. One, for example, is to compare the time of evaporation or volatilization of a fuel having a high end point with one of a low end point (time for benzol, 26 min., and for typical motor gasoline, 145 min.).

The heat value of the motor benzol is about 18,700 B.t.u. per lb. as compared with 17,460 B.t.u. per lb. for gasoline. The difference is still more striking when considered on the basis of volume, as benzol has a greater specific weight and its value is 137,000 B.t.u. per gal. as compared with 113,500 B.t.u. per gal. for gasoline.

In tests made on a four-cylinder engine an increase of horsepower with motor benzol as compared with gasoline is claimed, as well as better performance. The tests, however, were not extensive enough to establish any reliable conclusion. (*Journal of the Society of Automotive Engineers*, vol. 11, no. 4, Oct., 1922, pp. 359–360, 1 fig., and discussion pp. 360–362, *ce*)

Handling Pulverized Coal by Novel Method. In the plans for equipment to be used by the new Cahokia Station of the Union Electric Light and Power Co., St. Louis, a novel method of weighing the fuel and conveying it from the pulverizers to the boilers is proposed.

A series of five blowing tanks will be placed below the floor level of the pulverizing room which will serve an equal number of pulverizing units. These blowing tanks will rest on platform scales, the dial of which will indicate to the operator in the pulverizing room the amount of fuel in the tank.

The fuel will feed into these tanks by gravity as desired from the fuel bins in the pulverizing room. Each charge will be weighed automatically and then elevated by compressed air to a height of about 75 ft. through 4-in. pipes. By means of a simple system of switching valves and parallel distributing mains cross-connected, any blowing unit can discharge into any of the eight enclosed storage hoppers in the boiler house.

The fuel requirements of the first group of units are estimated at 1000 tons in 16 hr. (*Iron Trade Review*, vol. 71, no. 15, Oct. 12, 1922, pp. 988, *d*)

GAS PRODUCERS

Suction-Gas Trucks and Tractors

French Suction-Gas Trucks and Tractors. Opportunities for the successful use of suction gas on commercial automotive equipment are greater in France than in most other countries on account of the high price of gasoline and abundance of charcoal.

The present fitting of suction-gas plants to trucks and tractors marks a period of transition, provision being made to use gasoline when the engine is required to develop temporarily more power, the suction-gas plant being usually installed as additional equipment.

The present article describes the "Lion" plant, the unit of the French Company of Agricultural and Industrial Material of Vierzon, and the Cazes suction-gas producer. All of them are intended to operate primarily on charcoal. The Vierzon Company's gas producer may employ also small chopped wood as fuel, or a mixture of charcoal and wood. As an example of the design the Cazes unit (Fig. 11) may be described. The producer A, lined with refractory material, has an annular steam generator B with air admission at C. The air on being drawn over the surface of the hot water takes up a certain quantity of steam, after which it passes through the pipe D to the bottom of the producer; this pipe also passes through the economizer E. The gas from the upper part of the producer continues its course by the pipe F into the economizer where it is cooled by contact with the walls, and also gives up part of its heat to the pipe D to raise the temperature of the steam-saturated air. Thence the gas enters the scrubber and finally into a condenser provided with a series of baffle plates which free the gas from any water and impurities. It is claimed that this system of recuperating the heat increases the calorific value of the gas and that consequently more power is developed in the engine. This would seem to be confirmed by the results of the Paris trials, when the 100-mm. by 150-mm. engine developed on the bench 20.4 hp., and the consumption of charcoal with a load of $3^1/_2$ tons was $54^1/_2$ kg. on the first day's run of $37^1/_4$ miles and on the second day 46 kg. It is true that the length of the engine stroke gave an advantage for the combustion of gas.

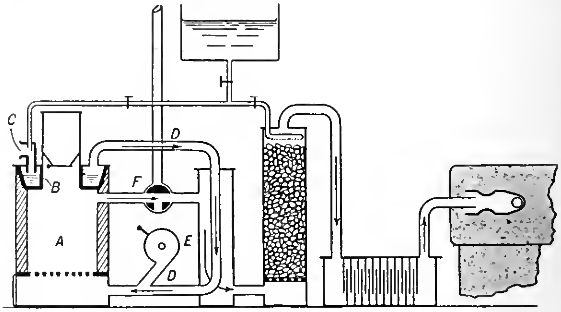


Fig. 11 The Cazes Suction-Gas Producer as Applied to Tractors

The Cazes producers have been used successfully on agricultural tractors, and in plowing tests a Tourand-Latil tractor equipped with this plant plowed $2^1/_2$ acres with a consumption of 45 kg. of charcoal of which the cost was 8.40 francs. In the latest type of suction-gas plant recently adapted to lorries the scrubber and condenser have been done away with and have been replaced by a double oil filter. In this way the weight has been reduced from 1120 lb. to 560 lb. The tendency of all makers of suction-gas plants for motor vehicles is to simplify them as much as possible by omitting the scrubber with its water supply, and the results already obtained with different systems tend to show that improvements will be carried out in the direction of compact and unobtrusive plants which will help to popularize the employment of suction gas for commercial vehicles. (*The Engineer*, vol. 134, no. 3483, Sept. 29, 1922, pp. 332–334, 9 figs., *dc*)

Automatically Controlled Water-Gas Producer, G. Vigreux. The feature of the apparatus described is that the blow and gas-making periods are equal, which allows of the joint working of two

units for a continuous production of gas and of economy in the size of the container required.

The reversing movements of the valves are effected automatically by power, while the air and steam deliveries are regulated by means of indicators and manometers. The sensible heat and the combustion heat of the blow gases are both controlled.

It was found to be essential to the scheme to have certain quantities of heat stored in the generator in order not to have to increase the blow or vary the steam delivery for any one period or successive periods. This is achieved by the special construction of the generator shown in the original article. (From a paper read at the Annual Meeting of the Société Technique du Gaz, abstracted through *Gas Journal*, vol. 159, no. 3095, Sept. 6, 1922, pp. 531, 1 fig., *d*)

HYDRAULIC ENGINEERING

Experiments on a Pelton Wheel and Needle Nozzle

Experiments on a Pelton Wheel and Needle Nozzle, Prof. A. H. Gibson. Experiments were carried out on a Pelton wheel forming part of the equipment of the author's hydraulic laboratory at the University of Manchester. As originally installed by the makers, this gave only moderate efficiencies. After modifications the efficiency was improved by some 15 per cent. The machine is a single wheel carrying 20 buckets and is supplied through a 6-in. pipe line terminating in a needle nozzle 1.57 in. in diameter. The jet from this cuts the bucket circle at a radius of 11.30 in., the diameter of the wheel over the tips of the bucket in the center line of the jet being 24.25 in.

In preliminary tests it was found that contrary to usual practice in this plant maximum efficiency was attained with an opening corresponding to about half-load, and an inspection of the jet through a glass panel on the turbine casing afforded grounds for belief that the reduction in efficiency may be partly due to the jet itself, as a distinct spreading of the jet after leaving the nozzle was observed, particularly with the larger openings. This spreading was apparently due to the water reaching the nozzle with a considerable velocity of whirl.

With a view to reducing the velocity of whirl of the water the nozzle was unshipped and four radial vanes made of $^1/_{16}$-in. sheet brass, each 6 in. long and 1 in. deep, were fitted as shown in Fig. 12. The effect of this alteration was very marked. For all openings the jet became perfectly solid and sensibly parallel up to its point of impact with the buckets, and with smaller openings had a clear glassy appearance indicating steady as opposed to sinuous motion.

Careful measurements with a view to determining the coefficients of contraction were made, and from these it appears that the coefficient of contraction is within the errors of measurement the same for 60 ft. as for 96 ft. head. The efficiency at first increases with the opening, but as the opening is increased beyond about three and a half turns there is a very marked diminution in velocity and efficiency. This attains a minimum value for an opening of about five and a half turns, at which the efficiency is only about 90 per cent.

Tests were also made with a modified form of nozzle and data on these presented in the original article. Additional series of experiments were made in order to determine the loss in mechanical friction and in windage. It was found that the horsepower consumed by friction and windage is proportional to the 2.17 power of the speed. Assuming, as appears to be justified by recent experiments, that the moment of mechanical friction of a well-lubricated high-speed bearing is sensibly independent of the speed and load and that the windage resistance is proportional to the square of the speed, the frictional moment T may be expressed as $a + bs^2$, where a and b are constants ($a = 1.25$; $b = 0.0000194$) and s the speed in r.p.m.

An interesting discussion of losses in buckets and kinetic energy of discharge is presented. This part, however, is not suitable for abstracting.

One of the features particularly emphasized by the author is the possibility of the rotary motion being produced by a bend, or generally by an obstruction in the pipe line. The experiments showed that during motion round a bend the velocity is greatest and the pressure least near the inside of the bend. In fact, the flow is somewhat analogous to that obtaining in a free vortex. The equalization of these pressures and velocities at the entrance to the straight portion of the pipe is accompanied by eddy formation, which appears to be the chief source of loss of energy occurring in curvilinear as opposed to straight-line flow. One incidental effect of the variation of pressure at the beginning of the straight portion is to set up a system of circulatory currents from the region of higher to that of lower pressure. Any irregularity in the cross-section of the pipe, or any difference in the roughness of the two halves of its periphery must, however, tend to increase the relative resistance to the flow of one of the outflowing branches of this current. In every case investigated by the author such a motion has been found superposed on the general motion of translation of the water, and the fact that this increases the relative velocity of water and walls for a given mean velocity of flow, must account for some, at all events, of the resistance to flow around a bend.

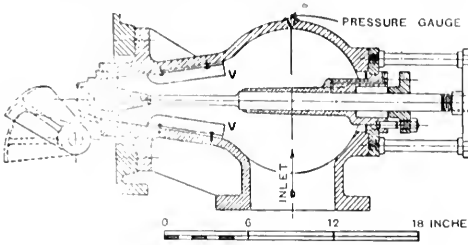


Fig. 12 Nozzle and Regulating Needle in Experimental Pelton Wheel

The tests indicate that the efficiency of a well-designed wheel and nozzle, even of small power, may be surprisingly high. In spite of the comparative smallness of the buckets, the actual efficiency of this plant attained a value of 79 per cent, and this with a jet efficiency of only 94 per cent. Experiments on other wheels with more perfectly designed nozzles show that the jet efficiency may readily be brought up to 97 per cent, which, with the present buckets, would give an overall efficiency of 82 per cent, while with larger buckets and the more efficient jet there would appear to be no reason why this overall efficiency should not attain a value in the neighborhood of 85 per cent. (*Proceedings of the Institution of Mechanical Engineers*, no. 3, 1922, pp. 643–661, 8 figs., *eA*)

INTERNAL-COMBUSTION ENGINEERING (See also Fuels and Firing)

Wilson Sleeve-Valve Supercharger Engine. Description of a supercharger engine designed in England. As constructed the experimental engine has two vertical cylinders, but the principle is equally suitable for a multi-cylinder engine. The power unit consists of two vertical cylinders in each of which is a single sleeve valve having suitable ports and a piston of ordinary construction. The two pistons work in unison, their cranks being set at 360 deg., i.e., a common crankpin is employed. The sleeves are operated by connecting rods off a small crankshaft running at half the main crankshaft speed and the sleeve cranks are set at 180 deg.

Crankcase compression is employed. On each upstroke of the two pistons a double charge is drawn into the crankcase through ports in each sleeve registering with the carburetor. On the pistons descending, they compress the charge in the crankcase, and another port in the sleeve of one cylinder then allows the compressed charge to be transferred to the combustion space of this cylinder. This completes the two-cycle operation which takes place in the crankcase.

In the cylinder there is a four-cycle operation in progress. As the pistons rise, one is on its compression stroke and the other on its exhaust stroke, since the sleeve-operating cranks are at 180 deg. As the piston, which is on its exhaust stroke, reaches the top dead center, the port in the sleeve through which the exhaust gases have passed is closed, and as the piston descends with all ports closed a partial vacuum is formed in the cylinder, until the piston uncovers the next series of ports, which at this moment are in communication with the carburetor. Accordingly, a charge is drawn into the cylinder, and as the piston descends the transfer port is

opened and the compressed charge in the crankcase is also forced through into the cylinder. The piston then ascends on the compression stroke in the ordinary way, all ports being closed, and the mixture is fired and the piston forced down on the working stroke when at a suitable moment the exhaust port is opened and the products of combustion are swept out as the piston rises on the exhaust stroke.

In the original article diagrams are given illustrating the cycle of operations of the engine. No data of any tests are given. (*The Autocar*, vol. 49, no. 1406, Sept. 29, 1922, pp. 596–597, 1 fig., *d*)

What Can We Expect from the Compound Gas Engine? Prof. W. J. Wohlenberg, Assoc-Mem. Am.Soc.M.E. The author points out that no experimental data are available on engines operating with the intercooling process, although Ricardo and certain European engineers have worked on modifications of the process for the purpose of increasing the possible mean effective pressure in a given cylinder. It is therefore not possible to compare the relative performance of actual engines.

Analytically, the author comes to the conclusion that maximum efficiency is not obtained with complete expansion, and, further, that for Otto compression ratios below six the intercooling cycle has a decided thermal advantage, but for compression ratios over seven the Otto cycle is preferable.

For normal loading the intercooling engine possesses a decided advantage thermally. For quality governing this advantage disappears at light loads. In fact, the author shows that under certain conditions 53 per cent more work may be accomplished per cycle by the intercooling engine, while the ideal thermal efficiency of the cycle is 58 per cent. At the same time an analysis of the weights of the parts in an intercooled engine would indicate that it is improbable that the weight of the additional parts will serve to offset as large a gain in power as 53 per cent. Moreover, if proper precautions are taken the combustion process in the intercooling engine should be at least as good as in the Otto engine. On the other hand, however, the author comes to the conclusion that the intercooling process is at a thermal and power disadvantage when it is not the means of increasing the final compression pressure. (*Power*, vol. 56, no. 15, Oct. 10, 1922, pp. 560–562, 4 figs., *c*)

5000-R.P.M. Engine with Positive Valve Control

Bignan Engine with Positive Valve Control. This design is primarily applicable to high-speed engines such as may be used in racing cars.

Each valve stem carries a guide working on two vertical shafts and carrying two conical rollers which take their motion from a cam the form of which in plan is a circular disk. The valve movement is then positively controlled and springs are entirely eliminated. The system is given the name "Desmodromique" by its designers.

The overhead valve gear is arranged in two groups, one over each pair of cylinders. The four valves in each group are spaced out in the form of a square, the diagonals of which intersect at the center of the circular cams. Thus, one cam operating the two inlet or two exhaust valves, as the case may be, brings one valve into action 90 deg. after the other, which corresponds, of course, to 180 deg. on the crankshaft since the driving shaft operating the valve gear runs at half the engine speed. The cams are so formed as to bring the valves gently to their seats, pressure within the cylinder holding them there, while the flat or non-acting portion of the cam passes between the rollers until they are opened again.

The cams are driven by bevel pinions from a centrally located horizontal overhead shaft, which, in turn, is driven by skew gears off a vertical shaft, the whole mechanism running in a bath of oil. This gear is said to have been already tested in practice, the engine thus equipped having attained a speed of 5000 r.p.m. (*The Autocar*, vol. 69, no. 1107, October 6, 1922, p. 626, 2 figs., *d*)

Adams Stepped-Piston Solid-Injection Engine. Description of an engine of moderate power designed to operate on low-grade asphalt-base fuel oils of the types produced in the Californian and Mexican fields. It is a direct reversible two-cycle motor and is built by E. T. Adams & Sons, Los Angeles, Cal.

Notwithstanding the fact that it is of the two-stroke-cycle type, it employs a flat-top piston without any deflectors, this being made possible by the arrangement and timing of air ports. Another feature of the engine is the use of an excess of scavenging air with the view to producing better scavenging and more complete combustion of the fuel. This scavenge air is compressed in the chamber formed by the step or enlarged lower section of the piston and cylinder, and not by separately driven scavenging pumps or by crankcase compression. The design is such that scavenge air is compressed in each cylinder for use in that same cylinder. (*Motorship*, vol. 7, no. 10, pp. 750–751, 5 figs., *d*)

Combined Poppet- and Sleeve-Valve Engine. Data of tests conducted at Armour Institute of Technology on a single-cylinder engine built by Victor R. Stenger.

The engine was made to test a valve layout (Fig. 13) which consists of a single poppet valve *A*, carried on a cage *B*, which also acts as a guide for the sleeve valve *C*. This cage is in reality the cylinder head and is held in place by the nut *D* threaded into the cylinder block. The poppet valve is operated in the conventional manner by the rocker arm *E*. The sleeve is operated in much the same manner by two parallel rocker arms *F*. The inlet and exhaust ports are shown by *G* and *H*, respectively.

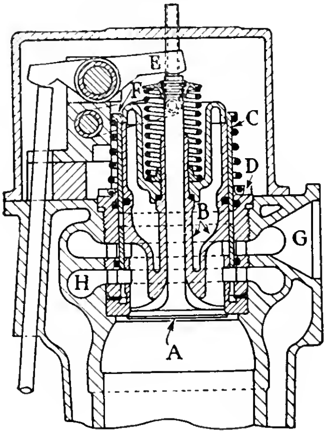


Fig. 13 Sectional View of Stenger Combined Poppet- and Sleeve-Valve Engine

It is claimed that this valve layout provides a greater ratio of valve area to cylinder volume, with consequent smaller throttling of the incoming and outgoing gases. The original article gives power, torque, and fuel-consumption curves of the engine tested which is a single-cylinder, 4-in. by $5^3/_4$-in. unit running on ordinary commercial gasoline. (*Automotive Industries*, vol. 47, no. 16, Oct. 19, 1922, pp. 765, 2 figs., *d*)

Utilization of Exhaust Gases, S. Snuyff. It is the author's opinion that the most economical way to utilize the exhaust gases from slow-speed Diesel engines is to lead them through a steam boiler and generate steam to be used in a steam engine, either reciprocating or turbine type, with a condenser. He advocates the use of a reciprocating steam engine rather than a combined Diesel-steam as in the Still engine. He comes to the conclusion that by installing an effective steam boiler with superheater, feedwater heater, etc., utilizing the exhaust heat of the engines and generating steam, connecting this to a turbo-electric set which delivers power to a motor direct-coupled to the main engine, the power can be increased by about 120 hp. for every 1000 b.hp. of the main engine. The author discusses the question of the respective weights and gives data on the conditions of operation of the compound plant. An appended editorial note states that in the article there are many problematical and theoretical aspects on which other engineers may have alternative views. (*Motorship*, vol. 7, no. 10, Oct., 1922, pp. 770–771, *g*)

Vaporization of Motor Fuels, P. S. Tice. Among other things, it is pointed out that change in pressure in the engine intake are of great importance in their effect on vaporization, particularly the changes following manipulation of the throttle.

As regards vaporization in the cylinder, the author does not believe that the conditions there are such as to make it possible to rely upon turbulence to build up a usable vapor content in the charge. (*Journal of the Society of Automotive Engineers*, vol. 11, no. 4, Oct., 1922, pp. 307–314, 7 figs., and discussion pp. 314–319, *ge*)

MACHINE TOOLS

Large Surfacing and Boring Machine

Large Surfacing and Boring Machine. Description of a machine, notable both for its size and details of construction, specially constructed by H. W. Kearns & Co., Ltd., Broadheath, near Manchester, England, for performing the machining operations on steam-turbine casings without resetting. This machine is shown in elevation and plan in Fig. 14.

Its weight is approximately 100 tons and it embodies such features as a traveling spindle of large diameter and an automatic facing motion. The spindle can be revolved either independently or simultaneously with the facing slide and the machine is capable of performing both boring and facing operations simultaneously. For boring work of medium diameter the facing slide does not revolve. Reverse motions are fitted both to the spindle and the facing slide, and the machine is fully automatic with reversible power feeds to the spindle, facing slide, vertical motion of the spindle slide, and the horizontal and transverse motions of the table. Rapid power traverse is fitted to all these movements, as well as to the longitudinal movement of the boring stay along the bed and to the vertical motion of the boring-bar support. In addition to these movements the turntable, which is detachable, can be caused to revolve in either direction by power. It can also be turned by the automatic feed, enabling continuous milling to be performed in a circular path. The facing slide is of the slotted type which allows of the tools being placed in the most convenient positions, while for wide faces two or more tools can be used simultaneously.

The spindle slide and the boring stay are balanced, the weights being carried inside the castings. The spindle slide and the boring stay can be moved together or independently, so that once the alignment has been obtained for the boring bar, it can be retained. Vernier scales are not fitted for this purpose, dial traverse indicators which give the reading of the height above any given indicators which give the reading of the height above any given date of line being used. These indicators are actuated by non-rotating screws, as already described in *The Engineer*. All the screws which operate the traverse are kept in tension and the end thrusts are taken by large bowl washers.

The capstan for the power and quick hand traverse for the spindle serves a double purpose. The handles used for moving the spindle require only a forward push to engage the automatic feed. The quick power motor circuit cannot be completed so long as the automatic feed lever is engaged. The traverse of the spindle of 48 in. at one setting can be obtained anywhere within the range of the 96 in. obtained at two settings. All the sliding surfaces are provided with oil boxes in the castings and the oil is fed on to the sliding ways by wicks, while the bearings that run continuously are fed with oil by drip feed from a central supply, and the bearings for the intermittent motion have telltale grease cups. After setting the slides, locking is performed by T-slots and bolts of large dimensions. In order to provide for wear, all the sliding surfaces can be adjusted by tapered gibs and end thrust on the traversing spindle and facing chuck is taken on ball washers of large diameters.

The following are some of the leading particulars of the machine, all of which are given in the original article:

Diameter of drilling and boring spindle	8 in.
Traverse of drilling and boring spindle at one setting	48 in.
Maximum diameter machine will face	108 in.
Number of speeds to spindle and chuck	24
Vertical traverse of sliding head	8 ft.
Maximum distance, center of spindle to main table	9 ft. 6½ in.

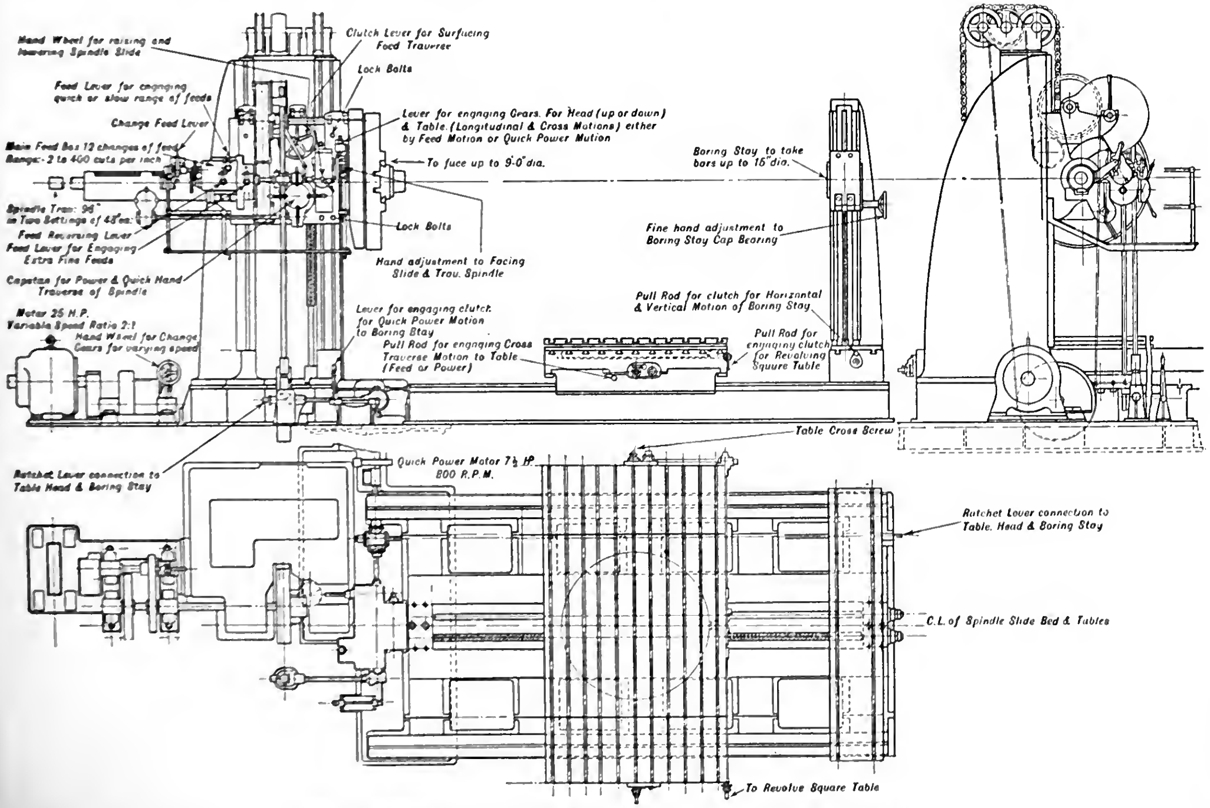


Fig. 14 Elevation and Plan of Large Surfacing and Boring Machine

Size of main table	108 in. by 96 in.
Size of detachable turn-table	96 in. by 96 in.
Longitudinal traverse of table	144 in.
Maximum diameter of bar machine will take	15 in.

The machine is driven by a 30-b.hp. electric motor, while a separate motor is fitted for operating the rapid power traverse motion. All the motions are controlled from the platform attached to the spindle slide, and duplicated control gear of the "push button" type is fitted for operation from the most convenient positions. Reversing to all motions except the feed, which is mechanical, is obtained electrically. (*The Engineer*, vol. 134, no. 3484, Oct. 6, 1922, pp. 360–361, 3 figs., *d*)

MECHANICS

New Principles in Rotative Balance, Amos F. Moyer, Mem. Am.Soc.M.E. Description of the balancing machine designed on the basis of principles evolved by Dr. B. L. Newkirk, of the General Electric Co., which makes it possible to measure directly the resultants for the two separate ends of a rotative body and to locate them without the necessity of separating the standing from the running balance. (*Journal of the Society of Automotive Engineers*, vol. 11, no. 4, Oct., 1922, pp. 368–372, 9 figs., *d*)

METALLURGY (See also Engineering Materials)

The Decarburization of Ferrochromium by Hydrogen, L. Jordan and F. E. Swindells. The recently developed "rustless" iron may be considered as stainless steel from which the carbon has been largely eliminated. The carbon content of rustless iron is in the neighborhood of, or less than, 0.1 per cent. In order to produce an iron alloy containing as high as 12 per cent chromium and still keep the carbon content as low as indicated, it is necessary to use ferrochromium lower in carbon than the more common commercial grades bearing 4 to 8 per cent carbon. Carbon-free ferrochromium made by aluminothermic methods is available, but at prices which are too high to allow its extended use in producing rustless iron.

Various procedures for decarburizing high-carbon ferrochromium have been described in a number of patents. The decarburization of ferrochromium by means of hydrogen has been suggested. The decarburization of cast iron and steels by heating in hydrogen at temperatures between 400 and 1200 deg. cent. has been described previously. Tests carried out on 60 per cent ferrochromium containing 8 per cent carbon showed that there was a slow decarburization of the powdered ferroalloy by dry hydrogen between 1100 and 1350 deg. cent. The removal of carbon was more rapid just above than below the melting point of the alloy. The most rapid decarburization was secured by bubbling hydrogen through molten ferrochromium at approximately 1500 deg. cent. Under these conditions nearly 1 per cent of carbon was removed from the alloy in four minutes as compared with four hours required to reduce the carbon 1.6 per cent at a temperature just below the melting point of the alloy. The most promising condition for refining high-carbon ferrochromium by this method is probably blowing the alloy with a blast of hydrogen in a converter. (Technical Abstract of *Scientific Papers of the Bureau of Standards*, no. 448, *d*)

MOTOR-CAR ENGINEERING (See also Gas Producers)

Frameless Lancia Chassis, W. F. Bradley. Description of a unit where the body made from sheet-metal stampings is so designed as to require no chassis frame. This has been already illustrated and briefly commented on in Mechanical Engineering, vol. 42, no. 9, Sept., 1920, p. 525.

By means of this design the weight of a four-passenger car with phaeton body and full equipment has been reduced to the unheard-of figure of 1650 lb., which is all the more remarkable from the fact that the car has a wheelbase of 122 in., track of 43 in., speed ability of 70 to 75 m.p.h. on the level, and a reputed gasoline consumption of 21 miles to the American gallon. This was done by eliminating frame members and the usual type of body construction with heavy body sills. The body is built up of two main pressed-steel side members having a thickness of 2 mm. These members are united by a series of cross-members formed into the following units: radiator housing, toe board and scuttle dash, frame and back rest of front seat, etc. From the toe board to the rear-seat back rest there is a longitudinal tunnel which receives the propeller shaft. The top of the tunnel is cut away just ahead of the front seat for the brake and change-speed levers to be passed through.

When the necessary dies and presses have been installed the Lancia type of construction is claimed to be very much cheaper than normal body building with its attendant chassis frame. The engine used on this car is a four-cylinder V-type with an angle of 20 deg. In addition to forming a V, the cylinders are in staggered relation. This disposition avoids the use of forked connecting rods and gives a separate bearing for each rod.

Instead of the usual type of forged axle, Lancia has a triangular steel-tube construction comprising a bottom horizontal tube uniting the radiator housing and the steering yokes, two tubes from the top of the steering yokes to the top of the radiator housing, and another pair from the bottom of the steering yokes to a point on the main frame on a line with the dash. Front suspension is by means of a system of enclosed coil springs and hydraulic shock absorbers, the cylinders for the hydraulic system serving also to house the coil springs. The front-wheel brakes are operated by pedal in conjunction with those on the rear wheels. A feature of the front-wheel brakes is that the drums are within the wheels, the center line of the drums almost coinciding with the center line of the tire. Aluminum drums with die-cast aluminum shoes are employed. (*Automotive Industries*, vol. 67, no. 15, Oct. 12, 1922, pp. 706–708, 3 figs., *dA*)

OIL ENGINEERING

Design and Operation of a Low-Pressure Absorption Plant, W. P. Dykema and A. A. Chenoweth. This report, which can only be referred to here in a very general manner, gives a detailed outline of an experimental plant installed in the Cushing oil field in Oklahoma and of its regular operation, together with records of temperatures, pressure, production, and changes in equipment. It also considers data on the latent heat of absorbed gases and a proposed means of overcoming the increase in temperature of the oil as it circulates through the towers.

In the opinion of the authors a low-pressure absorption plant can easily recover all the valuable gasoline fractions from rich casing-head gas if the absorption oil and the gas being absorbed are kept at a temperature not higher than 80 deg. and not necessarily less than 70 deg. fahr. This temperature range must be maintained throughout the absorbing process, from the time the oil and gas first come into contact until each, separated, leaves the absorption towers on its way through the plant. It is certain, however, that the more closely the temperature is held to the lower value, the more satisfactory and complete is the cleaning of the gas from all marketable gasoline. Data not fully set out in the report confirm this statement and a table given illustrates it by showing an air temperature of 58 deg. fahr. and an oil temperature of 81 deg. as it starts through the absorbers. The increase of 20 deg. fahr. in added heat, by reason of the latent heat of the absorbed gases, here 20 per cent of the total, is therefore of great importance. (*Bureau of Mines Technical Paper 263*, 1922, 40 pp., 14 figs., *ep*)

PHYSICS (See Power-Plant Engineering)

POWER-PLANT ENGINEERING (See also Fuels and Firing; Railroad Engineering)

Application of the Stefan Law to the Calculation of Furnaces, Prof. Vicente Burgaleta. The author presents the general theory of radiation and develops formulas for the expression of the Stefan law, which he proposes to apply to the calculation of furnaces. In the first part of the article he establishes the experimental bases for the calculation of emission and absorption of radiant heat, using methods not generally employed in engineering literature, and from these, by an analytical method, he establishes the precision and limits of the Stefan law. In the second part he shows how the Stefan law may be applied to the calculation of furnaces and then compares results obtained by this method, in

particular on locomotive furnaces, with values generally known. The article is of a mathematical character and not suitable for abstracting. (*Anales de la Asociacion de Ingenieros del Instituto Catolico de Artes e Industrias*, vol. 1, no. 1, Jan., 1922, pp. 39–45, 5 figs., *pmA*)

The Effect of Polarized Mercury on Boiler Tubes, Geo. L. Fowler, Mem. Am.Soc.M.E. Data of an investigation made as to the characteristics of the film produced in boiler tubes by the boiler compound known as "polarized mercury." It is not stated where and by whom this investigation was made.

It is stated that the film as it was found on the tube was a smooth glossy black, much smoother than the original surface of the tube when new and having a slightly lustrous polish resembling that of Russia iron. It was exceedingly hard and brittle, very closely adherent to the metal beneath, and could only be removed with difficulty. It could not be peeled off and could only be separated from the metal by using a hard and sharp scraper, the removed material coming off in the shape of a finely divided powder. There were no flakes, for the brittleness of the material was such that any disturbance of it caused it to crumble.

The tube examined was partly covered with scale, but this could be easily removed by scraping it off with an ordinary scraper, leaving the tube clean and free from any adhering particles. When clean the tube was found to be almost entirely covered with the black film referred to above.

In the physical examination of the film it proved to be impossible to detect the presence of mercury microscopically. Chemical analysis showed that the film consisted of black magnetic oxide of iron (Fe_3O_4) and some ferric oxide (Fe_2O_3), together with a small amount of free mercury present, which was, however, a mere trace. The amount of ferric oxide present was also very small. The protective properties of the film are ascribed to the presence of magnetic oxide of iron and a theory is offered to account for the formation of the black magnetic oxide, and the role played in this process by previous deposits of scale. (*Railway and Locomotive Engineering*, vol. 35, no. 10, Oct., 1922, pp. 255–257, 10 figs., *dg*)

Underfeed Stokers of the Detroit Edison Co., E. E. Dubry. Description of a 13-retort underfeed stoker with a total grate area of 470 sq. ft., which makes possible a big reduction in the number of overhead bunkers and coal-conveying equipment.

For some time the Detroit Edison Co. has desired to see what could be done with a long stoker feeding the furnace from one side only, as with this scheme it would become possible to reduce the cost of the boiler unit by reducing the number of overhead bunkers from three to one. The introduction of the so-called superstoker (a stoker having long retorts and the dimensions increased to permit the necessary high rates of coal feed) by the Sanford Riley Stoker Co. afforded an opportunity to try out the single-end arrangement of stoker and furnace.

In general design this stoker does not differ materially from the standard Riley type, but the entire mechanism is larger and heavier throughout. There are thirteen retorts, fed by rams 11 in. in diameter having a stroke of 12 in., giving a piston displacement nearly 80 per cent larger than that of the 9-in. ram having a 10-in. stroke, so that with the crankshaft running at a slightly higher speed these thirteen rams feed coal as rapidly as do the twenty-six retorts of the double-ended stoker.

The outstanding feature of this particular type of stoker is that the tuyeres or grate blocks are movable in a direction parallel to the path of the coal. The length of travel is adjustable and under control of the operator, but the period of oscillation is dependent upon the stoker speed, since each complete tuyere box, from the point where coal enters to the end of the apron at the clinker grinder, is driven by its corresponding ram.

No complete test of the unit has yet been made, but various preliminary observations lead to the belief that the work of the two sides of the boiler is quite evenly distributed since the gas temperature at the beginning and end of each half are practically the same, likewise the temperatures of the steam leaving each superheater. The stoker responds quickly in an increase in the rate of combustion and can pick up load as rapidly as the double-ended units. (*Power*, vol. 56, no. 14, Oct. 3, 1922, pp. 536–538, 5 figs., *d*)

RAILROAD ENGINEERING (See also Engineering Materials; Power-Plant Engineering)

Steam-Propelled Unit Railway Motor Car. Description of the type recently placed in service on the Canadian National Railways, and built by the Unit Railway Car Co., Boston, Mass.

The car has a water-tube boiler and an oil burner. The power plant embodies the principles used in the Stanley steam automobile and is built under the same patents. In the first run from Boston to Toronto it covered without any trouble the distance of 660 miles with a running speed for much of the distance of between 45 and 55 m.p.h. The body of the car is of steel construction and the car is equipped with standard couplers. The trucks are of a modified arch-bar pedestal type of light construction. The car is designed for single-end operation, but may be driven at equal speed in either direction. The light weight of the car complete is 59,000 lb., of which 13,000 lb. is for the power plant complete with all auxiliaries.

The boiler is of the water-tube type and is made in 12 sections, being constructed throughout of seamless boiler tubes. Each section consists of a front and back vertical header, the two being joined by 22 water tubes inclined at about 11 deg. to the front header and a single connecting steam tube at the top inclined at about 1 deg. to the back header. All tubes are straight and are electrically welded to the headers; opposite each end of every tube an opening is provided in the headers through which the tube can be inspected, cleaned, or, in case of rupture, can be temporarily plugged.

The construction of the steam drum and connections is such that they act as a desaturator. From the steam drum the steam passes through the superheater in series, an arrangement which has been found to increase materially the life of the superheater unit.

The steam pressure ordinarily carried is about 80 lb. per sq. in., while the ultimate temperature after passing through the superheater is from 650 to 800 deg. fahr. The car is propelled by a simple two-cylinder engine mounted on the front side of the forward truck, power being transmitted to the axle by a single spur gear pressed on to the center of the axle.

The high-pressure superheated steam is carried from the throttle to the engine by a flexible pipe, while the exhaust steam from the main and auxiliary engines is conducted to an air-cooled condenser located on the roof of the car at the forward end. The auxiliary steam engine just referred to drives the two feedwater pumps, the fuel-oil pump, duplex-cylinder lubricating-oil pump, and the 2-kw. d.c. generator. This engine is run at constant speed and governed by a ball-type governor.

Records taken from cars in service show an average consumption of approximately 0.7 gal. of distillate, or 0.65 gal. of kerosene per car-mile. At the low price at which distillate can be obtained in many places, this represents a fuel cost of about four cents per car-mile. For lubricating purposes two gallons of a special cylinder oil has been found to be sufficient for a 400-mile run and one gallon of engine oil for the same mileage.

The mechanical efficiency in the main engine and drive is high. The boiler efficiency when using superheated steam at 700 to 800 deg. fahr. at the atomizer is said to be about 77 per cent. The time required to generate steam with storage air for the atomizer is from 20 to 25 min., and with steam at 200 lb. pressure, approximately 18 min. An evaporation of about 14 lb. of water from and at 212 deg. fahr. may be obtained per square foot of wetted heating surface. The main engine uses from 14 lb. to 19 lb. of water, depending upon load and grade conditions, to develop one horsepower-hour. (*Railway Age*, vol. 73, no. 16, Oct. 14, 1922, pp. 711–713, 5 figs., *d*)

Locomotive-Type Steam Desaturator

Steam Desaturators on Hungarian Railroads, Desider Ledacs Kiss. Until very recently steam desaturators have been only experimentally applied to American locomotives, but as large-diameter boilers and limited overhead clearance in modern locomotives are making it increasingly difficult to elevate the throttle sufficiently above the water level to insure dry steam, such devices are becoming of interest in connection with locomotive design in this country.

The Stein desaturator has been recently applied to approximately 1000 locomotives on the Hungarian State Railways. The principle of this device is based on the fact that water which has a higher specific weight may be separated from the steam flowing to the throttle by the centrifugal force resulting from a sudden reversing in the direction of the steam flow. The unrestricted return of the separated water is secured by means of a water seal or siphon device. The desaturator therefore consists of two principal parts—the separator and the water seal. The separation of moisture from the steam by means of centrifugal force is effected before the steam flows into the throttle by directing the steam through an intercepting port which is curved into a small radius. In this curved passage the small particles of moisture due to centrifugal force are hurled against the plate constituting the outer radius of this passage. This separation of moisture from the steam is further effected in a chamber joining the curved intercepting port where the steam suddenly reversed its direction and simultaneously diminishes its velocity so that the particles of moisture fall to the bottom of the chamber. The water separated from the steam flows back into the boiler through a siphon which also constitutes a water seal, while the desaturated steam flows upward to the throttle valve.

The device is relatively inexpensive to construct, has no moving parts, and, it is said, its maintenance is practically negligible.

Tests have shown that the performance of a locomotive equipped with the desaturator is superior to that without it, and that locomotives equipped with desaturators require 25 per cent less cylinder oil for lubrication than locomotives operating without desaturators.

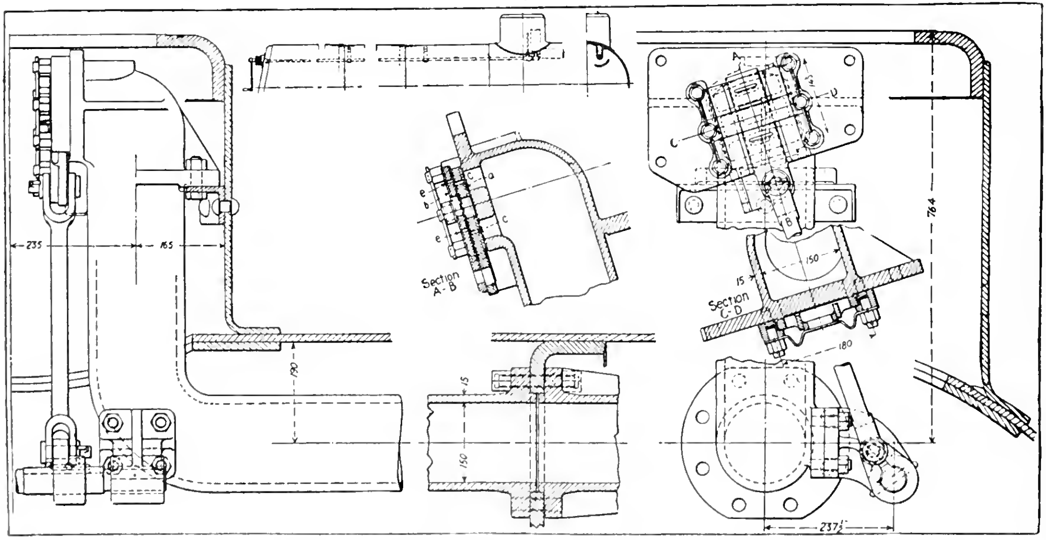


Fig. 15 Structural Details and Method of Applying Semi-Balanced Slide-Valve Throttles to Locomotives of the Hungarian State Railways

The peculiar type of balanced slide throttle valve was designed for use in conjunction with desaturators. The double-beat throttle valve commonly used on American motive power is rarely used in Europe, the objection to this type being the liability of the valve to leakage in bad-water districts owing to the incrustation of scale deposited on the valve seats.

The partially balanced slide valve of a type used on the Hungarian State Railways is shown in Fig. 15.

This throttle consists of two slide valves as shown, (*a*) being the main slide valve while the casing valve (*c*) has a limited travel. The latter is operated by a lever (*k*), so that in opening the throttle lever this casing valve is first moved to the point where the slot (*e*) coincides with the slot (*e*) in the main slide valve, when steam is admitted to the dry pipe, thus balancing the pressure on the main slide valve. As the main valve is opened, the casing valve moves with it, but in the meantime the casing valve has served to admit a small quantity of steam so that a sudden inrush of steam to the cylinders is avoided. Another advantage of the casing valve is found in the light running of the locomotive and in drifting when it is desirable to keep a small quantity of steam in the cylinders for the purpose of better lubrication, particularly where the steam is superheated. Under these conditions the easing valve will alone supply sufficient steam to keep the piston-valve and cylinder surfaces well lubricated, thus obviating the practice of running with a "cracked" throttle ordinarily employed with the double-beat throttle valve. (*Railway Review*, vol. 71, no. 15, Oct. 7, 1922, pp. 475–478, *d*)

REFRIGERATION

Feather-Valve Compressors of Three Types, Construction and Operation, F. L. Fairbanks, Mem. Am.Soc.M.E. Paper based on the experience of the author with the apparatus at the Richmond Street Station of the Quincy Market Cold Storage and Warehouse Company, Boston, Mass.

In order to meet increased load conditions which proved to be in excess of original expectations, the speed of the (Boyle) compressors at the plant was increased from time to time until one of over 70 r.p.m. had been reached. It was found that while the capacity was thereby augmented it did not increase in proportion to the increase in speed, this being ascribed to lag in the operation of the poppet valves and to the excessive inertia of the heavy reciprocating parts which began to tell at the increased speeds.

In order to meet these conditions rather than with an idea of increased economy, it was decided to install a booster which consisted of a steam-driven, twin-tandem, enclosed-crankcase, feather-valve air compressor designed to deliver air at 75 lb. per sq. in., the only changes being made to adapt it for ammonia, aside from using a somewhat heavier flywheel, being in the stuffing boxes and a few other minor details.

In operating this booster, steam was taken from the mains at 125 lb. per sq. in. pressure, superheated 100 deg. fahr., and the exhaust was delivered to the intermediate steam receiver between the high- and low-pressure cylinders of the larger compressor. In other words, the steam end of the booster was compounded with the steam end of the larger compressor with a view to getting the best economy possible under the conditions.

The method of operation was to operate the large compressor at a constant speed of 40 r.p.m.—approximately the builder's rating—at which speed the valves and reciprocating parts functioned without distress, and to operate the booster at a speed necessary to produce the tonnage required; this change of speed in the booster being accomplished by varying the Meyer cut-off to meet the local conditions, up to a maximum speed of 300 r.p.m.

It was expected that this booster, at an expense of about one-twelfth of the cost of the larger machine and with a very limited

floor space available, would double the capacity of the larger compressor at its rated speed.

Operation has shown that the expected has been easily exceeded and, while this was probably the first application of the feather-valve compressor to ammonia service, it has been one of the most pleasing and most satisfactory pieces of apparatus in the equipment of the plant.

A cross-compound or two-stage synchronous-motor-driven machine is also described. Tests were conducted and the resultant data show the advantages of compound compression.

Another installation, in which two old slow-speed single-acting vertical compressors and two absorption machines were removed to accommodate a new uniflow-steam-engine-driven compressor, is described. This installation, as well as the other two already mentioned, was tested to ascertain its efficiency. (*Refrigerating Engineering*, vol. 9, no. 3, Sept., 1922, pp. 85–92 and 94, 101–102, 11 figs., *deA*)

SHIPBUILDING

The Flettner Rudder. A new type of rudder which is said to have already been fitted to one or two vessels of moderate size and will be installed on the *Odenwald*, an 8000-ton twin-screw motor vessel now being built for the Hamburg-American Line.

The rudder is based upon the well-known principle that when a rudder is turned in a moving stream of water such as is produced by the propeller there is caused a difference of pressure on the two sides. In the Flettner arrangement the rudder consists of a main and auxiliary rudder, the latter having usually only in the neighborhood of one-twentieth of the surface of the former. The power required to turn it is comparatively small, and the pressure difference created is therefore utilized automatically to cause the movement of the main rudder. By a suitable means a small vertical shaft within the rudder spindle is operated by hand from the bridge. At the bottom of the shaft an attachment is made to a short beam carrying two parallel links the opposite ends of which are attached to a similar beam carrying the auxiliary rudder. This is, of course, capable of swinging independently of the main rudder. It is claimed (says the *Motor Ship*) that although the area of the auxiliary rudder may be 5 per cent of that of the main rudder, the power required for its operation is actually only between 2 and 3 per cent of that which is needed for actuating a rudder in the ordinary way.

On the motorship *Odenwald* the spindle actuating the auxiliary rudder is operated from the bridge by means of steering cable of a size normally used on a small boat with hand steering gear. There is also an emergency gear, enabling the rudder to be operated in the ordinary way, either by hand or from a steam windlass on deck. It should be noted that when the engines are reversed and the vessel goes astern the rudder swings right round through an angle of 180 deg.

The Flettner rudder, which is attracting the utmost attention in Germany, is the outcome of prolonged experimental work, while the principle was adopted in connection with airplanes during the war. Although the *Odenwald* represents the first large ship on which it will be fitted, it has been adapted to the small Dutch steamer *Frigido*, a vessel of about 210 tons gross. For many months past this vessel has been in operation with the rudder, which, it is stated, is operated by hand with a steering wheel no larger than a motor-car steering wheel. The steering wire in this case is said to be only 4 mm. in diameter, and it is reported that in heavy weather and in crowded waters it has always proved extremely successful. (*The Practical Engineer*, vol. 66, no. 1858, Oct. 5, 1922, p. 222, *d*)

STEAM ENGINEERING (See Railroad Engineering)

TESTING AND MEASUREMENTS

X-Ray Examination of Inner Structure of Strained Metals, Chiefly Copper Wires, Prof. Akimasa Ono. Data of experiments wherein X-ray interference figures obtained from several copper wires are reported with special regard to the crystal arrangement in the strained copper. Experiments show that a copper rod composed of an irregular mass of small crystals on being drawn into wire takes a fibrous structure, the arrangement of crystal lattices being transformed into a state of axial irregularity. This may perhaps account for the changes in such properties as hardness and strength.

By finding the inclinations of several simple planes in the face-centered cubic lattice and calculating the relative intensity of rays reflected by the planes, it was shown that a group of this kind of lattices with the trigonal axis in the longitudinal direction of the specimen gives rise to the pattern obtained in the experiment.

The author believes that it is probable that the trigonal axis coincides with the longitudinal direction or the fiber direction of the specimen, and whether this is really the case may be tested by a spectrographic investigation which is now being arranged for. (*Memoirs of the College of Engineering, Kyshu Imperial University*, Fukuoka, Japan, vol. 2, no. 5, 1922, pp. 241–260 and 5 plates of illustrations, *c*)

THERMODYNAMICS (See Power-Plant Engineering)

VARIA

A New Sculpturing Method, W. F. Engelmann. This new method consists of two separate steps: the recording of the form of the object, and the carving out of the reproduction.

The recording is done by means of a moving-picture camera equipped with a black shade movable through worm and worm wheel in such a manner that only a part of the object is illuminated. To record a face, for example, the shade is first placed so that only the tip of the nose is projecting into the light and gradually drawn back until the entire face is exposed to the camera. In this way a number of photographs are obtained, the outline of each new picture giving the contour of a different plane of the object and each picture being slightly different in size from its neighbors on both sides.

The second step, which is the carving out of the reproduction, is a simple machining operation in which the reproduction is milled out in as many planes as there were contour pictures made of the object. Each plane of the reproduction has its own contour picture which is used as a pattern from which to copy the contour of a plane. The outline of the contour picture is transferred to its plane by a pantograph which holds in its one free end a tracer disk and in its other free end a milling cutter.

Several modifications of the plane are described in the booklet. No data are given to show whether actual machines have been built on the plan described, and what results have been obtained. (Pamphlet published by author, Chicago, Ill., 1922, 35 pp., 6 figs., *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reveiwer. Opinions expressed are those of the reviewer, not of the Society.

Addendum to Table of the Torsional Strength of Bars

The following should be added to the table of the Torsional Strength of Bars published in the November, 1922, issue (pp. 738, 739, 740) of Mechanical Engineering.

In the table in question:

G = modulus of rigidity

δ = angle of torsion in a given length.

The value of ψ are, as follows:

n =	1	1.5	2	3	4	6	8	10	∞
ψ_1 =	0.6753	0.8476	0.9300	0.9854	0.9970	0.9999	~ 1	~ 1	1
ψ_2 =	0.6753	0.7279	0.7395	0.7423	0.7423	0.7425	0.7425	0.7425	0.7425
ψ_3 =	0.1404	0.1957	0.2286	0.2633	0.2808	0.2982	0.3070	0.3123	0.3333
ψ_4 =	4.81	4.33	4.07	3.74	3.55	3.35	3.26	3.20	3.00
ψ_5 =	0.1539	0.1362	0.1318	0.1357	0.1412	0.1491	0.1535	0.1562	0.1667
ψ_6 =	0.1472	0.2015	0.2277	0.2154	0.2491	0.2500	0.2500	0.2500	0.2500

Test Code for Reciprocating Displacement Pumps

Preliminary Draft of the Eighth in the Series of Nineteen Test Codes Being Formulated by the A.S.M.E. Committee on Power Test Codes

THE Committee on Power Test Codes is now engaged in the revision of the A.S.M.E. Test Codes of 1915. Mr. Fred R. Low is Chairman of the Main Committee of twenty-five which guides the work of the nineteen Individual Committees. Below is reproduced the eighth of these codes to be completed. The Individual Committee which developed this Code is headed by Mr. D. A. Decrow as Chairman and consists of C. H. Anderson, E. H. Brown, G. J. Foran,[1] and L. E. Strothman. Mr. Strothman was Chairman of the Committee from the time of its organization in December, 1918, until his death in May, 1922.

The Committee and the Society will welcome suggestions for corrections or additions to this draft of its Code from those who are especially interested in the manufacture and testing of Reciprocating Displacement Pumps, whether driven by steam, gasoline, electric, or other forms of motive power. These comments should be addressed to the chairman of the Committee in care of The American Society of Mechanical Engineers.

Introduction

1 The code for reciprocating steam pumping machinery applies to tests for determining the performance of the pump and engine, including reheaters, heaters and jackets, if any, and jacket pumps, circulating pumps, condensate pumps and vacuum pumps which are concerned in their operation. For tests of pumping machinery and boiler plant combined, reference should be made to the Code for Complete Steam Power Plants.

Object

2 In accordance with the "General Instructions" the object of the test should be determined and recorded. If the object relates to the fulfilment of a contract-guarantee, an agreement should be made between the interested parties concerning all matters about which dispute may arise, as noted in Par. 3 of the "General Instructions," and the points agreed upon should be stated in the Report of the Test.

Measurements

3 The fundamental measurements that must be made in a duty trial of a reciprocating steam pumping engine are:

(*a*) Amount of water pumped, in pounds
(*b*) Average head, in feet
(*c*) Amount of steam consumed, in pounds; or the amount of heat consumed, in B.t.u.

In addition to the above, the following principal data are to be determined:

(*d*) Diameter and stroke of plungers and rods
(*e*) Diameter of steam cylinders and piston rods
(*f*) Stroke of the steam pistons
(*g*) Speed, in revolutions
(*h*) Indicated horsepower of steam and water cylinders
(*i*) Steam pressure at throttle in pounds per square inch above atmosphere
(*j*) Atmospheric pressure in inches of mercury
(*k*) Quality of the steam (moisture or superheat at the throttle)
(*l*) Exhaust pressure in pounds per square inch above zero, or vacuum in inches of mercury
(*m*) Receiver pressures in pounds per square inch
(*n*) Temperature of the exhaust steam.

Instruments and Apparatus

4 The instruments and apparatus required for a performance test of a reciprocating displacement pump are:

(*a*) Tanks and platform, scales for weighing the quantities of condensed steam, leakage water or boiler feedwater in accordance with the object of the test and local conditions
(*b*) Graduated scales attached to the water glasses of the boiler, if the feedwater is measured; the elevation of zero mark of the graduations being fixed and recorded with reference to some part of the gage-glass fitting which will not be moved or altered by the destruction and renewal of the glass
(*c*) Pressure gages, vacuum gages and thermometers provided with suitable mercury wells
(*d*) Steam calorimeters
(*e*) Barometer
(*f*) Revolution counter or other accurate speed-measuring device
(*g*) A venturi meter or other means for measuring the quantity of water pumped
(*h*) Graduated stroke scales for direct-acting pumps
(*i*) Indicators for the steam and water cylinders
(*j*) A planimeter
(*k*) A dead-weight gage tester.

Directions regarding the application, use, and calibration of the instruments and apparatus noted and statements as to their accuracy are given in Paragraphs Nos. .... of the "Code on Instruments and Apparatus."

The gage on the discharge main should be attached near the pump discharge nozzle, and that on the suction main near the suction nozzle. The gage pipes should be provided with valves at the gages and pet-cock outlets on the pump side of their valves. The pet cocks should be occasionally opened to let out the air, if any, and fill the pipes with water when under pressure, or let in the air and empty them of water, if any, when under vacuum.

Preparations

5 Paragraphs 1 to 19 of the General Instructions should first be carefully studied. The dimensions of the pumps should next be determined and recorded, especially those of the plungers and rods. Note should also be taken of the physical conditions not only of the pumping machinery but of all parts of the plant concerned. The testing appliances may then be installed and the leakage tests conducted.

5a *Dimensions.* The dimensions of steam and water cylinders should be determined by methods described in the "Test Code for Reciprocating Steam Engines," Par. 5a.

5b *Leakage of Engine.* The amount of leakage of the engine should be determined by weighing. There may be leakage through valves, past the piston or in the condenser. For approved methods of determining the amount of this leakage see Pars. Nos. ......of the "Code on Instruments and Apparatus."

5c *Leakage Test of Pump.* The tightness of the suction and discharge valves and the plunger packing, if it is of the inside-packed construction, should be ascertained by putting the specified discharge pressure on them and observing the leakage by removing a handhole or manhole cover on the suction side of the part being tested. If consistent with object in view, the valves should be made tight and the plunger packing should leak only enough to insure that the friction of the packing on the plunger is not excessive. The leakage past the valves and plungers should be measured by conducting the leakage water to weighing tanks or other measuring devices, such as a weir or orifice, which are suitable for the quantity to be measured, and the rate of leakage past each valve deck and plunger determined. In correcting the plunger displacement for the leakage thus found it should be remembered that each valve deck and single-acting plunger leaks during only one-half the period of the test. In the case of a direct-acting steam pump the rate of leakage can be determined by closing the main discharge valve, which must be proved to be tight, making certain that the plunger chamber and suction connections are filled with water and running the pump fast enough to keep the discharge-pressure at the normal test pressure. The rate of leakage as determined by this test may be deducted from the duty-test rate in computing the net quantity of water pumped.

6 *Water Rate.* The water rate or steam consumption of the engine should be determined by measuring the condensate from the surface condenser, if that type of condenser is in use, all the steam used by the engine and auxiliaries concerned passing into the condenser. If the condenser leaks, the defects causing such leakage should be remedied, or suitable leakage corrections should be made. The amount of condensation from jackets and reheaters as well as the steam used by the auxiliaries concerned, if not included in the condensate measurement, should be added thereto. If a surface condenser is not available, the steam consumption should be determined by feedwater tests, which require the measurement of the various supplies of water fed to the boiler. The water from separators and drips on the main steam line, the steam used for other equipment not a part of the engine under tests, and of the water and steam which escapes by leakage from the boiler

---

[1] Deceased.

and piping, must also be measured, and these quantities deducted from the total quantity of feedwater.

7 *Measurement of Water Pumped.* The quantity of water pumped should be determined by actual measurement, using a venturi meter, weir, orifice, or pitot tube, in accordance with the directions of the "Code on Instruments and Apparatus." This measurement should be checked by comparison with plunger displacement, corrected for plunger and valve leakage, the latter being determined as directed in Par. 5c. When the actual measurement cannot be obtained the plunger displacement method alone may be used. In direct-acting pumps the actual stroke of each plunger must be determined by the use of graduated stroke scales.

Operating Conditions

8 The operating conditions should conform to the object of the test and these should prevail throughout the trial, as pointed out in Par. 19 of the "General Instructions." Care should be taken that air is not snifted into the pump cylinders. In such cases where air enters in sufficient quantity to be revealed by the indicator diagrams from the pump cylinders or other means, the quantity of water determined by the plunger-displacement method must be corrected accordingly. If an air pump is used to remove air which enters the suction pipe in the supply system of the pumping engine, such a pump is not to be considered a part of the engine equipment so far as it concerns the test.

Starting and Stopping

9 The engine and appurtenances should be first thoroughly heated and run under the prescribed conditions until uniformity is secured. When surface-condenser measurement is used, a test for steam or heat consumption with substantially constant load should be continued for such time as may be necessary to obtain a number (not less than four) of successive hourly records, during which the results are reasonably uniform. Where the steam consumption is determined by measuring the feedwater to the boiler, the duration should be at least 5 hours, and preferably 10 hours.

9a When a surface condenser is used, the test should start by commencing to weigh or measure the condensate and any other quantities of steam consumption involved, at the same time beginning the regular observations and other necessary test work. At the end of the allotted time the test is stopped by discontinuing the measurements and observations. When feedwater measurements are employed, the test should be started by carefully observing the steam pressure and water level in the boiler, and the level in the feed tank, if measuring tanks are used, at the same time beginning the water measurements and taking up the regular work of the test. At the end of the prescribed time, the water levels and steam pressure should be brought as near as practicable to the same points as at the start, and the observations discontinued. If there are differences in the water levels or pressure, proper corrections must be applied to the water measurements.

9b When feedwater measurements are employed care should be taken in cases where the activity of combustion affects the height of water, that the same conditions of fire and draft are secured at the end as at the beginning. Care should also be observed to note the average height of water in the glass when the water line fluctuates.

Records

10 The general data should be recorded as pointed out in Pars. 20 to 30 of the "General Instructions." Instruments should be read and indicator cards taken from each end of each cylinder at least quarter-hourly when the conditions are uniform and oftener when there is much variation. By permitting the pencil to trace over the diagrams several times a pencil band will result, thus giving a better average than a single line for power measurement. If there are wide fluctuations in readings they should be shown by recording instruments. Each indicator card should be marked with the number, date, time, scale of spring and end of cylinder, and on one card of each set the readings of the steam gages should be recorded. The log should contain the record of the readings of steam and vacuum gages, thermometers, calorimeters, speed indicator, load-measuring devices, and all other instruments, and these readings should be obtained at practically the same time the indicator diagrams are made. The areas, length, mean effective pressures, and cut-offs shown by the indicator diagrams, should also be entered in the log. If complete test data are desired representative steam-pipe diagrams should be taken with an indicator applied near the throttle-valve gage and operated by connection to the reducing motion of the cylinder indicators.

10a A set of specimen indicator cards should be carefully selected from the whole number taken, and these should be embodied in the record. The specimen cards selected should be such as to show the average conditions of pressure and cut-off. If steam-pipe diagrams are obtained, specimens of these should also be placed in the record.

11 *Throttle Pressure.* The throttle pressure, or the average pressure in the steam pipe just before the throttle, is that shown by a corrected steam gage attached to the steam pipe $1^1/_2$ to 2 diameters from the throttle. Fluctuations in this pressure may be reduced by a moderate choking of the gage cock. When greater precision is desired or when the fluctuations in pressure are large the average pressure may be found by working up the steam-pipe indicator diagram taken at or near the same point, and finding the mean pressure for the entire stroke, during the periods of admission.

11a If the guarantee contract states that a certain steam pressure is to be maintained at the throttle, then the low part of the line should be used in determining the steam pressure.

Calculation of Results

12 *Water Rate.* Whether the engine is supplied with wet, dry and saturated, or superheated steam, the actual steam consumption is stated in the report of the test. When the engine is supplied with wet steam, the quantity of dry and saturated steam comprised in the wet steam is found by deducting from the total weight of steam as measured the moisture as shown by a calorimeter near the throttle. Superheated steam requires no correction. The "estimated steam" consumed corresponding to any desired or specified set of conditions as to moisture, superheat, pressure, and vacuum which differ from the conditions of the test—such, for example, as those required by a contract guarantee or acceptance test—should be determined in the manner previously agreed upon by the interested parties in accordance with Par. 3 of the "General Instructions." (See also Code on Definitions and Values, Par. 152, and Test Code for Steam Turbines.)

12a In view of the fact that "dry saturated steam" is practically unobtainable commercially and that the presence of moisture is detrimental to the economy of the engine to a greater degree than the amount present in the steam would indicate, arbitrary corrections (referred to in Par. 11 above) for correcting the actual water rate for quality are to be used in arriving at a value of "Estimated Steam."

13 *Heat Consumption.* The number of heat units consumed by an engine per hour is found by multiplying the consumption, as measured in pounds of steam per hour, by the difference between the total heat in one pound of steam at the average pressure and of the average quality found in the steam pipe near the throttle and the heat in one pound of water at the temperature of saturated steam at the average pressure existing in the exhaust pipe near the cylinder.

14 *Indicated Horsepower.* The indicated horsepower for *each end* of the cylinder is found by using the formula

$$\text{I.hp.} = \frac{PLAN}{33{,}000}$$

where P represents the mean effective pressure in pounds per square inch, L the length of the stroke in feet, A the area in square inches of the piston less the area of the piston rod, if any, and N the number of active strokes per minute. The total horsepower of a cylinder is the sum of the horsepower developed in the two ends.

14a The mean effective pressure should be found by dividing the area of the diagram in square inches as determined with a correct planimeter, by the length of the diagram in inches, and multiplying the quotient by the average corrected scale of the indicator spring. (The length of an indicator diagram is the distance between two perpendiculars to the atmospheric line drawn at the extremities of the diagram.) If a planimeter is not available, the approximate mean effective pressure may be determined by finding the average height of the diagram in inches as obtained by averaging a suitable number of ordinates, at least twenty, measured between the lines of the forward and return strokes, and then multiplying this average by the scale of the spring.

15 *Thermal Efficiency.* The proportion of the total heat consumption which is converted into work is called the "thermal efficiency," and is found by dividing 2545 (B.t.u. equivalent to 1 hp-hr.) by the number of heat units actually consumed per hp-hr. (Par. 13). The quotient is multiplied by 100 to express the thermal efficiency in per cent. The formula is:

$$\text{Thermal Efficiency} = \frac{2545}{w\,(H_1 - q_2)}$$

where w = pounds of steam as supplied per i.hp-hr.
H_1 = total heat above 32 deg. per pound of steam at the initial conditions prevailing before throttle valve.
q_2 = heat of liquid above 32 deg. in one pound of water at the temperature of saturated steam at exhaust pressure.

16 *Engine Efficiency.* The engine efficiency is the ratio obtained by dividing the heat equivalent of the actual work done by the heat available for an ideal engine. The accepted standard for the ideal steam engine is the Rankine cycle (Code on Definitions and Values, Par. 145). The engine efficiency is obtained by the following equation:

$$\text{Engine Efficiency (referred to i.hp.)} = \frac{2545}{w\,(H_1 - H_2)}$$

where w = pounds of steam as supplied per i.hp-hr.
H_1 = total heat above 32 deg. per pound of steam at the initial conditions prevailing before the throttle valve
H_2 = total heat above 32 deg. per pound of steam after adiabatic expansion from initial conditions to the final pressure.

H_1 and H_2 can be found from any Total Heat-Entropy diagram. $(H_1 - H_2)$ is the heat available for work per pound of steam.

17 *Head.* The head is determined from two elements, viz., the "discharge pressure," which is the pressure in the discharge main referred to the center line of the pump cylinders (or other datum line as may be determined on), and the "suction lift" or "suction pressure," which is the vaccum or pressure in the suction main referred to the same datum. When the suction main is under a vacuum the head is found by adding the "suction lift" to the "discharge pressure," both expressed in feet. When the suction main is under pressure the head is found by subtracting the "suction pressure" from the "discharge pressure," both expressed in feet.

17a *Discharge Pressure.* The discharge pressure is found by adding to the pressure in feet shown by the gage connected to the discharge main the vertical distance in feet between the center of the gage (if of the Bourdon spring type) or the lower surface of the mercury (if of the mercury type) above the center line of the pump cylinders (or other datum determined on). Should the gage be located below the datum line this distance is to be subtracted instead of added.

17b *Suction Lift.* The suction lift is found by adding to the pressure in feet shown by the vacuum gage connected to the suction main the vertical distance in feet between the datum line noted and the point where the gage pipe connects to the main. Should the vacuum gage be located above the datum line, this distance is to be subtracted instead of added.

17c *Suction Pressure.* The suction pressure, which obtains in cases where the suction pipe is under pressure, is found by subtracting the vertical distance in feet between the datum line and the center of the gage on the suction main (if of the Bourdon spring type) or the lower surface of the mercury (if of the mercury type) from the pressure in feet shown by the suction gage.

17d *Velocity head* If there is a material difference in the velocities at the discharge and suction gage connections to the mains, the head should be corrected for the difference in the velocity heads in the two mains.

If there is a material difference in the velocities at the discharge and suction gage connections to the mains, the head should be corrected for the difference in the velocity heads in the two mains.

18 *Leakage of Pump.* The percentage of leakage in a reciprocating pump is found by dividing the quantity of leakage during the test, as computed from the rate of leakage determined on the leakage trial, by the plunger displacement during the test, and multiplying the quotient by 100.

19 *Capacity.* In cases where the water discharged is not otherwise measured, the capacity in gallons per 24 hours is found by multiplying the net area in square feet of all the plungers by the length of the stroke in feet, the number of discharge strokes per minute, the constant 1440 and the constant 7.48, and deducting the total pump leakage in gallons per 24 hours.

20 *Water Horsepower.* The water horsepower is found by multiplying the weight of water discharged, in pounds per hour, by the head, in feet, and dividing the product by 1,980,000.

21 *Duty per 1000 Lb. of Steam.* The duty in foot-pounds of work done per 1000 pounds of steam is found by multiplying the number of pounds of water discharged by the pump during the test, by the head in feet, dividing the product by the number of pounds of steam consumed during the test, and multiplying the quotient by 1000.

22 *Duty per 1,000,000 B.t.u.* The duty in foot-pounds of work done per 1,000,000 B.t.u. is found by multiplying the number of pounds of water discharged by the pump during the test by the head in feet, dividing the product by the number of B.t.u. consumed, and multiplying the quotient by 1,000,000.

23 *Friction and Mechanical Efficiencies.* The *percentage of total friction* is found by subtracting from the average i.hp. of the steam engine the average water horsepower (Par. 20) and dividing the remainder by 100 times the engine i.hp. The *combined mechanical efficiency* of the entire engine is found by dividing the water horsepower (Par. 20) by the engine i.hp. and multiplying the quotient by 100. The *mechanical efficiency of engine and pump* is found by dividing the average pump i.hp. by the average engine i.hp. and multiplying the quotient by 100. The *hydraulic efficiency of the pump* is found by dividing the average water horsepower (Par. 20) by the average pump i.hp. and multiplying the quotient by 100.

24 *Correction Factors for Duty and Economy.* The correction factors to be applied when the conditions as to pressure, quality of steam, or vacuum differ from those desired or required, should be based so far as practicable on data determined from the engine itself. For example, the effect of a variation of pressure from that desired may be determined by making two additional tests at pressures 5 lb. and 10 lb., respectively, below that of the main test, plotting the results, and obtaining a curve of performance, on the basis of which the correction may be applied.

On tests conducted to determine if economy (heat and steam consumption) guarantees have been met, it is often necessary, and on tests for other purposes it is frequently desired, to estimate the performance of the steam end under conditions of steam pressure, quality (moisture or superheat) and vacuum different from those prevailing and obtainable during the tests. It is not feasible to give correction factors for a variation of conditions, but for steam pressure and vacuum (or back pressure) which can be readily varied over a considerable range, any necessary correction factor can be approximated closely by running a series of preliminary tests covering a range of pressures and plotting the computed economies as a function of the variable factor.

A variation of superheat in a plant is not ordinarily so readily effected, but by manipulating the rate at which the boilers are fired, a series of variable superheat tests can often be obtained and a correction factor experimentally determined. It is not considered practicable in test work not conducted for research purposes to determine the effect of moisture in the steam on the economy of the engine, but because of the fact that it is believed that moisture in the steam is more unfavorable to the economy than is indicated by the percentage of moisture present, it is important that any correction for moisture should cover but very minor variations in the quality. Further, since the first ten degrees of superheat affect the economy more favorably than the second ten degrees, etc., it is imperative that the use of correction factors for differences in quality (moisture or superheat) when the steam is near the saturation point should not be based on data that do not apply to the engine and the condition of the test.

If the tests are in connection with contract guarantees, all parties concerned should agree on the corrections prior to the final tests. In all cases the report, text and tabulation or summary should plainly state (first) the actual test results and (second) the estimated corrected result and, so far as possible, the corrections should be applied to the final computed test results and not to any of the component measurements, such as the total weight of steam per hour, etc.

Data and Results

25 The data and results of the tests should be reported in accordance with the form (Table 1) given herewith, adding lines for data not provided for or omitting those not required. Unless otherwise indicated, the items should be the averages of all observations.

TABLE 1 DATA AND RESULTS OF RECIPROCATING DISPLACEMENT STEAM-PUMP TEST

A.S.M.E. Code of 1922

General Information

(1) Date of test..........
(2) Location..........
(3) Owner..........
(4) Builder..........
(5) Test conducted by..........
(6) Object of test..........

Description, Dimensions, Etc.

(7) Type of unit..........
(8) Number of steam cylinders..........
(9) Diameter of steam cylinders: hp......in.; i.p.....in.; l.p.....in.
(10) Stroke of steam end..........
(11) Number of plungers..........
(12) Single or double-acting..........
(13) Diameter of plungers..........in.
(14) Stroke of plungers..........in.

(15) Type of condenser..........
(16) Cooling surface in condenser..........sq. ft.
(17) Type and size of condenser pumps..........
(18) Type and size of any exhaust or receiver feed-water heaters, steam reheaters, and jacket pumps or other auxiliaries a part of the unit..........
(19) Vertical distance of gage on discharge main above or below datum line of pump cylinders..........ft.
(20) Vertical distance of gage on suction main below or above datum line of pump cylinders..........ft.

Test Data and Results

(21) Duration of test..........hr.

Average Pressures:

(22) Barometric pressure   in. of mercury..........lb. per sq. in.
  (a) Corresponding absolute pressure..........lb. per sq. in.
(23) Pressure in steam pipe near throttle by gage..........lb. per sq. in.
(24) Pressure in 1st receiver by gage..........lb. per sq. in.
(25) Pressure in 2nd receiver by gage..........lb. per sq. in.
(26) Vacuum in exhaust pipe near engine by gage..........in. of mercury
  (a) Corresponding absolute pressure..........lb. per sq. in.
(27) Pressure in jackets and reheater by gage..........lb. per sq. in.

Temperatures:

(28) Temperature of external air..........deg. fahr.
(29) Temperature of engine room..........deg. fahr.
(30) Temperature of steam near throttle, if superheated..........deg. fahr.
(31) Temperature of saturated steam at throttle pressure..........deg. fahr.
(32) Temperature of saturated steam corresponding to pressure in exhaust pipe engine..........deg. fahr.
(33) Temperature of steam in exhaust pipe as observed..........deg. fahr.
(34) Temperature of condensate leaving jackets and reheaters..........deg. fahr.
(35) Temperature of condensate leaving feedwater heaters..........deg. fahr.
(36) Temperature of condensate leaving surface condenser..........deg. fahr.
(37) Temperature of water in discharge main of pump..........deg. fahr.

Water Pressures and Head:

(38) Pressure shown by gage on discharge main..........lb.
(39) Vacuum or pressure shown by gage on suction main..........in. of mercury or lb.
(40) Discharge pressure referred to datum line..........ft.
(41) Suction lift or suction pressure referred to datum line..........ft.
(42) Head, expressed in feet..........ft.
(43) Head, expressed in lb...........lb.

Quality of Steam near Throttle:

(44) Number of degrees of superheat, if any..........deg. fahr.
(45) Percentage of moisture in steam..........per cent

Total Steam Quantities:

(46) Total steam consumed by engine as measured..........lb.
(47) Total dry and saturated steam or superheated steam consumed (Par. 12)..........lb.
(48) Total condensate from surface condenser..........lb.
(49) Total consumption of feedwater..........lb.
(50) Total condensate from jackets and reheaters..........lb.
(51) Correction factor conforming to conditions agreed upon (See Pars. 12 and 12a)..........
(52) Equivalent total steam consumed conforming to conditions agreed upon (Items 46 × Item 51)..........lb.

Total Pump Quantities:

(53) Total quantity of water pumped, in gallons..........gal.
(54) Total quantity of water pumped, in pounds..........lb.
(55) Total plunger displacement in gallons..........gal.

Hourly Steam Quantities:

(56) Steam consumed per hour, as measured (Item 46 ÷ Item 21)..........lb.
(57) Dry and saturated steam consumed per hour (Item 47 ÷ Item 21)..........lb.
(58) Equivalent steam consumed, conforming to conditions agreed upon (Item 52 ÷ Item 21)..........lb.

Hourly Pump Quantities:

(59) Quantity of water pumped per hour..........lb.
(60) Leakage of plunger and pump values per hr..........lb.
(61) Plunger displacement per hour..........lb.
(62) "Slip," in percentage of plunger displacement (Item 61 — Item 59) ÷ (Item 59 × 100)..........per cent

Heat Consumption:

(63) Total heat above water at 32 deg. fahr. per lb. of steam at throttle..........B.t.u.
  (a) Heat of liquid at temperature of steam at exhaust pressure..........B.t.u.
  (b) Heat supplied per pound of steam..........B.t.u.
(64) Heat consumed per hour (See Par. 13)..........B.t.u
(65) Heat available for work per lb. of steam, from adiabatic expansion between initial conditions and final pressure according to Rankine cycle (See Par. 16)..........B.t.u.

1st 2d 3d
Cyl. Cyl. Cyl

Indicator Diagrams:

(66) Nominal cut-off..........per cent
(67) Mean effective pressure, engine..........lb. per sq. in.
(68) Mean effective pressure, pump..........lb. per sq. in.
(69) Maximum pressure above atmosphere..........lb. per sq. in.
(70) Absolute back pressure at lowest point..........lb. per sq. in.

Speed:

(71) Total number of revolutions..........
(72) Total number of single strokes..........
(73) Average length of stroke, if direct-acting..........ft.
(74) Revolutions per minute..........r.p.m.
(75) Single strokes per minute..........str.p.m.
(76) Piston and plunger speed..........ft. per min.

Power:

(77) Indicated horsepower developed by whole engine..........i.hp.
(78) 1st cylinder, crank end..........i.hp.
  head end..........i.hp.
(79) 2d cylinder, crank end..........i.hp.
  head end..........i.hp.
(80) 3d cylinder, crank end..........i.hp.
  head end..........i.hp.
(81) Indicated horsepower developed by pumps..........i.hp.
(82) Water horsepower (Item 59 × Item 42) ÷ 1,980,000..........hp.

Economy Results:

(83) Steam consumed per i.hp-hr. as measured (Item 56 ÷ Item 77)..........lb.
(84) Dry saturated or superheated steam consumed per i.hp-hr. (Item 57 ÷ Item 77)..........lb.
(85) Estimated steam consumed per i.hp-hr. conforming to conditions agreed upon (Item 58 ÷ Item 77)..........lb.
(86) Heat consumed per i.hp-hr. (Item 64 ÷ Item 77)..........B.t.u.
(87) Heat available according to Rankine cycle per i.hp-hr. (Item 65 × Item 66)..........B.t.u.

Efficiency Results:

(88) Thermal efficiency referred to i.hp. (2545 ÷ Item 86) × 100..........per cent
(89) Engine efficiency (referred to Rankine cycle) based on i.hp. (2545 ÷ Item 87) × 100..........per cent
(90) Hydraulic efficiency of pumps (Item 81 × 100) ÷ Item 81..........per cent
(91) Mechanical efficiency of engine and pump cylinders (Item 81 × 100) ÷ Item 77..........per cent
(92) Combined mechanical efficiency of entire engine and pump (Item 82 × 100) ÷ Item 77..........per cent

Duty:

(93) Duty per 1000 lb. of net steam, as measured (Item 54 × Item 42 × 1000) ÷ (Item 46)..........ft-lb.
(94) Duty per 1,000,000 B.t.u. (Item 54 × Item 42 × 1,000,000) ÷ Item 63..........ft-lb.

Specimen Indicator Diagrams:

(95) Specimen diagrams from each steam cylinder and each pump cylinder..........

Revised Economy and Duty after Applying Correction Factors for Variations from Contract Conditions

26 The revised economy and duty [items (83)–(87), (93) and (94), Table 1] obtained after applying the correction factors, as described in the text, for the variations of the test conditions from the contract conditions should be tabulated here. The correction factors shall be stated in percentages, and the basis and method of determining them described.

Duty Trials and Tests of Reciprocating Displacement Pumps Driven by Prime Movers Other Than Reciprocating Steam Engines

27 The rules given previously, governing the pumps, all apply to reciprocating pumps regardless of the type of driving apparatus.

28 For rules governing the driving machine, see code which applies to such machine (as an oil engine, gas engine, water wheel, etc.)

29 In cases in which the pump is driven by an electric motor, the characteristics and efficiency of the motor and the power input to the motor should be obtained and used in accordance with the rules of the American Institute of Electrical Engineers.

30 The form of the tabulation of the test results will be dependent on the object of the test and will, in general, be a combination of the parts of Table 1 which refer to the pump and the form recommended in the code applying to the driving machine.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Fire Prevention A3-22. Fire and Explosion Hazards of Petroleums and Petroleum Products. A report of an investigation on this subject made by Messrs. S. H. Katz and N. A. C. Smith for the Bureau of Mines was recently issued as Serial No. 2400.

The report discusses in order, Fire Hazards in Oil Refineries, Fire Hazards Associated with Petroleum Products, Flammability of Petroleum and its Products, Vapor Pressure and Volatility, Vapor Pressure, Volatility, Flash Point, Fire Points, Explosive Limits, and Ignition Temperatures. Address H. Foster Bain, Director of the Bureau of Mines, Department of the Interior, Washington, D. C.

Forest Products A2-22. Experimental Work on the Development of a Theory of the Protection of Wood by Preservatives. Practical methods of preserving wood against the attack of low forms of life require the injection of some material which inhibits the attacking organism. A working hypothesis states that wood preservative must possess sufficient solubility in water to produce a solution of lethal concentration.

Presented at the American Chemical Society Meeting held at Pittsburgh, Pa., September 4 to 9. Address Charles L. Parsons, Secretary of the American Chemical Society, 1709 G Street, N. W., Washington, D. C.

Fuels A13-22. Fusibility of Coal Ash. Data regarding the softening temperatures of coal ash from several hundred coals from the different fields of the country are contained in the Bureau of Mines Bulletin No. 209, Fusibility of Ash from Coals of the United States, by W. A. Selvig, assistant analytical chemist, and A. C. Fieldner, supervising chemist.

The Bureau of Mines has made a general survey of the "fusing" or "softening" temperatures of the ash from coals of the United States. This information, when used together with the large number of coal analyses published by the Bureau, will assist the consumer of coal in comparing different coals, and in selecting the coal best adapted for his purpose.

Coal ash is the incombustible residue remaining after the complete combustion of coal; it is derived from the inorganic mineral co nstituents of the coal. The ash-forming constituents are (1) inherent or intrinsic impurities that are present in an intimate mixture with the coal substance, and are derived either from the original material or from external sources such as sedimentation and precipitation while the coal-forming plant remains accumulated; (2) impurities, formed either during the laying down of the coal bed or subsequently, that occur in the form of partings, veins, and nodules of clay, shale, "slate," pyrite, and calcite; and (3) impurities that become intimately mixed with the coal in the process of mining, such as fragments of roof and floor. Coal ash is composed largely of compounds of silica, alumina, lime, and iron, with smaller quantities of magnesia, titanium, and alkali compounds. Bulletin 209 may be obtained by addressing the Bureau of Mines, Washington, D. C.

Fuel Utilization A1-22. Fusibility of Coal Ash. See *Fuels A13-22.*

Heat A4-22. Color Temperature of Artificial Light Sources. See *Illumination A1-22.*

Illumination A1-22. Color Temperature of Artificial Light Sources. Bureau of Standards Scientific Paper No. 443, dealing with the measurement of the color temperature of the more efficient artificial-light sources, describes a new method for measuring color temperatures between 3000 and 4000 deg. abs. cent. Data are presented on the color temperature of the gas-filled tungsten lamp and carbon arc. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.

Temperature Measurements A1-22. Color Temperature of Artificial Light Sources. See *Illumination A1-22.*

Water, Sewage and Sanitation A1-22. Plumbing Systems in Dwellings. A tentative report on residence plumbing has been prepared by the sub-committee on plumbing of the Department of Commerce's Building Code Committee. This report presents recommendations for design of plumbing systems in one and two-family dwellings, and outlines the principles which it is believed should govern the public control of such work through plumbing codes and inspection. These recommendations are based on extensive series of experiments with plumbing equipment conducted at the Bureau of Standards under the direction of the sub-committee; also on investigations of practice and opinion in all parts of the country. This report is being sent out in limited numbers for comment and criticism, and the revised report published later for distribution.

Detailed rules for plumbing practice are now being prepared, and will be given in a subsequent report. The experimental work is being continued and demonstration equipment, open to public inspection, will soon be installed. Address Dr. S. W. Stratton, Director of the Bureau of Standards, Washington, D. C.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work, and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Ceramics and Glass B1-22. Economies in Brick-Kiln Operation. Under the supervision of R. T. Stull, supervising ceramist, and in coöperation with the American Face Brick Association, the National Paving Brick Manufacturers' Association, the Common Brick Manufacturers' Association, and the Hollow Building Tile Association, investigations are being continued by the United States Bureau of Mines at various commercial plants on industrial kilns burning heavy clay products, with the object of reducing fuel consumption, shortening the time of burning, and at the same time improving the quality of the product. In several cases results have shown the possibility of saving one-third of the fuel, and cutting down the burning time of the kiln by one-third, with a resulting saving in cost.

Some of the problems attacked by Mr. Stull are: cause and prevention of red core in brick; cause and effect of so-called "blue-smoke;" removal of sulphur fumes from kiln gases in order that they may be used in dryers; cause of slabbing or popping in clays high in siderite; cause of kiln glazing on shale brick (pavers) when certain coals are used; relation between porosity and rattler tests and effect of lamination of both; why some clays swell long before zero porosity is obtained; and cause of bloating of enamel ware. Considerable light has been thrown on the first four problems by work in connection with the oxidation of the incidental minerals found in clays.

Address H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

Clay Products B1-22. Economies in Brick-Kiln Operation. See *Ceramics and Glass B1-22.*

Corrosion B6-22. Corrosion of Chromium Steels. By means of apparatus designed at the Bureau of Standards and which is now being tried out, it will be possible to regulate the corrosion tests which are being conducted on various metals more closely than is possible by simple immersion in acids, which is the usual method employed in a test of this kind. The apparatus is designed to raise and lower the specimens so that they will be subjected to alternate attacks of the acid or other corroding liquid and the oxidizing action of the atmosphere.

Corrosion B7-22. Experiments on Soil and Stray-Current Corrosion. See *Electrolysis B2-22.*

Electrolysis B2-22. Experiments on Soil and Stray-Current Corrosion. During the first half of the month the work of burying specimens of pipe in connection with the Bureau of Standards' soil-corrosion investigation was completed in the territory west of the Mississippi River, and definite arrangements have been made for burying the last group of pipes in the states bordering the Great Lakes. Attention has been directed to starting chemical investigations that have a bearing on the soil-corrosion research, on the study of the effect of lime on both soil corrosion and stray-current electrolysis, on the possibilities of cathodic protection against both stray-current electrolysis and soil corrosion.

Investigations have also been started in an attempt to throw light on the relation between the corrosion of iron and the physical structure of the metal.

Ferrous Alloys B1-22. Molybdenum Steel. The work on molybdenum as an alloying element in steel, conducted at the Ithaca, N. Y., field office of the United States Bureau of Mines, in coöperation with the Vanadium Corporation of America, will be continued in the present fiscal year as a Bureau of Mines problem. The object of this work is to add to the technical information on the value of molybdenum. One of the few elements entering into true alloy steels of which the United States possesses an abundance of high-grade ore, readily mined and handled. Though there are limitations to its use, it is plainly of great value in steel that is to be heat-treated to produce superior qualities.

Molybdenum is slowly taking rank along with nickel, chromium, and vanadium as alloying elements for high-grade steel.

Besides the more common physical tests, single-blow impact and repeated-impact tests have been made by the Bureau of Mines on the molybdenum and on comparison alloy steels in coöperation with the Wyman-Gordon Company.

Chief attention has been given to endurance tests. This work has been expedited by conclusions drawn from the recently reported work on endurance testing at the University of Illinois and at the Naval Experiment Station. The making of the steels and the heat treatment and preparation of test bars have been completed. Actual endurance testing remains to be done before complete conclusions can be drawn.

Further study is also to be made on the relationship of the "rise of temperature" method of endurance testing, and the regular method of actually testing the steels to destruction by long-time tests. Address H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

Fuels B3-22. CARBONIZED LIGNITE FUEL. In the course of the lignite investigations being conducted by W. W. Odell, fuel engineer, of the Bureau of Mines, in coöperation with the University of North Dakota, two carloads of lignite were recently carbonized at the rate of 10 tons per day. A satisfactory residue was obtained at an approximate cost of $5.50 per ton, as against a cost of approximately $6.25 a ton for the residue produced in the oven used during the experiments conducted during the summer of 1921.

Address H. Foster Bain, Director of the Bureau of Mines, Washington, D. C.

Fuels B4-22. SCREEN SIZING OF COAL AND MINERALS. See *Mining, General B1-22.*

Iron and Steel B5-22. MOLYBDENUM STEEL. See *Ferrous Alloys B1-22.*

Iron and Steel B6-22. USE OF OXYGEN IN METALLURGICAL OPERATIONS. Use of oxygen in connection with the enrichment of the blast in the blast furnace and in practically all phases of pyrometallurgical work will increase, according to Dr. F. G. Cottrell, the efficiency of metallurgical operation with a resultant production of metals at lower cost and possibly the use of lower-grade ores.

The Bureau of Mines now has outlined plans for two studies which will be carried on simultaneously. The first will cover the present-day processes for the production of oxygen, in order to determine the feasibility of attempting to produce oxygen, or oxygenated air, in such amounts and at such a cost as to permit of its use in metallurgical operations. The second study will be devoted to the feasibility of using oxygen, or oxygenated air, in metallurgical operations.

Iron and Steel B7-22. SYNTHETIC CAST IRON. As is well known, pig iron is not produced on the Pacific Coast at the present time in sufficient quantities to meet the demand for iron of such grades as are required for foundry purposes. Foundry iron is costly, due to high freight rates on eastern iron that is brought in and to the high cost of coke suitable for use in the cupola. On the other hand, considerable steel scrap is to be had, and attention has been recently given by the members of the Electrometallurgical Section of the Northwest Station of the Bureau of Mines at Seattle to the problem of producing cast iron by melting scrap steel in the electric furnace. These conditions were established by numerous experiments conducted in a laboratory furnace holding 300 lb. of metal.

Address H. Foster Bain, Director of the Bureau of Mines, Washington, D. C.

Iron and Steel B8-22. EFFECT OF MANGANESE ON THE STRUCTURE OF STEEL. The effect of manganese on the structure of iron-carbon alloys in the annealed and the normalized conditions has been determined. This study forms part of the general investigation of iron alloys which is now in progress, and the results will be published as soon as possible by the Bureau of Standards.

Metal Manufactures, Miscellaneous B2-22. CAUSE OF SPECKING OF GROUND COAT ENAMELS. Some preliminary tests have been conducted by the Bureau of Standards in a study of the causes of specking of ground-coat enamels. This specking appears as spots of oxide and slag in the enamel coating, a condition which appears to be due to excessive local rusting of the steel previous to the firing of the enamel.

Preliminary tests have been made on steel cups furnished by a manufacturer of such articles and coated with regular stock enamels. The results of the test indicate that the rusting and subsequent specking are due to an excess of acid or salts in the enamel. The defect has been remedied by the addition of sufficient sodium hydroxide to the enamel previous to the dipping operation. Since this defect is a serious one in the production of white enamel ware, it will probably be advisable to continue this investigation in order to go into the subject more thoroughly.

Metallurgy and Metallography B2-22. USE OF OXYGEN IN METALLURGICAL OPERATIONS. See *Iron and Steel B6-22.*

Mining, General B1-22. SCREEN SIZING OF COAL AND MINERALS. A study is being made by the Bureau of Mines at Urbana, Ill., of the equipment and methods used in screen sizing of coal and coke, metalliferous ores, stone gravel, and various mineral products.

Non-Ferrous Metals B3-22. HEAT TREATMENT OF NON-FERROUS ALLOYS. At the Pittsburgh, Pa., experiment station of the Bureau of Mines heat-treatment experiments, including quenching and annealing, have been conducted on a number of cast non-ferrous alloys including the following. 88 : 10 : 2 Cu-Sn-Zn; 85 : 5 : 5 Cu-Sn-Zn-Pb; 85 : 4 : 5 : 6 Cu-Sn-Zn-Pb; 90 : 10 Cu-Sn; 90 : 6 : 3 : 1 Cu-Sn-Zn-Pb; 85 : 15 Cu-Sn; 86 : 4 : 6 : 3 : 1 Cu-Ni-Sn-Zn-Pb; and 89.9 : 10 : 0.1 Cu-Sn-P. The results are being summarized.

Address Prof. M. D. Hersey, Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa.

Ventilation B2-22. PHYSIOLOGICAL EFFECTS OF HIGH TEMPERATURES AND HUMIDITIES. The Bureau of Mines, in coöperation with the United States Public Health Service and the Society of Heating and Ventilating Engineers, is engaged in a study of the relative importance and correct correlation of the many individual factors concerned in the problem of the physiological effects of different conditions of temperature, humidity, and air motion.

INFLUENCE OF DESIGN ON COST OF OPERATING AIRPLANES

(Continued from page 825)

COMPARISON WITH RAILROAD COST

A detailed and comprehensive comparison of airplane cost with railroad rates is not within the scope of this paper. However, one example is cited to emphasize the importance of the foregoing figures and to correct the impression that air transport is enormously expensive. The distance from New York to Chicago, as previously stated, is 908 miles on the Pennsylvania Railroad or about 700 miles in a straight line, a flying distance, say, of from 750 to 800 miles. *Were it possible to load the airplane fully on each trip*, the operating cost would be 6.5 cents per passenger-mile or $48.75 to $52 per passenger. This compares with the railroad rate of $51.30, including fare, excess fare, and pullman. Allowing for the trip to and from the fields, as well as an intermediate stop, the time by air would average about 9 hours as against 20 hours by the Pennsylvania Railroad's "Broadway Limited." The only reason why we cannot carry passengers at such rates today is that it costs too much to get the business.

CONCLUSIONS

The following general conclusions may be drawn from the data considered:

Duration. That designed duration should not exceed the minimum necessary to complete scheduled trips safely in a head wind and that, for the type considered, it should not in any case exceed four hours.

Factor of Safety. That the factor of safety should be kept to the minimum consistent with the conditions and that it should in no case exceed six.

High Speed. That high speeds beyond those accompanying the necessary reserve horsepower are undesirable and, for the type considered, the high speed should not exceed 105 to 110 m.p.h. at 5000 ft.

Climbing Speed. That climbing speed should be only sufficient to provide a reasonable margin of safety for emergencies, and an initial rate of climb of 400 to 500 ft. (from the altitude of the operating field) in the first minute is proposed as a tentative standard.

Reserve Horsepower. That reserve horsepower should be kept down to that necessary to provide the required climbing speed.

Flying on One out of Two Engines. That flying on one out of two engines is utterly impracticable, because of prohibitive cost.

Flying on Two out of Three Engines. That the requirement of ability to fly on two out of three engines is reasonable and practicable.

Safety Requirements. That initial rate of climb instead of reserve horsepower or speed range should be the measure of safe performance.

Size. That the moderate-sized machine is the most efficient at present, and for the type considered this size is about 500 to 600 sq. ft. in area.

Operating Cost. That aircraft designed for commercial purposes and fully loaded can be operated conservatively at a total cost of 0.030 to 0.032 cent per pound-mile or about 6.5 cents per passenger-mile, not including the cost of obtaining the business, and that this cost cannot be even approached by machines not suited to the purpose.

Second Revision of A.S.M.E. Boiler Code, 1922

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the Society in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be invited and where they may present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

The revisions which have met the approval of the Boiler Code Committee are here published. It is the request of the Committee that these revisions be fully and freely discussed so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

The revisions here published are limited to the paragraphs appearing in the 1918 Edition of the A.S.M.E. Boiler Code, and the paragraph numbers refer to the paragraphs of similar number in that edition. For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

PREAMBLE:—ADD THE FOLLOWING TO THE PREAMBLE:

THE COMMITTEE DOES NOT EXPRESS OPINIONS ON TYPES OF BOILERS OR APPARATUS, NOR APPROVE OR DISAPPROVE OF ANY GENERAL DESIGN OR ESTABLISH WORKING PRESSURES THAT MAY BE CARRIED FOR SPECIFIC DESIGNS. FOR EXAMPLE, SHOULD A BOILER BE SUBMITTED BY A TRADE NAME OR THAT OF THE MANUFACTURER FOR APPROVAL OF THE BOILER CODE COMMITTEE, THE BOILER CODE COMMITTEE WOULD NOT EXPRESS ITS APPROVAL OR DISAPPROVAL. THE BOILER CODE COMMITTEE WOULD, HOWEVER, STAND READY TO INTERPRET ANY ONE OF THE RULES OF THE CODE AS APPLIED TO THE BOILER, BUT IT WOULD NOT SET THE PRESSURE THAT COULD BE CARRIED NOR PASS ANY OPINION IN REGARD TO THE MERITS OF A BOILER OR APPARATUS.

PAR. 1 REVISED:

1 Specifications are given in these Rules for the important materials used in the construction of boilers and where given, the materials shall conform thereto. IF, IN THE DEVELOPMENT OF THE ART OF BOILER CONSTRUCTION, OTHER MATERIALS THAN THOSE HEREIN DESCRIBED BECOME AVAILABLE, SPECIFICATIONS FOR THE SAME MAY BE SUBMITTED FOR CONSIDERATION AND APPROVAL.

PAR. 11 REVISED:

11 Pressure parts of superheaters, separately fired or attached to stationary boilers, unless of the locomotive type, shall be of wrought steel, PUDDLED OR KNOBBLED CHARCOAL WROUGHT IRON, or cast steel of Class B grade, as designated in the Specifications for Steel Castings.

PAR. 19 ADD THE FOLLOWING TO THIS PARAGRAPH:

FOR PLATES OVER 1 IN. IN THICKNESS, WHERE THE SHEET IS HEAVIER THAN ORDINARILY REQUIRED IN ORDER TO AFFORD GREATER STRENGTH OF TUBE-HOLE LIGAMENTS, THE BUTT STRAPS MAY BE PROPORTIONED IN ACCORDANCE WITH THE *required* THICKNESS, BUT IN NO CASE MAY THEY BE LESS THAN ONE-HALF THE PLATE THICKNESS.

PAR. 21 REVISED:

21 *Tubes for Water-Tube Boilers.* The maximum allowable working pressures for tubes used in water-tube boilers shall be for the various diameters and gages measured by Birmingham wire gage, as given in Table 2. REDRAWN PIPE NOT TO EXCEED $1^1/_2$ IN. STANDARD PIPE SIZE WHICH MEETS THE PIPE SPECIFICATION, MAY BE USED FOR WATER-TUBE BOILERS FOR A WORKING PRESSURE NOT TO EXCEED 200 LB. PER SQ. IN., WHEN SCREWED IN THE SHEET, PROVIDED THE WALL THICKNESS IS AT LEAST 50 PER CENT GREATER THAN THE WALL THICKNESS REQUIRED BY TABLE 2.

PAR. 182 ADD THE FOLLOWING TO REVISED FORM AS PUBLISHED IN THE JULY ISSUE OF MECHANICAL ENGINEERING:

THE BACK PITCH OF TUBE HOLES OR RIVETS SHALL BE MEASURED EITHER ON THE FLAT PLATE BEFORE ROLLING, OR ON THE MEDIAN LINE AFTER ROLLING.

PAR. 185 REVISED:

185 When shell plates exceed $^9/_{16}$ in. in thickness in horizontal-return-tubular boilers, the portion of the SHELL plate [s] forming the laps of the circumferential joints, where exposed to the fire or products of combustion, shall be planed or milled down as shown in Fig. 8, to A THICKNESS OF NOT OVER $^1/_2$ in. [in thickness], provided the requirement in Par. 184 is complied with.

PAR. 187 CHANGE PARS. 187 AND 188 TO PARS. 188*a* AND 188*b* AND INSERT A NEW PAR. 187 AS FOLLOWS:

187 *Seamless Construction.* DRUMS, SHELLS OR DOMES MAY BE OF SEAMLESS DRAWN CONSTRUCTION WITH OR WITHOUT INTEGRAL HEADS PROVIDED THE MATERIAL FROM WHICH THEY ARE FORMED CONFORMS TO THE REQUIREMENTS OF ANY ONE OF THE SPECIFICATIONS IN THE CODE FOR SHELL MATERIAL.

PAR. 193 CHANGE PAR. 193 TO PAR. 192*d* AND INSERT NEW PAR. 193 AS FOLLOWS:

193 IN APPLYING REINFORCING PLATES TO THE DRUMS OF WATER-TUBE BOILERS TO STRENGTHEN THE SHELL WHERE THE TUBES ENTER, THEY SHALL BE RIVETED TO THE SHELL, AND THE TUBES SHALL BE EXPANDED INTO THE INNER AND OUTER PLATES SO THAT THE RIVETS AND TUBES WILL HOLD THE PLATES TOGETHER IN ACCORDANCE WITH THE RULES FOR STAYED SURFACES.

THE SPACING OF THE RIVETS WITH RESPECT TO THE TUBES SHALL CONFORM TO PAR. 199 FOR STAYED SURFACES, USING A VALUE OF 135 FOR C, AND SHALL BE BASED ON A UNIT PRESSURE EQUAL TO THE PRESSURE THAT CAN BE CARRIED BY THE INNER PLATE WITH A FACTOR OF SAFETY OF 5.

> (NOTE: WHERE A REINFORCING PLATE IS INSIDE THE STEAM DRUM IT IS THE INNER PLATE; WHERE IT IS OUTSIDE AND THERE IS NO INNER REINFORCING PLATE, THE UNREINFORCED SHELL OF THE DRUM IS THE INNER PLATE.)

THE TENSION IN RIVETS AND TUBES SHALL CONFORM TO PARS. 220 AND 232.

THE COMBINED DRUM SHELL AND REINFORCING PLATE OR PLATES SHALL HAVE A FACTOR OF SAFETY OF NOT LESS THAN 5 IN THE LIGAMENTS, WHEN CALCULATED IN ACCORDANCE WITH PAR. 192, ALSO IN RIVET CONNECTIONS. WHEN REINFORCING PLATES OR BUTT STRAPS ARE EXPOSED TO FLAME OR GAS OF THE EQUIVALENT TEMPERATURE, THE JOINTS SHALL BE PROTECTED THEREFROM.

PAR. 195 REVISED:

195 [Convex Heads.] The thickness required in an unstayed dished head with the pressure on the concave side, when it is a segment of a sphere, shall be calculated by the following formula:

$$t = \frac{5.5 \times P \times L}{2 \times TS} + {}^1/_8$$

where

t = thickness of plate, in.
P = maximum allowable working pressure, lb. per sq. in.
TS = tensile strength, lb. per sq. in.

NOTE:—Matter in caps—added matter; matter in brackets—to be deleted.

L = radius to which the head is dished, in.

Where two radii are used the longer shall be taken as the value of L in the formula.

Where the radius is less than 80 per cent of the diameter of the shell or drum to which the head is attached the thickness shall be at least that found by the formula by making L equal to 80 per cent of the diameter of the shell or drum.

[Concave Heads.] Dished heads with the pressure on the convex side shall have a maximum allowable working pressure equal to 60 per cent of that for heads of the same dimensions with the pressure on the concave side.

When a dished head has a manhole opening, the thickness as found by these Rules shall be increased by not less than $^1/_8$ in. over that called for by the formula. Where a dished head has a flanged opening supported by an attached flue, the increase of $^1/_8$ in. in thickness is not required. IF MORE THAN ONE MANHOLE OPENING IS INSERTED, THE MINIMUM DISTANCE BETWEEN THE OPENINGS SHALL BE NOT LESS THAN ONE-FOURTH OF THE OUTSIDE DIAMETER OF THE HEAD.

PAR. 199 REVISED:

199 The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where

P = maximum allowable working pressure, lb. per sq. in.

T = thickness of plate in *sixteenths* of an inch

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, in.

C = 112 for stays screwed through plates not over $^7/_{16}$ in. thick with ends riveted over

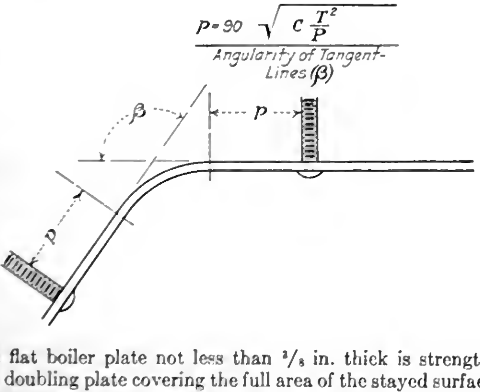
C = 120 for stays screwed through plates over $^7/_{16}$ in. thick with ends riveted over

C = 135 for stays screwed through plates and fitted with single nuts outside of plate OR WITH INSIDE AND OUTSIDE NUTS OMITTING WASHERS

C = 150 for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate

C = 175 for stays fitted with inside and outside nuts and outside STEEL washers where the diameter of washers is not less than 0.4 p and thickness not less than T.

FOR STAYS AT THE UPPER CORNERS OF FIREBOXES THE PITCH FROM THE STAYBOLT NEXT TO THE CORNER TO THE POINT OF TANGENCY OF THE CORNER CURVE SHOULD BE.



If a flat boiler plate not less than $^3/_8$ in. thick is strengthened with a doubling plate covering the full area of the stayed surface and securely riveted thereto and having a thickness of not less than $^2/_3$ T, then the value of T in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plate but not more than one and one-half times the thickness of the boiler plate, and the value of C given above may also be increased 15 per cent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

Acceptable proportions for the ends of through stays with washers are indicated in Fig. 14.

FIG. 14 REVISE SIDE EXPLANATION TO READ:

Not less than $2^1/_2$ Diameters of Bolt AS MEASURED ON THE OUTSIDE OF THE THREADED PORTION but must be 0.4 Pitch of Stays if C = 175.

PAR. 196 REVISED:

196 When dished heads are of a less thickness than called for by Par. 195, they shall be stayed as flat surfaces, no allowance being made in such staying for the holding power due to the spherical form. IF A DISHED HEAD IS FORMED WITH A FLATTENED SPOT OR SURFACE FOR THE ATTACHMENT OF A CONNECTION OR FLANGE, THE DIAMETER OF THE FLAT SPOT SHOULD NOT EXCEED THE VALUE OF p AS GIVEN IN THE FORMULA IN PAR. 199 OR IN TABLE 4, FOR THE PRESSURE AND THICKNESS OF HEAD INVOLVED.

PAR. 200 REVISED:

200 *Staybolts.* The ends of [screwed] staybolts OR STAYS SCREWED THROUGH PLATES, shall be riveted over or upset by equivalent process OR FITTED WITH NUTS. The outside ends of solid staybolts, 8 in. and less in length, shall be drilled with a hole at least $^3/_{16}$ in. diameter to a depth extending at least $^1/_2$ in. beyond the inside of the plates, or hollow staybolts may be used. On boilers having a grate area not exceeding 15 sq. ft., or the equivalent in gas- or oil-fired boilers, the drilling of staybolts is optional. Solid staybolts over 8 in. long, and flexible staybolts of either the jointed or ball-and-socket type, need not be drilled. Staybolts used in waterlegs of water-tube boilers shall be hollow or drilled at both ends, irrespective of their length. ALL STAYBOLTS NOT NORMAL TO THE STAYED SURFACE SHALL HAVE THREE ENGAGING THREADS OF WHICH ONE SHALL BE A FULL THREAD.

PAR. 208 REVISED:

208 The diameter of a screw stay shall be taken at the bottom of the thread OR WHEREVER IT IS OF [provided this is] the least diameter.

PAR. 212*a* REVISED:

212*a* The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays OR RIVETED LONGITUDINAL JOINT OR OTHER CONSTRUCTION EXCEPT HAND-HOLES. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. 199, using 70 for the value of C.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays OR RIVETED LONGITUDINAL JOINT OR OTHER CONSTRUCTION EXCEPT HANDHOLES. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table 5, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

PAR. 212*b* ADD THE FOLLOWING TO THIS PARAGRAPH:

THE ABOVE FORMULA APPLIES TO THE LONGITUDINAL CENTER SECTION OF THE WRAPPER SHEET, AND IN CASES WHERE E IS REDUCED AT ANOTHER SECTION, THE MAXIMUM ALLOWABLE WORKING PRESSURE BASED ON THE STRENGTH AT THAT SECTION, MAY BE INCREASED IN THE PROPORTION THAT THE DISTANCE FROM THE WRAPPER SHEET TO THE TOP OF THE CROWN SHEET AT THE CENTER, BEARS TO THE DISTANCE, MEASURED ON A RADIAL LINE THROUGH THE OTHER SECTION, FROM THE WRAPPER SHEET TO A LINE TANGENT

TO THE CROWN SHEET AND AT RIGHT ANGLES TO THE RADIAL LINE. (SEE FIG. $14^1/_2$.)

Par. 216 Revised:

216 Stays shall be used in the tube sheets of a fire-tube boiler if the distance between the edges of the tube holes exceeds the maximum pitch of staybolts for the corresponding plate thickness and pressure given in Table 4. That part of the tube sheet which comes between the tubes and the shell need not be stayed, if the GREATEST distance [to the nearest tangent common to two tube holes when] measured ALONG A RADIAL LINE FROM THE INNER SURFACE OF THE SHELL TO THE CENTER POINT OF THE TANGENT COMMON TO ANY TWO TUBE HOLES ON THE SHELL SIDE OF SUCH [on any radius of the tube sheet that intersects the tangent between the] holes does not exceed 1.25 TIMES THE [this] maximum pitch OF STAYBOLTS FOR THE CORRESPONDING PLATE THICKNESS AND PRESSURE GIVEN IN TABLE 4 [by more than 3 in.]. The tube holes to which a common tangent may be drawn in applying this rule shall not be at a greater distance from edge to edge than the maximum pitch referred to.

Par. 218 Revised:

218 When STAYS ARE REQUIRED the portion of the headS below the tubes in a horizontal-return-tubular boiler SHALL BE SUPPORTED BY THROUGH STAYS WITH NUTS AT THE FRONT HEAD. WHERE A manhole opening is provided [with] the flange of which is formed from the solid plate and turned inward to a depth of not less than three times the required thickness of the head, measured from the outside, the area to be stayed as indicated in Fig. 16, may be reduced by 100 sq. in. [The surface around the manhole shall be supported by through stays with nuts inside and outside at the front head.]

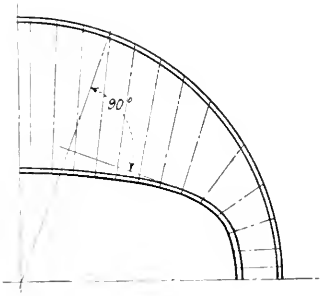


Fig. $14^1/_2$ Staying for Wrapper Sheet of Locomotive Boiler

The distance in the clear between the bodies of the braces, or of the inside braces where more than two are used, shall not be less than 10 in. at any point.

Table 5 Place an Asterisk after the Word "Diameter" Each time it Appears in this Table, and Insert the Following Note at Bottom of Table:

* DIAMETERS TAKEN AT BODY OF STAY.

Par. 230 Add the Following to this Paragraph:

IN A FORM OF REINFORCEMENT FOR CROWN SHEETS WHERE THE TOP SHEET OF THE FIREBOX IS A PART OF A TRUE CIRCLE NOT EXCEEDING 120 DEG. IN ARC, AND IS BRACED WITH ARCH BARS EXTENDING OVER THE TOP AND DOWN BELOW THE TOP ROW OF STAYBOLTS AT THE SIDES, THESE ARCH BARS BEING RIVETED TO THE WATER SIDE OF THE CROWN SHEET THROUGH THIMBLES, THE MAXIMUM ALLOWABLE WORKING PRESSURE SHOULD BE DETERMINED BY ADDING TO THE MAXIMUM ALLOWABLE WORKING PRESSURE FOR A PLAIN CIRCULAR FURNACE OF THE SAME THICKNESS, DIAMETER AND LENGTH BY THE FORMULA IN PAR. 239, THE PRESSURE P_1 DETERMINED FROM THE FOLLOWING FORMULA, WHICH IS A MODIFICATION OF THAT IN PAR. 241, SECTION *a*

$$P_1 = 10{,}000{,}000\,\frac{b \times d^3}{p \times D^3}$$

WHERE

b = net width of crown bar, in.
d = depth of crown bar, in.
p = longitudinal pitch of crown bar, in.
D = outside diameter of furnace, in.

PROVIDED THAT THE MAXIMUM ALLOWABLE WORKING PRESSURE MUST NOT EXCEED THAT DETERMINED BY THE FORMULA FOR FURNACES OF THE ADAMSON TYPE, IN PAR. 242 WHEN L IS MADE EQUAL TO p, AND ALSO PROVIDED THAT THE DIAMETER OF THE HOLES FOR THE STAYBOLTS IN THE CROWN BARS DOES NOT EXCEED $^1/_3\,b$, AND THE CROSS-SECTIONAL AREA OF THE CROWN BARS IS NOT LESS THAN 4 SQ. IN., PAR. 199 WOULD GOVERN THE SPACING OF THE STAYBOLTS, RIVETS OR BOLTS ATTACHING THE SHEET TO THE BARS, AND PAR. 212*b* THE SIZE OF THE STAYBOLTS, RIVETS OR BOLTS.

Par. 231 Revised:

231 *Maximum Allowable Working Pressure on Truncated Cones.* *a* Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone when not over 38 in. diameter at the large end, may be used without stays if computed by the rule for plain cylindrical furnaces (Par. 239) making D in the formula equal to the diameter at the large end; provided that the longitudinal joint conforms to the requirements of Par. 239.

b When over 38 in. in diameter at the large end, that portion which is over 30 in. in diameter shall be [fully] supported by staybolts or gussets. IF SUPPORTED BY STAYBOLTS PAR. 212D SHALL APPLY. IF SUPPORTED BY GUSSETS THE SPACING OF THE RIVETS ATTACHING THE GUSSETS TO THE COMBUSTION CHAMBER SHALL NOT EXCEED THE STAYBOLT SPACING GIVEN BY PAR. 212D. [to conform to the provisions for staying flat surfaces. In this case.] The top row of staybolts shall be at a point where the cone top is 30 in. or less in diameter.

In calculating the pressure permissible on the unstayed portion of the cone, the vertical distance between the horizontal planes passing through the centers of the rivets at the cone top, and through the center of the top row of staybolts shall be used as L in Par. 239, and D in that paragraph shall be the inside diameter at the center of the top row of staybolts.

Par. 239 Revised:

239 *PLAIN CIRCULAR FURNACES.* The Following Rules Apply in General to Unstayed Circular Furnaces:

a-1 THE LONGITUDINAL JOINT MAY BE RIVETED OR LAP WELDED BY THE FORGING PROCESS, OR THE FURNACE MAY BE OF SEAMLESS CONSTRUCTION

a-2 THE LONGITUDINAL JOINT IF RIVETED SHALL HAVE AN EFFICIENCY GREATER THAN

$$\frac{P \times D}{1250 \times T}$$

a-3 THE WALLS SHALL NOT BE LESS THAN $^5/_{16}$ IN. THICK

a-4 BUTT STRAP SEAMS SHALL BE USED ONLY WHERE THEY ARE PROTECTED FROM CONTACT WITH THE FIRE

a-5 THE FURNACE MAY BE OF ANY LENGTH OR HEIGHT

Par. 240 Omit this Paragraph and Replace by the Following:

240 THE FOLLOWING RULES APPLY SPECIFICALLY TO UNSTAYED CIRCULAR FURNACES 12 IN. IN DIAMETER AND OVER:

A 12 IN. TO 18 IN. OUTSIDE DIAMETER, INCLUSIVE.

b-1 A RIVETED LONGITUDINAL JOINT MAY BE OF THE LAP TYPE

b-2 THE MAXIMUM ALLOWABLE WORKING PRESSURE FOR FURNACES NOT MORE THAN FOUR AND A HALF DIAMETERS IN LENGTH OR HEIGHT SHALL BE DETERMINED BY FORMULAE *a* AND *b* AS FOLLOWS:

a WHERE THE LENGTH DOES NOT EXCEED 120 TIMES THE THICKNESS OF THE PLATE

$$P = \frac{51.5}{D}\,[(18.75 \times T) - (1.03 \times L)]$$

b WHERE THE LENGTH EXCEEDS 120 TIMES THE THICKNESS OF THE PLATE

$$P = \frac{4250 \times T^2}{L \times D}$$

WHERE

P = MAXIMUM ALLOWABLE WORKING PRESSURE, LB. PER SQ. IN.

D = OUTSIDE DIAMETER OF FURNACE, IN.
L = TOTAL LENGTH OF FURNACE BETWEEN CENTERS OF HEAD RIVET SEAMS (NOT LENGTH OF A SECTION), IN.
T = THICKNESS OF FURNACE WALLS, IN SIXTEENTHS OF AN INCH

b-3 THE MAXIMUM ALLOWABLE WORKING PRESSURE FOR FURNACES OVER FOUR AND ONE-HALF DIAMETERS IN LENGTH OR HEIGHT SHALL BE DETERMINED IN ACCORDANCE WITH PAR. 241.

B OVER 18 IN. OUTSIDE DIAMETER TO AND INCLUDING 30 IN. INSIDE DIAMETER.

c-1 A RIVETED LONGITUDINAL JOINT MAY BE OF THE LAP TYPE

c-2 THE MAXIMUM ALLOWABLE WORKING PRESSURE SHALL BE DETERMINED BY FORMULAE *a* AND *b* IN A; IF OVER SIX DIAMETERS IN LENGTH OR HEIGHT, *L* IN THE FORMULA SHALL BE TAKEN AS SIX TIMES THE DIAMETER.

C OVER 30 IN. INSIDE DIAMETER TO AND INCLUDING 36 IN. INSIDE DIAMETER.

d-1 A RIVETED LONGITUDINAL JOINT MAY BE OF THE LAP TYPE PROVIDED THE FURNACE DOES NOT EXCEED 36 IN. IN LENGTH OR HEIGHT

d-2 IF THE LENGTH OF A HORIZONTAL FURNACE EXCEEDS 36 IN. AND THE JOINT IS RIVETED, A BUTT AND SINGLE OR DOUBLE STRAP CONSTRUCTION SHALL BE USED AND SHALL BE LOCATED BELOW THE GRATE

d-3 THE MAXIMUM ALLOWABLE WORKING PRESSURE SHALL BE DETERMINED BY FORMULAE *a* AND *b* IN A; IF OVER SIX DIAMETERS IN LENGTH *L* IN THE FORMULA SHALL BE TAKEN SIX TIMES THE DIAMETER.

D OVER 36 IN. INSIDE DIAMETER TO AND INCLUDING 38 IN. OUTSIDE DIAMETER.

e-1 WHEN RIVETED THE LONGITUDINAL JOINT OF A HORIZONTAL FURNACE SHALL BE BUTT AND SINGLE OR DOUBLE STRAP CONSTRUCTION AND SHALL BE LOCATED BELOW THE GRATE

e-2 THE MAXIMUM ALLOWABLE WORKING PRESSURE SHALL BE DETERMINED BY FORMULAE *a* AND *b* IN A; IF OVER SIX DIAMETERS IN LENGTH *L* IN THE FORMULA SHALL BE TAKEN AS SIX TIMES THE DIAMETER.

Par. 248 Combine this Paragraph with Par. 249 and Insert Following New Paragraph:

Cutting of Plates

248 PLATES MAY BE CUT BY MACHINING, PUNCHING, SHEARING OR CUTTING BY THE ELECTRIC ARC OR GAS, PROVIDED ENOUGH METAL IS LEFT AT ANY UNFINISHED EDGES TO MEET THE REQUIREMENTS OF PARS. 249, 253, AND 257.

Par. 250 Revised:

250 A fire-tube boiler WITH TUBES UNDER 5 IN. DIAMETER shall have THE [both] ends of the tubes FIRMLY [substantially] rolled and beaded, or rolled and welded at the firebox or combustion-chamber end, AND ROLLED AND BEADED AT THE OTHER END. IN THE CASE OF TUBES UNDER $1^1/_4$ IN. DIAMETER, THE TUBES MAY BE EXPANDED BY THE PROSSER METHOD IN PLACE OF ROLLING. IN THE CASE OF TUBES 5 IN. IN DIAMETER AND OVER, THE TUBES SHALL BE SECURED BY RIVETING OR OTHER APPROVED METHOD AT BOTH ENDS. IF WELDED, THE WELDING SHALL BE AROUND THE EDGE OF THE BEAD OR IF THE TUBE IS NOT BEADED THE TUBE SHEET SHALL BE CHAMFERED OR RECESSED TO A DEPTH AT LEAST EQUAL TO THE THICKNESS OF THE TUBE. IN NO CASE SHALL THE TUBE END EXTEND MORE THAN $^3/_8$ IN. BEYOND THE TUBE SHEET.

Par. 251 Revised:

251 The ends of all tubes, suspension tubes and nipples shall be flared not less than $^1/_8$ in. over the diameter of the tube hole on all water-tube boilers and superheaters, or they may be flared not less than $^1/_8$ in., rolled and beaded, or flared, rolled and welded. WHERE SPECIAL REDRAWN PIPE AS PROVIDED IN PAR. 21 IS USED FOR TUBES IN WATER-TUBE BOILERS, THE MINIMUM NUMBER OF THREADS SHALL CONFORM WITH THE VALUES GIVEN IN TABLE 8. THE CLOSED ENDS OF THE STUB TUBES SHALL BE WELDED BY THE FORGING PROCESS.

Fig. 20 Change Note at Bottom of Figure to Read:

Dimensions OF FINISHED HEADS may be larger or $^1/_{10}$ smaller than those shown. Fillets under heads may be used but are not required. Change Caption to Read: Acceptable Forms of FINISHED Rivet Heads.

Par. 253 Revised:

253 *Drilling of Holes.* ALL HOLES IN BRACES, LUGS AND SHEETS FOR RIVETS OR STAYBOLTS SHALL BE DRILLED, OR THEY MAY BE PUNCHED, AT LEAST $^1/_8$ IN. LESS THAN FULL DIAMETER FOR MATERIAL NOT MORE THAN $^5/_{16}$ IN. THICK, AND AT LEAST $^1/_4$ IN. LESS THAN FULL DIAMETER FOR THICKER MATERIAL, NOT MORE THAN $^5/_8$ IN. THICK.

HOLES SHALL NOT BE PUNCHED IN MATERIAL MORE THAN $^5/_8$ IN. THICK.

FOR FINISHING THE RIVET HOLES, THE PLATES, BUTT STRAPS, BRACES, HEADS AND LUGS SHALL BE FIRMLY BOLTED IN POSITION BY TACK BOLTS, FOR FINAL DRILLING OR REAMING TO FULL DIAMETER.

THE FINISHED HOLES MUST BE TRUE, CLEAN AND CONCENTRIC.

Par. 255 Revised:

255 *Rivets.* Rivets shall be of sufficient length to completely fill the rivet holes and form heads at least equal in strength to the bodies of the rivets. Forms of FINISHED rivet heads that will be acceptable are shown in Fig. 20.

Par. 256 Revised:

256 Rivets shall be SO DRIVEN AS [machine-driven wherever possible with sufficient pressure] to fill the [rivet] holes PREFERABLY BY A MACHINE WHICH MAINTAINS THE PRESSURE UNTIL NO PART OF THE HEAD SHOWS RED IN DAYLIGHT [and shall be allowed to cool and shrink under pressure]. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used. A rivet shall be driven each side of each tack bolt before removing the tack bolt.

Par. 257 Revised:

257 *Calking.* The calking edges of plates, butt straps and heads shall be beveled to an angle not sharper than 70 deg to the plane of the plate, and as near thereto as practicable. Every portion of the UNFINISHED [sheared] surfaces of the calking edges of plates, butt straps and heads shall be planed milled or chipped to a depth of not less than $^1/_8$ in. Calking shall be done with a [roundnosed] tool OF SUCH FORM THAT THERE IS NO DANGER OF SCORING OR DAMAGING THE PLATE UNDERNEATH THE CALKING EDGE.

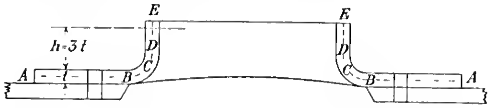


Fig. $20^1/_2$ Cross-Section of Flanged Manhole Frame

Par. 258 Revised:

258 *Manholes and Handholes.* An elliptical manhole opening shall be not less than 11 by 15 in., or 10 by 16 in. in size. A circular manhole opening shall be not less than 15 in. in diameter. A handhole opening in THE SHELL OF a boiler OR DRUM, the greatest dimension of which exceeds 6 in., shall be reinforced in accordance with the rules for manholes.

Par. 260 Revised:

260 Manhole frames on shells or drums when used, shall have the proper curvature, and on boilers over 48 in. in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. 21. The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength (REQUIRED BY PAR. 180) of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other opening. WHEN A FLANGED MANHOLE FRAME IS USED THE FLANGED PORTION OF THE FRAME MAY BE CONSIDERED AS REINFORCEMENT UP TO A HEIGHT (h) OF THREE TIMES THE FLANGE THICKNESS (SEE FIG. $20^1/_2$).

Par. 261 Revised:

261 The strength of the rivets in shear on each side of a manhole frame or reinforcing ring shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening

and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole, or other opening, SUCH AS THOSE CUT FOR STEEL NOZZLES AND BOILER FLANGES, OVER 3-IN. PIPE SIZE.

Par. 268 Revised:

268 *Threaded Openings.* ALL PIPE THREADS SHALL CONFORM TO THE AMERICAN PIPE STANDARD AND ALL [a pipe] connectionS 1 in. in diameter or over shall have not less than the number of threads given in Table 8.

If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 100 lb. per sq. in., a NOZZLE OR SADDLE FLANGE [connection] riveted to the boiler to receive a flanged fitting shall be used for all pipe openings over 3-in. pipe size.

IF SPECIAL REDRAWN PIPE, NOT TO EXCEED $1^1/_2$ IN. STANDARD PIPE SIZE MADE FROM LAPWELDED IRON OF PUDDLED STOCK AND TESTED TO 1000 LB. HYDRAULIC PRESSURE, IS USED IN WATER-TUBE OR PORCUPINE BOILERS FOR A WORKING PRESSURE NOT TO EXCEED 200 LB. PER SQ. IN., WHEN SCREWED IN THE SHEET, WHICH HAS A WALL THICKNESS AT LEAST 50 PER CENT GREATER THAN THE WALL THICKNESS REQUIRED BY THE CODE FOR TUBES OF WATER-TUBE BOILERS, THE MINIMUM NUMBER OF THREADS SHALL CONFORM WITH THE VALUES GIVEN IN TABLE 8 AND THE CLOSED ENDS OF THE STUB TUBES MAY BE WELDED BY THE FORGING PROCESS.

Par. 269 Revised:

269 *Safety Valve Requirements.* Each boiler RATED TO DISCHARGE OVER 2000 LB. OF STEAM PER HOUR AT THE ALLOWED PRESSURE shall have two or more safety valves WHEN THE GENERATING CAPACITY OF THE BOILER EXCEEDS 2000 LB. PER HOUR. THE METHOD OF COMPUTING THE STEAM GENERATING CAPACITY OF THE BOILER SHALL BE AS GIVEN IN PAR. 421 OF THE APPENDIX [except a boiler for which one safety valve having a relieving capacity of 2000 lb. per hour or less, is required by the rules].

Par. 272 Revised:

272 ALL safety valves shall be so CONSTRUCTED THAT NO SHOCKS DETRIMENTAL TO THE VALVE OR TO THE BOILER ARE PRODUCED [of such a type that] AND SO THAT no failure of any part can obstruct the free and full discharge of steam from the valve. Safety valves may be of the direct spring-loaded pop type with seat and bearing surface of the disk inclined at any angle between 45 deg. and 90 deg. to the center line of the spindle. The valve shall be rated at a pressure 3 per cent in excess of that at which the valve is set to blow.

Safety valves may be used which give any opening up to the full discharge capacity of the area of the opening at the base of the valve, provided the movement of the valve is gradual so as not to induce lifting of the water in the boiler.

[All safety valves shall be so constructed that no detrimental shocks are produced through the operation of the valve.] Weighted lever safety valves shall not be used.

Par. 273 Revised:

273 Each safety valve 1 IN. SIZE AND LARGER shall be plainly marked by the manufacturer IN SUCH A WAY THAT THE MARKINGS WILL NOT BE OBLITERATED IN SERVICE. The markings may be stamped on the body, cast on the body, or stamped or cast on a plate or plates permanently secured to the body, and shall contain the following:

a The name or identifying trademark of the manufacturer

b The nominal diameter

c The steam pressure at which it is set to blow

(*d* Blow down, or difference between the opening and closing pressures)

(*e*) *d* The weight of steam discharged in pounds per hour at a pressure 3 per cent higher than that for which the valve is set to blow

(*f*) *e* A.S.M.E. Std.

Par. 274 Revised:

274 The MINIMUM AGGREGATE [total] relieving capacity of ALL OF the safety valve or valves required on a boiler shall be not less than that determined on the basis of 6 lb. of steam per hour per sq. ft. of boiler heating surface for water-tube boilers. For all other types of power boilers, the total relieving capacity shall be not less than that determined on the basis of 5 lb. of steam per hour per sq. ft. of boiler heating surface. IN MANY CASES A GREATER RELIEVING CAPACITY OF SAFETY VALVES WILL HAVE TO BE PROVIDED THAN THE MINIMUM SPECIFIED BY THIS RULE AND IN EVERY CASE THE REQUIREMENT OF PAR. 270 SHALL HOLD. [For boilers with maximum allowable working pressures above 100 lb. and on the basis of 3 lb. of steam per hour per sq. ft. of boiler heating surface for boilers with maximum allowable working pressures at or below 100 lb. per sq. in.]

The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose, only the tubes, fireboxes, shell, tube sheets and the projected area of headers need be considered. The minimum number and size of safety valves required shall be determined on the basis of the total relieving capacity and the relieving capacity marked on the valves by the manufacturer. WHERE THE FIRING CONDITIONS ARE CHANGED TO INCREASE THE RATE OF STEAM GENERATION, THE SAFETY VALVE CAPACITY SHALL BE INCREASED TO MEET THE NEW CONDITIONS AND BE IN ACCORDANCE WITH PAR. 270.

Par. 275 Revised:

275 IF THE SAFETY VALVE CAPACITY CANNOT BE COMPUTED, OR IF IT IS DESIRABLE TO PROVE THE COMPUTATIONS, IT [Safety valve capacity] may be checked in any one of the three following ways, and if found insufficient, additional capacity shall be provided:

[remainder of paragraph unchanged]

Par. 276 Revised:

276 When two or more safety valves are used on a boiler, they may be either separate or twin valves made by mounting individual valves on Y-bases, or duplex, triplex or multiplex valves having two or more valves in the same body casing. THE VALVES SHALL BE MADE OF EQUAL SIZES, IF POSSIBLE, AND IN ANY EVENT IF NOT OF THE SAME SIZE, THE SMALLER OF THE TWO VALVES SHALL HAVE A RELIEVING CAPACITY OF AT LEAST 50 PER CENT OF THAT OF THE LARGER VALVE.

Par. 277 Revised:

277 The safety valve or valves shall be connected to the boiler independent of any other steam connection, and attached as close as possible to the boiler, without any unnecessary intervening pipe or fitting. SUCH INTERVENING PIPE OR FITTING, IF USED, SHALL NOT BE LONGER THAN THE FACE TO FACE DIMENSION OF THE AMERICAN EXTRA-HEAVY IRON FLANGED TEE FITTING OF CORRESPONDING SIZE SHOWN IN TABLE 17 AND FIG. 33. Every safety valve shall be connected so as to stand in an upright position, with spindle vertical, when possible.

Par. 278 Revised:

278 Each safety valve shall have AT LEAST A full-sized direct connection to the boiler. No valve of any description shall be placed between the safety valve and the boiler, nor on the discharge pipe between the safety valve and the atmosphere. When a discharge pipe is used, it shall be not less than the full size of the valve, and shall be fitted with an open drain to prevent water from lodging in the upper part of the safety valve or in the pipe. EACH VALVE SHALL HAVE AN OPEN DRAIN TAPPED FOR DRIP PIPE THROUGH THE CASING BELOW THE LEVEL OF THE VALVE SEAT. IN THE CASE OF FIRE-TUBE BOILERS, THE SAFETY VALVE OPENINGS SHALL BE NOT LESS THAN THOSE CORRESPONDING TO SAFETY VALVES HAVING THE INTERMEDIATE LIFTS AND CORRESPONDING RELIEVING CAPACITIES GIVEN IN TABLE 15.

Par. 279 Revised:

279 If a muffler is used on a safety valve it shall have sufficient outlet area to prevent back pressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid any possibility of restriction of the steam passages due to deposit. When an elbow is placed on a safety valve discharge pipe, it shall be located close to the safety valve outlet or the pipe shall be securely anchored and supported. All safety valve discharges shall be so located or piped as to be carried clear from running boards or working platforms

used in controlling the main stop valves of boilers or steam headers.

Where discharge pipes are used, THEY SHALL BE AS SHORT AND AS STRAIGHT AS POSSIBLE AND the cross-sectional area at any point shall be at least equal to the combined areas of the discharge outlets of the valves discharging therethrough. Ample drainage shall be provided at or near each safety valve and where the water of condensation may collect.

Par. 280 Revised:

280 When a boiler is fitted with two or more safety valves on one connection, this connection to the boiler shall have a cross-sectional area not less than the combined area BASED ON THE NOMINAL DIAMETERS of all of the safety VALVE CONNECTIONS [valves with which it connects].

Par. 281 Revised:

281 Safety valves shall operate without chattering and shall be set and adjusted as follows: To close after blowing down not more than 4 PER CENT NOR LESS THAN 2 PER CENT OF THE SET PRESSURE, BUT NOT LESS THAN 2 LB. IN ANY CASE. [4 lb. on boilers carrying an allowed pressure less than 100 lb. per sq. in. gage. To close after blowing down not more than 6 lb. on boilers carrying pressures between 100 and 200 lb. per sq. in. gage inclusive. To close after blowing down not more than 8 lb. on boilers carrying over 200 lb. per sq. in. gage.]

Par. 282 Revised:

282 To insure the valve being free, each safety valve shall have a substantial lifting device by which the valve may be raised from its seat at least 1/16 in. when there is no pressure on the boiler. THE VALVE SHOULD NOT BE LIFTED UNLESS THERE IS SUFFICIENT STEAM PRESSURE ON THE BOILER TO BLOW ALL DIRT AND SCALE CLEAN FROM THE SEAT.

Par. 286 Revised:

286 A safety valve over 3 in. size, used for pressures greater than 15 lb. per sq. in. gage, shall have a flanged inlet connection The dimensions of flanges subjected to boiler pressure shall conform to the American Standard given in Table [s] [16 and] 17 of the Appendix [for the pressures therein specified], except that the face of the safety valve flange and the nozzle to which it is attached may be flat and without the raised face for pressures up to an including 250 lb. per sq. in. For higher pressures, the raised face shall be used.

Par. 287 Revised:

287 When the valve body is marked [with the letters A.S.M.E. Std.] as required by Par. 273, this shall be a guarantee by the manufacturer that the valve conforms to the details of construction herein specified.

Par. 289 Revised:

289 Every safety valve used on a superheater, discharging superheated steam, shall have a steel body INCLUDING ALL PARTS WHICH COME IN CONTACT WITH THE STEAM BETWEEN THE INLET AND OUTLET, with a flanged inlet connection, and shall have the seat and disk of nickel composition or equivalent material, and the spring fully exposed outside of the valve casing so that it shall be protected from contact with the escaping steam.

Par. 290 Revised:

290 Every boiler shall have proper outlet connections for the required safety valve or valves, independent of any other outside steam connection, the area of opening to be at least equal to the aggregate [nominal] area BASED ON NOMINAL DIAMETERS of all of the safety valves to be attached thereto. An internal collecting pipe, splash plate or pan may be used, provided the total area for inlet of steam thereto is not less than TWICE [one and one-half times] the aggregate area of the CORRESPONDING NOMINAL DIAMETERS OF THE attached safety valves. The holes in such collecting pipes shall be at least 1/4 in. in diameter and the least dimension in any other form of opening for inlet of steam shall be 1/4 in.

Par. 299 Cancel Present Wording of Revision as Published in July Issue of Mechanical Engineering and Substitute the Following:

299 *Fittings.* FLANGED CAST IRON PIPE FITTINGS INCLUDING THOSE FOR STEAM AND FOR FEED WATER AND WHERE THE PRESSURES DO NOT EXCEED 160 LB. SHALL CONFORM TO THE AMERICAN STANDARD GIVEN IN THE APPENDIX. IF THE FITTINGS ARE BELOW THE WATER LINE THEY SHALL BE EXTRA HEAVY.

FOR PRESSURES EXCEEDING 160 LB. PER SQ. IN., FITTINGS MORE THAN 2 IN. PIPE SIZE OR EQUIVALENT CROSS SECTIONAL AREA, SHALL BE OF CAST OR FORGED STEEL. (SEE PARS. 9 AND 245.) THE DIMENSIONS OF THE FLANGES AND DRILLING SHALL CONFORM TO THE AMERICAN STANDARD GIVEN IN TABLE 17.

FOR PRESSURES EXCEEDING 250 LB. PER SQ. IN., THE FLANGE THICKNESS, AND THE THICKNESS OF THE BODIES SHALL BE INCREASED TO GIVE AT LEAST THE SAME FACTOR OF SAFETY AS THE FITTINGS SPECIFIED IN THE TABLE, WHEN USED FOR THE MAXIMUM PRESSURES PERMITTED IN THE CODE.

THE FACE OF THE FLANGE OF A SAFETY VALVE, AS WELL AS THAT OF A SAFETY VALVE NOZZLE MAY BE FLAT AND WITHOUT THE RAISED FACE, FOR PRESSURES NOT EXCEEDING 250 LB. BUT SHALL HAVE THE RAISED FACE FOR HIGHER PRESSURES.

THE NUMBER OF BOLTS IN A FLANGE MAY BE INCREASED, PROVIDED THEY ARE LOCATED ON THE STANDARD BOLT CIRCLE. OTHER EXCEPTIONS ARE NOTED IN PAR. 12. TABLES 16 AND 17 DO NOT APPLY TO FLANGES ON THE BOILER SIDE OF STEAM NOZZLES, OR TO FLANGES LEFT BY THE MANUFACTURER AS PART OF THE BOILER, AND DO NOT APPLY TO FITTINGS DESIGNED AS PART OF THE BOILER.

Par. 306 Revised:

306 Each superheater shall be EQUIPPED [fitted] with AT LEAST ONE drain SO LOCATED AS WILL MOST EFFECTIVELY PROVIDE FOR THE PROPER OPERATION OF THE APPARATUS.

Par. 311*a* Revised:

311*a* On all boilers except those used for traction and portable purposes, when the maximum allowable working pressure exceeds 125 lb. per sq. in., each bottom blow-off pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be OF extra heavy CONSTRUCTION. [except that.] On a boiler having multiple blow-off pipes, a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required. TWO INDEPENDENT VALVES OR A VALVE AND A COCK MAY BE COMBINED IN ONE BODY PROVIDED THE COMBINED FITTING IS THE EQUIVALENT OF TWO INDEPENDENT VALVES OR A VALVE AND A COCK SO THAT THE FAILURE OF ONE TO OPERATE COULD NOT AFFECT THE OPERATION OF THE OTHER.

Par. 312 Revised:

312 A bottom blow-off pipe when exposed to direct furnace heat shall be protected by fire-brick, OR OTHER HEAT RESISTING MATERIAL SO ARRANGED THAT THE PIPE MAY BE INSPECTED [a substantial cast iron removable sleeve or a covering of non-conducting material].

Par. 314 Cancel Present Wording of Revision as Published in July Issue of Mechanical Engineering and Substitute the Following:

314 THE FEED WATER SHALL BE INTRODUCED INTO A BOILER IN SUCH A MANNER THAT THE WATER WILL NOT BE DISCHARGED DIRECTLY AGAINST SURFACES EXPOSED TO GASES OF HIGH TEMPERATURE, OR TO DIRECT RADIATION FROM THE FIRE, OR CLOSE TO RIVETED JOINTS OF SHELL OR FURNACE SHEETS.

Par. 315 Omit First Section of Revision as Published in August Issue of Mechanical Engineering, and Retain Last Section of Paragraph as Follows:

315 In Fig. 22 is illustrated a typical form of flange for use on boiler shells for passing through piping such as feed, surface, blow-off connections, etc., and which permits of the pipes being screwed in solid from both sides in addition to the reinforcing of the opening in the shell.

Par. 316 Cancel Present Wording in Boiler Code and Replace by Second Section of Revised Par. 315 as Published, as Follows:

316 In THESE AND other types of boilers where both internal and external pipes making a continuous passage are employed, the boiler bushing or its equivalent shall be used.

Par. 321 Revised:

321 The water connections to the water column of a boiler [shall be of brass] WHEN PRACTICAL, shall be provided with a cross

AT EACH RIGHT-ANGLE TURN to facilitate cleaning. FOR PRESSURES OF 200 LB. STEAM PRESSURE OR LESS, THE WATER CONNECTION, IF PIPE IS USED, SHALL BE OF BRASS.

Par. 323 Revised:

323 *Methods of Support.* A horizontal-return-tubular boiler over 78-in. in diameter shall be supported from steel lugs by the outside suspension type of setting, independent of the boiler side walls. The lugs shall be so designed that the load is properly distributed between the rivets attaching them to the shell and so that no more than two of these rivets come in the same longitudinal line on each lug. The distance girthwise of the boiler from the centers of the bottom rivets to the centers of the top rivets attaching the lugs shall be not less than 12 in. The other rivets used shall be spaced evenly between these points. If more than four lugs are used they shall be set in four pairs, THE LUGS OF EACH PAIR TO BE SPACED NOT OVER 2 IN. APART AND THE LOAD TO BE EQUALIZED BETWEEN THEM. (SEE FIG. 22¾.)

Par. 324 Revised:

324 A horizontal return tubular boiler 14 FT. OR MORE IN LENGTH, over 54 in. and up to and including 78 in. in diameter, shall be supported by the outside suspension type of setting, or at four points by not less than eight steel or cast-iron brackets set in pairs.

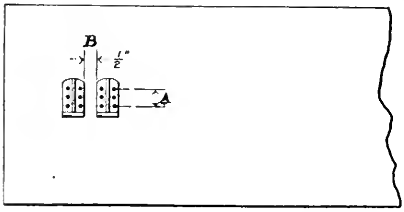


Fig. 22¾ Spacing of Supporting Lugs in Pairs on H.R.T. Boilers

Par. 328 Revised:

328 A water-tube boiler shall have the firing doors, furnace inspection doors and clinker doors of the inward-opening type, unless such doors are provided with substantial and effective latching or fastening devices OR OTHERWISE SO CONSTRUCTED AS to prevent them WHEN CLOSED from being blown open by pressure on the furnace side.

Par. 332 Revised:

332 Each boiler shall conform in every detail to these Rules, and shall be distinctly stamped with the symbol as shown in Fig. 23, denoting that the boiler was constructed in accordance therewith.

After obtaining the stamp to be used when boilers are to be constructed to conform with the A.S.M.E. Boiler Code, a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, if known, is to be notified that an inspection is to be made and he shall inspect such boilers during construction and after completion. At least two inspections shall be made, one before reaming rivet holes and one at the hydrostatic test. In stamping the boiler after completion, if built in compliance with the code, the builder shall stamp the boiler in the presence of the inspector, after the hydrostatic test, with the A.S.M.E. Code stamp, the builder's name and the serial number of the manufacturer. A data sheet shall be filled out and signed by the manufacturer and the inspector. This data sheet together with the stamp on the boiler shall denote that it was constructed in accordance with the A.S.M.E. Boiler Code.

IN CASES WHERE BOILERS CANNOT BE COMPLETED AND HYDROSTATICALLY TESTED BEFORE SHIPMENT, THE PROPER STAMPINGS SHALL BE APPLIED AND TWO DATA SHEETS SIGNED AS HEREIN PROVIDED BY THE SAME OR DIFFERENT INSPECTORS COVERING THE PORTIONS OF THE INSPECTIONS MADE AT THE SHOP AND IN THE FIELD, THE DATA SHEETS EACH TO BE SEPARATELY SENT TO THE PROPER DESTINATION.

Each boiler shall be stamped adjacent to the symbol as shown in Fig. 24, with the following items with intervals of about one-half inch between the lines:

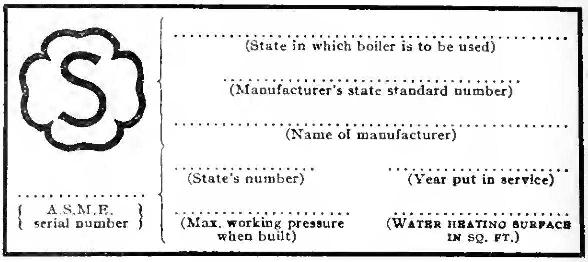


Fig. 24 Form of Stamping

1 A.S.M.E. [Manufacturer's] serial number WHICH MAY BE THE MANUFACTURER'S SERIAL NUMBER
2 State in which boiler is to be used
3 Manufacturer's State standard number
4 Name of manufacturer
5 State's number
6 Year put in service
7 Maximum working pressure when built
8 WATER HEATING SURFACE IN SQ. FT.

Items 1, 2, 3, 4, 7 AND 8 are to be stamped at the shop where built.

Items 5 and 6 are to be stamped by the proper authority at point of installation.

Par. 351 Omit this Paragraph.
Table 15 Add Following Note at End of this Table:

THIS TABLE SHOWS THE COMPUTED RELIEVING CAPACITIES FOR SAFETY VALVES OF VARIOUS SIZES AND IS INTENDED FOR REFERENCE ONLY. HOWEVER, THERE IS NO LIMIT SET IN THE CODE TO THE AMOUNT THE SAFETY VALVE MAY LIFT, PROVIDED THE VALVE OPERATES PROPERLY, AND IT MAY BE THAT THE RELIEVING CAPACITY STAMPED ON THE VALVE BY THE MANUFACTURER WILL BE GREATER THAN ANY OF THOSE GIVEN IN THIS TABLE.

Par. 429 Revised:

429 The least diameter of fusible metal shall be not less than ½ in., except for maximum allowable working pressures of over 175 lb. per sq. in. or when it is necessary to place a fusible plug in a tube, in which case the least diameter of fusible metal shall be not less than ⅜ in. IF A FUSIBLE PLUG IS INSERTED IN A TUBE THE TUBE WALL SHALL BE NOT LESS THAN 0.22 IN. THICK OR SUFFICIENT TO GIVE FOUR THREADS.

Par. 430 *r* Revised:

r In Economic Type Boilers—in the rear head, NOT LESS THAN 2 IN. above the upper row of tubes.

Revise Par. L-18 and Table L-2 of Locomotive Code as Follows:

Par. L-18 Change second paragraph to read: In the case of superheater flues which are expanded [the gage of], the expanded end may be ½ [1½] gage [s] lighter and the swaged end THREE [two] gages heavier than the gage thickness SPECIFIED.

Table L-2 Change title to read: MINIMUM Gage Thickness of Walls of Fire Tubes or Flues.

All gage thickness numbers in table to be increased by one, i.e., in place of 7 insert 8, in place of 8 insert 9, etc. Omit note under table.

Work of A.S.M.E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the

Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 395, 397, 406 and 407, as formulated at the meeting of September 20, 1922, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 395

(Annulled)

Case No. 397 (Reopened)

Inquiry: Was it the intent, in Par. 199, to permit a value of 175 for C where copper washers were used as described in the definition for C?

Reply: It is the opinion of the Committee that the washers should be of steel to permit the use of 175 for C. Copper washers may be used provided the value of C is taken the same as if no washer were used.

Case No. 406

Inquiry: Will a form of forged steel boiler nozzle with flange pressed hot over the end neck of the nozzle which is compressed or forged into a recess or groove in the flange conform to the requirements of the Code?

Reply: It is the opinion of the Committee that this method of forming a steam outlet connection meets the requirements of the Rules in the Boiler Code.

Case No. 407

Inquiry: Is it permissible under the Rules of the Code for Boilers of Locomotives to mark a safety valve A.S.M.E. Std., when it is not fitted with a lifting device, whereas Par. 282 of the Power Boiler section of the Code requires such a lifting device?

Reply: Inasmuch as Par. 282 of the Power Boiler section of the Code requires a lifting device and there is no similar requirement in the section of the Code for Boilers of Locomotives, it is the opinion of the Committee that safety valves for use in stationary service under the Power Boiler Rules must be fitted with a lifting device and those intended for use on boilers of locomotives need not have such a lifting device, and that it is proper in each case to mark the safety valve A.S.M.E. Std.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on activities and policies of the Society in Research and Standardization.

Castings Direct from the Ore as Made at the Rouge Plant of the Ford Motor Company

To the Editor:

The author of an article entitled Making High-Grade Castings Direct from the Ore, an abstract of which appears in Mechanical Engineering for October, 1922, page 660, seems to have been misinformed. Since the article as it stands might mislead some member of our engineering fraternity, the following is offered as a correct outline of the practice at the Rouge Plant of the Ford Motor Company.

The line of blast furnaces lies 225 ft. west of the parallel line of 24 cupolas of 78 in. diameter, shell-lined to 60 in. The cupolas are divided into three batteries of eight stacks each. Pollock 75-ton, 3-trunnion, elliptical ladles on railroad trucks take the hot metal from the blast furnace on to the track west of the foundry parallel to the line of cupolas. A 100-ton Wellman-Seaver-Morgan ladle tilting gantry crane running on broad-gage track straddles the ladle cars.

Three pairs of Pollock 30-ton hot-metal containers originally took the blast-furnace metal from the 75-ton ladles to the 1-ton ladle line which runs in front of the cupolas. These 30-ton containers are built of steel plate, entirely closed except at the filling hole and pouring spout, and have the ordinary refractory lining. They were filled at the tilting crane alternately and run to the pouring stands. Twenty-ton trolleys lifted the containers off their cars at the rear and tilted them about their pouring spouts to serve the 1-ton ladles. So much for the blast-furnace metal.

The foundry scrap, sprues, gates, special pig, steel scrap, etc. are melted in the cupolas.

The one-ton ladles from which the molds were poured ran to the monorail scales at the 30-ton container, received about half a ton of blast-furnace metal, ran to the adjacent cupolas and received another half-ton of cupola metal, and then ran to the pouring lines of the mold conveyors.

This method is being gradually modified. At No. 1 division the 30-ton container remains at the pouring stand and is served from the 75-ton ladle by two 15-ton Whiting ladles. A gas burner in the 30-ton container keeps the metal hot. At No. 2 division two ladles of about 10 tons capacity will soon be used to receive blast-furnace metal from the 75-ton ladle and to pour into the 1-ton ladles without any 30-ton container. At No. 3 division, one 10-ton ladle is used between the 75-ton ladle and the 1-ton pouring ladles.

The layout at No. 2 will probably be final for both large and small molding of automobile and tractor parts. If cold metal is experienced a gas burner can be placed in the 75-ton ladle, but this will probably not be required.

Although a vacuum-walled container may have been contemplated by the Experiment Department, it would seem to be extremely impracticable, and is wholly unknown to the Foundry Engineering Department.

Clarence A. Brock.

Detroit, Mich.

The Surge-Tank Problem

To the Editor:

Referring to the letter from Mr. Jakobsen, appearing in the November issue of Mechanical Engineering, his claim that the differential surge tank is not usually the best design for low- or medium-high-head plants indicates, on the face of it, that he has something better to offer, and I am sure that the many users of this method of regulation in the United States and Canada will look forward with interest to the publication of the article which he says is forthcoming.

Inasmuch as a shortage in power has been so flatly attributed to the use of the differential principle, it may be of engineering interest to set forth a contrary point of view, even before discovering what Mr. Jackobsen would "generally" recommend in place of the differential surge tanks, which have been so frequently adopted.

For this purpose it may be pertinent once more to compare a simple surge tank with a differential under precisely the same physical conditions: that is to say, the two areas must be the same and the plant must be fully loaded at the bottom of a large surge occurring in a differential regulator. The internal riser pipe is then to be considered removed, leaving a simple surge tank with un-

restricted connection to the conduit and comparison made with the former case.

It will be seen at once that it is only fair to regard the plant as fully loaded under the most unfavorable head occurring at the "critical moment" when the water level in the riser is lowest, for otherwise there would still be power available for sale, which does not seem to furnish a sound economic basis for comparison.

If the simple tank now be subjected to the same load change which has been successfully sustained by the differential regulator, it is probably only necessary to point out that the turbines would not be able to carry the load at the bottom of the resulting surge because it would be much larger than in the former case, thus inviting the governor to try to open the gates beyond their wide-open position, with a consequent drop in speed of prohibitive amount.

In this case the shortage in power would last so long before the water surface rose enough to furnish the required head that no one would even consider the possibility of tiding over this large gap by means of flywheel effect. In other words, the flywheel is intended to help carry the load only during acceleration of the water in the comparatively short penstocks between the regulator and the turbines, and not during the long time required to accelerate the water in the long conduit. The surge tank is the "flywheel" for the latter purpose.

It is just possible that Mr. Jakobsen has confused these two ideas, because the only shortage of power resulting from the use of a differential regulator, so far as I know, is that which makes a theoretically greater call upon the flywheel during and sometimes shortly after the first quick impulse of the governor following a sudden load change.

This shortage of power is recognized and understood and provides the excuse for the flywheel, which, of course, when properly proportioned in connection with the area of the riser pipe and the ports controlling the outflow from the tank, does not mean a material net shortage of power delivered to the bus bars, and this is the only concern we have in this connection.

To attempt to discredit the economy of a differential regulator because it drops the penstock power a trifle more than does a simple tank during and only during the extremely short impulse period above referred to, would be, to my mind, to lose a proper sense of proportion. In other words, this disadvantage must be vastly augmented in the imagination before it gains a place in a practical mind beyond a purely academic point.

I do not mean to intimate that this is the "shortage" to which Mr. Jakobsen refers, but I mention it because I can think of no other, and he has made it necessary for me to hunt as diligently as possible for a sound basis for his sweeping statement.

It should be noted that the foregoing comparisons have particular reference to a sudden load change of somewhat unusual magnitude and also to low- and medium-high heads, or, to the very conditions under which, according to Mr. Jakobsen, the differential regulator fails to give a good account of itself.

It might be added that the differential regulator properly designed is not intended to exercise its full or ideal differential action except for the very largest load change selected by judgment as that beyond which good speed regulation is of no consequence because of too infrequent occurrence.

For load changes of half this maximum the differential action already largely disappears, and therefore—almost all the time in most cases—any academic advantage attributed to the simple tank is shared equally by the other.

The many advantages of the differential regulator have been set forth so long ago and have been criticized and studied by so many able engineers both in this country and abroad, that it seems hardly worth while to point them out again in this discussion.

The cone-shaped tank to which Mr. Jakobsen refers seems to me to owe some of its virtue to a diffident approach toward the idea of a faster-dropping water level during the early part of the surge which is the vital principle of differential action. This idea is, however, the one he condemns as producing "shortage of power at some critical moment," and therefore it will be of general interest to find out by what means he proposes to improve upon or replace the differential regulator in most cases of low- or medium-high-head plants.

The conical shape has an advantage in some cases in providing a greater area at times of low water in the pond, but it is equally applicable to the tank of a differential regulator and presents a virtue quite apart from the matter under discussion.

It should be remembered that the drop of water level in the riser is anything but sudden as compared to the time for the governor to make an initial adjustment of the turbine gates.

In closing, I wish to invite Mr. Jakobsen and others to a very full public discussion of the points which he has raised, and to avoid lost motion and confusion, I would like to suggest that great care be used in selecting any numerical examples as a means of demonstration, so that they will represent normal conditions and the best principles of design for the accomplishment of a stated purpose.

R. D. JOHNSON.

New York, N. Y.

Mathematical Determination of the Modulus of Elasticity

TO THE EDITOR:

The method for determining the modulus of elasticity herein elucidated has for its *raison d'etre* extreme simplicity, combined with mathematical precision, eliminating the necessity of measuring minute elongations under heavy loads.

In Fig. 1 CAD represents a light strip of the material to be tested,

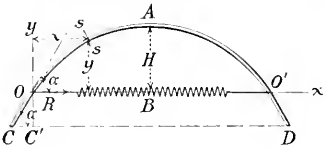


FIG. 1

of uniform cross-section, easily yielding to a certain amount of bending within its elastic limit, and resting freely in a horizontal plane, for the elimination of vertical-load influences.

B is a common spring balance or scale, such as can be found in any hardware store, forming part of the cord holding the points O and O' of the strip in its bent position, as shown, and indicating the existing tension R along the cord OO'.

The strip to be tested is extended to the points C and D below the cord OO' for reasons that will become clear later.

For the cross-section s-s of the strip with its coördinates x, y, the moment M of the external forces is Ry; the moment of resistance of the cross-section s-s is EI/ρ, E denoting the modulus of elasticity, I the moment of inertia of the cross-section of the strip, and ρ the radius of curvature at the section s-s. Replacing the curvature $1/\rho$ by its expression—

$$\frac{\dfrac{\partial^2 y}{\partial x^2}}{\left[1+\left(\dfrac{\partial y}{\partial x}\right)^2\right]^{1\frac{1}{2}}}$$

we obtain the equation—

$$-M = -Ry = +\frac{EI}{\rho} = EI\,\frac{\dfrac{\partial^2 y}{\partial x^2}}{\left[1+\left(\dfrac{\partial y}{\partial x}\right)^2\right]^{1\frac{1}{2}}} \;\ldots\ldots [1]$$

which shows that the bending curve cannot be a circular arc, the curvature varying with y. The minus sign is taken before M, because $\partial y/\partial x$ being the tangent of the angle of the curve element with the axis Ox, decreases with x, hence $\partial^2 y/\partial x^2$ is negative.

Multiplying both members in Equation [1] by $2(\partial y/\partial x)\,dx$ and integrating, we obtain:

$$R\int 2y\,\frac{\partial y}{\partial x}\,dx = -EI\int \frac{2\,\dfrac{\partial y}{\partial x}\cdot\dfrac{\partial^2 y}{\partial x^2}\cdot dx}{\left[1+\left(\dfrac{\partial y}{\partial x}\right)^2\right]^{1\frac{1}{2}}}$$

or

$$Ry^2 = \frac{2EI}{\sqrt{1 + \left(\frac{\partial y}{\partial x}\right)^2}} + C \ldots\ldots\ldots\ldots [2]$$

For the point O of intersection of the strip with the cord, $y = 0$, and $\partial y/\partial x$ becomes $\tan \alpha$, where α is the angle of the curve element with the cord OO' at the point O. Hence for that point Equation [2] becomes—

$$O = \frac{2EI}{\sqrt{1 + \tan^2\alpha}} + C; \quad \text{or} \quad C = -2EI \cos \alpha$$

Introducing the obtained expression for C into [2], we obtain—

$$Ry^2 = 2EI\left(\frac{1}{\sqrt{1 + \left(\frac{\partial y}{\partial x}\right)^2}} - \cos \alpha\right) \ldots\ldots\ldots [3]$$

Now, for the apex A of the curve, $y = H$, $\partial y/\partial x = 0$, and [3], applied to the cross section at A, becomes—

$$RH^2 = 2EI(1 - \cos \alpha) \ldots\ldots\ldots\ldots\ldots [4]$$

The angle α entering in this equation is obtainable by direct linear measurements, and without the use of a protractor: that is to say the extension OC of the strip being straight, it must coincide with the tangent to the curve at point O, hence—

$$\cos \alpha = \frac{CC'}{OC} = \frac{CD - OO'}{2OC}$$

To apply Equation [4] correctly, the test strip must become perfectly straight when the cord OO' is relaxed.

Let now the cord OO' be tightened up to an additional amount of tension ΔR, so that the spring balance will indicate $R + \Delta R$ tension, and the corresponding deformations of the test strip will be H_1 and α_1. Introducing these new notations into [4], we obtain—

$$(R + \Delta R)H_1^2 = 2EI(1 - \cos \alpha_1)$$

Multiplying this equation by H^2 and subtracting from it [4] multiplied by H_1^2 gives—

$$\Delta RH^2H_1^2 = 2EI[H^2(1 - \cos \alpha_1) - H_1^2(1 - \cos \alpha)] \ldots [5]$$

In this equation ΔR is the cord tension corresponding not to the total deformation of the test strip, H_1 and α_1, but to the change in its deformation from H and α to H_1 and α_1. Hence Equation [5], unlike Equation [4], may be applied to a test strip that is already partly bent and curved, which is of great advantage, as it eliminates the necessity of using a perfectly straight strip and keeps the bending within the elastic limit. Instead, a partly bent strip may be used, applying a small tension to produce but a slight change in its already existing large and easy-to-measure deformations.

From Equations [4] and [5] the modulus of elasticity E is easily determined, or any other factor, like R or I, may be determined when E is known from tables of the strength of materials.

The expression within the brackets in Equation [5] may become negative; then ΔR, too, would be negative; that is, by further tightening up the cord its tension R decreases instead of increases. That may happen in case the angle α is too large. Hence the testing strip should not be too much bent at the start.

Although as a matter of simplicity a spring balance is shown in the illustration as forming a part of the cord, in practice, however, it proves very clumsy, requiring strips that are both long and wide with holes drilled to let the cord through and obstructing correct measuring.

For that reason a suitable dynamometer has been designed, which is shown in Fig. 2 in the form it has been entered at the Patent Office. As seen, it consists of two extension clamps at the tops of which are inserted the ends of the testing strip, which may have the form of a thin band or of a round wire. The clamps are elongated and forked, forming extensions to the strip, and each has a pivoted square block inside the fork with holes in the center of the blocks through which passes freely a long rod having a bolt head at one end and a screw thread at the other. Between the bolt head and washer and the adjacent pivoted block a spring is mounted on the rod, surrounded by a cylindrical casing with two longitudinal slots and graduations marked alongside, as shown at A, Fig. 2. Through these slots pass the lugs of the washer, indicating the compression of the spring in pounds.

The threaded end of the rod is provided with a thumb nut and a set-screwed collar. Thus, the testing strip is held in its strained bent position at one end by the compression of the spring and at its other by the thumb nut with the rod between the two pivoted blocks forming the cord in tension.

The dimensions H, h, b, and c are convenient to measure and the cord tension in pounds is readily shown on the spring casing.

The deduction of the formulas is the same as before, except that at the end of the testing strip, at its entrance into the clamp, where $\partial y/\partial x$ becomes $\tan \alpha$, y is not 0, but equal to h, so that the constant $C = Rh^2 - 2EI\cos \alpha$, and Equations [3], [4] and [5] now become—

$$R(y^2 - h^2) = 2EI\left(\frac{1}{\sqrt{1 + \left(\frac{\partial y}{\partial x}\right)^2}} - \cos \alpha\right) \ldots\ldots [3_1]$$

$$R(H^2 - h^2) = 2EI(1 - \cos \alpha) \ldots\ldots\ldots\ldots [4_1]$$

$$\Delta R(H^2 - h^2)(H_1^2 - h_1^2) = 2EI\,[H^2 - h^2)(1 - \cos \alpha_1) - (H_1^2 - h_1^2)(1 - \cos \alpha)] \ldots\ldots\ldots\ldots [5_1]$$

$$\cos \alpha = \frac{b - c}{2a}; \quad \cos \alpha_1 = \frac{b_1 - c_1}{2a}$$

The set-screwed collar, shown close to the thumb nut, serves for verifying whether the test has been carried on within the elastic limit or not: namely, setting the collar close to the thumb nut at the start of the test and noting the corresponding tension R of the spring when it is slightly compressed; then, if at the close of the test, when the pivoted block and thumb nut are brought again close to the set-screwed collar, the spring registers the same tension as at the start, the elastic limit has not been exceeded; if the tension is less than at the start, then the elastic limit has been exceeded, and the strip has lost part of its resisting tension.

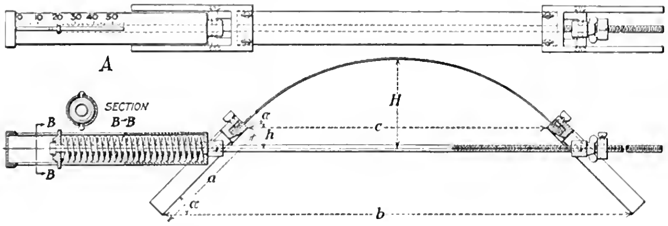


Fig. 2

The writer has applied Equation [4] to wooden strips of common white pine, using a common spring balance, and obtained $E = 1,013,000$, in one test, and $E = 955,000$ in another; the tables give $E = 1,000,000$, for white pine.

The tension T per unit area at any cross-section of the strip can easily be determined in the following manner: Replacing the third member in Equation [1] by $TI/0.5e$, where e is the thickness of the strip, both this term and EI/ρ expressing the same moment of resistance of the cross-section, we have the equation—

$$Ry = \frac{TI}{0.5e} \ldots\ldots\ldots\ldots\ldots\ldots [6]$$

For the cross-section at the apex A, y becomes H and T becomes T_{max}, and—

$$RH = \frac{T_{max}I}{0.5e} \ldots\ldots\ldots\ldots\ldots [7]$$

To apply these two equations correctly, the strip must become straight when the cord is relaxed.

Syracuse, N. Y. David Guelbaum.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Dexter S. Kimball, *President*

William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Alex. G. Christie

Ralph E. Flanders John T. Wilkin

O. G. Dale

PUBLICATION STAFF:

C. E. Davies, *Managing Editor*

Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Engineering and Economics

EVERY engineering problem has an economic phase of fundamental importance. Every machine, every power plant, every bridge and every mine operation must have some economic justification. This often imposes rigid restrictions upon the possible solutions of the engineering problem involved, making them more difficult. The engineer thus has a thorough appreciation of some of the principles of economics.

Progress in the establishment of our present-day civilization is due in no small part to the work of the engineer, and its maintenance and development are a matter of great responsibility for this profession which has stated its function as that of directing the use of men and materials for the service of mankind. To properly shoulder this responsibility and perform this function, the engineer must be prepared to take a broader interest in the economic problems of our political structure. He must have a deeper knowledge than is required to satisfy the economic demands of an engineering problem. He must understand the relation of his work to the production and distribution of the wealth of the world, and this will bring him face to face with those who have developed the principles of political economy.

It is no new realization that engineers must be well grounded in political economy. Engineering societies have discussed some parts of the subject and the technical press has devoted space to it. Technical schools are encouraging its study. But the first time that any organized attempt to gather engineers and economists together in any large way will occur at the coming Annual Meeting of The American Society of Mechanical Engineers, when a joint session will be held with the American Economic Association.

The program that has been announced for the session gives promise of great interest. The papers to be presented by Dr. Wesley C. Mitchell of Columbia University and E. M. Herr, President of the Westinghouse Electric and Manufacturing Company, with the discussion by leaders in both professions should develop the importance of mutual understanding by both groups and emphasize the desirability for a more permanent relation between them to encourage future joint discussion of economic problems.

In his paper, Dr. Mitchell establishes the intimate connection between the work of the engineer and that of the economist in the production of wealth. He tells of the parallel careers of James Watt, the inventor, and Adam Smith, the economist. He states the problems to be faced and holds out the hope of an adequate solution by the method of scientific analysis, so skilfully used by the engineer in the solution of his technical problems.

Mr. Herr will deal with the human phase of the process of producing wealth. The opening paragraphs of his paper show most surprisingly that the labor problems of today and conditions of over twenty-five centuries ago do not differ fundamentally except in the matter of background. He then establishes the importance of industry, evaluates the factors relating to the human problem in it, states the principles necessary for solution, and concludes in an appeal for the substitution of reason for force in the settlement of industrial disputes.

This program was arranged by the Management Division of The American Society of Mechanical Engineers and it is to be congratulated. The results of the meeting should be bountiful and far-reaching.

Coal Facts

THE appointment of the fact-finding commission for the coal industry will be welcomed by the engineering profession as the first step in the elimination of periodic interruptions which have meant severe inconvenience and which, if continued, will spell disaster to the comfort of the people of this country as well as to the industries.

Secretary Hoover has pointed out that the biennial struggles in the coal industry, which have hindered the necessary regular supply, are in part symptoms of a disease which should be treated from an accurate diagnosis of "facts." He has further pointed out that there are 2500 too many bituminous mines and 200,000 too many people in the business, with a resultant waste of labor and capital which levies tremendous tribute on the entire country. Intermittent operation resulting from this over-capacity and from labor disputes aggravates the coal-transportation difficulties. Stabilization of this industry, fundamental to our comfort and progress, must be achieved and the coal commission is charged with the duty of discovering the facts upon which proper legislation for the public welfare may be based.

The confidence which the engineering profession must have in the soundness of the proposed procedure is heightened by the appointment of two engineers as members of the commission. One of these is John Hays Hammond, chairman of the commission and the other is George Otis Smith who is Director of the United States Geological Survey. In a recent editorial comment on the personnel of the commission, *Mining and Metallurgy* makes the following statement:

> These two names alone relieve the mining industry of the dread that the commission to be appointed would bring in a more or less nebulous report which would be rejected by both the operators and the miners and leave the industry just where it was before.
>
> The other members of the commission are ex-Vice President Marshall, distinguished for his practical good sense and integrity; a sound lawyer, Judge Samuel Alschuler; a public-spirited editor, Clark Howell; Dr. Edward T. Devine, a social worker of national reputation, and Charles T. Neill, manager of the bureau of information of the Southeastern railways.
>
> This is an eminent body of men and the President and the people of the country are to be congratulated on their selection. No less fortunate are the mine operators and the miners themselves. The former are assured of an intelligent investigation of the intricate technical details of the mining business by two outstanding mining engineers whose integrity is as great as their ability.
>
> The appointment of Dr. George Otis Smith on this commission is a happy one for another reason. The Geological Survey is the greatest repository of facts and figures of the coal-mining industry in existence today and no commission could function without the aid of his department. Acting as a commissioner, he will be freed from the restraint imposed upon him as Direct of the Survey. This efficient machinery already functioning in the gathering of facts and statistics will very much expedite the work of the commission. Should these two outstanding members of our profession return findings which are surprising to the public and unpalatable to the coal operators, we shall at least be sure that there has been no thimblerigging which would accelerate our progress towards economic disaster in the country's most needful industry.

Great is the responsibility of this commission. Its opportunity for accomplishing an epoch-making work is boundless, and the engineering profession will follow its procedure with sympathy and profound interest.

Commercial Air Transportation Heralded at Detroit Congress

AN INTENSE desire to see aeronautics established on a safe and sane basis as a means of transportation was clearly expressed at the Second Aeronautical Congress held at Detroit, in October, when the National Aeronautical Association was formed. Prof. E. P. Warner represented The American Society of Mechanical Engineers on this occasion and reported that the bare statement of activities cannot adequately express the intensity of the interest shown in the new organization or the keenness of the desire of all those present that the National Aeronautical Association should be so established as to unite all elements and to play an important part in placing American aeronautics in a position where it can render strong and important service to the state, both in the military and in the economic spheres. Past animosities were forgotten and all elements worked together to lay a most encouraging foundation.

The week of the Detroit meeting was an important one for aeronautics. On Monday, October 11, the first National Air Institute was held under the auspices of the Detroit Aviation Society. The permanent chairman was Professor Herbert C. Sadler of the University of Michigan, and he presided over a program arranged by a Committee representing the National Advisory Committee for Aeronautics, Society of Automotive Engineers, The American Society of Mechanical Engineers, and the Aeronautical Chamber of Commerce of America, Inc.

In his opening remarks Professor Sadler emphasized the importance of transportation as the primary factor in the advance of civilization. Today it is the keynote of commercial enterprise, often the governing factor in the success or failure of almost any business. There is in history an inexorable demand for increase in speed, and on land and sea our speed limits are nearly reached. In the air, however, we can obtain speeds even in excess of those on land and sea and with a relatively moderate expenditure of power.

Dr. Joseph S. Ames contributed discussion on the importance of scientific investigation in the general aeronautical program. Lewis E. Pierson, President of the Merchants' Association of New York City, clarified the relation between commercial aviation and the commercial bank. Charles F. Redden, Governor of the Aeronautical Chamber of Commerce of America, indicated the advantages of air transportation over water as compared with that over land. He gave the record of the Aeromarine airways whose planes traveled one million miles and carried fifteen thousand passengers without mishap. Col. Paul Henderson, Second Assistant Postmaster-General, in speaking of the air mail, called attention to the fact that from July 16, 1921 until September 7, 1922 two million miles were flown without accident: 94.39 per cent of all trips were finished on schedule time. C. G. Peterson presented an analysis of the proposed direct air-mail route between Chicago and New York. William P. McCracken, Jr., Chairman of the Aviation Committee of the American Bar Association, discussed the aeronaut's rights, the aeronaut's liabilities and the extent of the power of government agencies to regulate aeronautics. Edmund Ely, President of the National Aircraft Underwriters Association, told of the studies of aircraft insurance, and Professor E. P. Warner, of Massachusetts Institute of Technology, reviewed the developments of commercial flying in Europe.

Considering the subject of commercial air transport J. R. Bibbins, Manager, Department of Transportation and Communication United States Chamber of Commerce, stated the following important principles as a result of a study by the United States Chamber of Commerce:

> The immediate support of basic national legislation on aeronautics providing for appropriate regulatory procedure.
>
> Such legislation to be broadly conceived, in the nature of an enabling act providing for the adoption, administration, and improvement from time to time of an Aeronautical Code under proper Government authorization created by the Act.
>
> Adequate facilities within the Department of Commerce for promoting the regulation and development of commercial air-transport operations in interstate and foreign commerce.
>
> Intra-state legislation and operations to conform as nearly as possible to the basic Federal legislation, or at least unified State action.
>
> Encouragement of widespread public support of this essential aeronautical legislation.

He then outlined the needs for a great essential ground organization including

> 1—Coöperation of districts and localities in providing properly equipped air harbors and intermediary air lanes, under unified Federal control.
>
> 2—Coöperation of the Government along certain lines of national aerologic and radio-broadcasting service.
>
> 3—Adequate motor collection and delivery system between air ports and the business centers.
>
> 4—Temporary continuance of the valuable pioneer development work of the Air Mail until substantial realization of above essentials permits of private enterprise.

Following the Air Institute meeting, over three hundred delegates representing groups of states divided into districts on the Government national defense basis met for the election of officers and for the consideration of routine business. The following were elected as officers of the National Aeronautical Association:

President, H. E. Coffin, Detroit
Vice-President, B. M. Mulvihill, Pittsburgh
Treasurer, B. F. Castle, New York City
Secretary, J. B. Coleman, Sioux City, Iowa

Governors, S. D. Walden, Detroit; P. H. Adams, Boston; G. L. Cabot, Cambridge, Mass.; D. Larkin, Jr., Buffalo; M. J. Cleary, New York City; L. F. Sevier, Pittsburgh; R. F. Walters, Baltimore; A. S. Fliery, Birmingham, Ala.; F. H. Burgin, Atlanta, Ga.; G. L. Martin, Cleveland; D. M. Outcalt, Cincinnati; C. S. Rieman, Chicago; Ralph Cram, Davenport, Iowa; Howard Wehrle, Kansas City, Mo.; Edgar Tobin, San Antonio, Tex.; William Long, San Antonio, Tex.; P. G. Johnson, Seattle, Wash.; C. H. Messer, Spokane, Wash.

Two of the national airplane races held at Selfridge Field, Mt. Clemens, Mich. during the week, developed features of particular engineering interest. Archibald Black, of the Aeronautic Division, A.S.M.E., whose paper on The Influence of Design on Cost of Operating Airplanes appears on p. 821 of this issue, commented on these races as follows:

> The Curtiss Trophy Race presented the first opportunity of comparing the performance of airplanes equipped with air-cooled engines with similar models equipped with water-cooled engines thus giving some definite data upon a much disputed point in airplane design. The Pulitzer Race brought out some novel and most interesting features of design and was responsible for some new high-speed records.
>
> The effect of great horsepower on speed was slight, the race being determined by resistance almost alone. While this has been generally known for years, it was never so emphatically demonstrated as in this race. For equal weight and wing area, etc., speed may be assumed to vary with the cube root of the horsepower, as is well known. However, in actual designs where landing speeds govern the maximum wing loading, increased horsepower means increased weight and added wing area. This, in turn, further cuts into the gain in speed, making it even less than the formula would promise.

Engineer to Head Canadian National Railway

The recent coming to North America of Sir Henry Worth Thornton is an event of considerable interest to engineers in America as well as in Canada, where he takes up the duties of president of the Canadian National Railways. Sir Henry Thornton is an engineering graduate of the University of Pennsylvania in 1894, and after experience with the Pennsylvania and Long Island Railroads, he left the superintendency of the latter road in April, 1914, to become general manager of the Eastern Railway Company of England. Americans doubtless recall the comments when he took this important executive position with a road that handles an immense passenger traffic, perhaps the largest in the world. During the war he was a member of the managers' committee for all English railways. In 1916, with the rank of Colonel in the Royal Engineers, he handled all inland navigation in France, Egypt and Mesopotamia. In 1917, Sir Henry went to Paris as assistant director-general of railway movements and in 1918 he was made inspector general of transportation on the continent with the rank of Brigadier-General. In 1919 he became a British subject, was knighted and received a number of continental honors, as well as the Distinguished Service Medal of the United States.

American engineers will follow with sympathetic interest his efforts in administering the Canadian National Railways with their severe and involved problems.

Nation-Wide Treatment of Management Problems

Reports From Local Sections Observing Management Week Show Success of Project—Human Element in Industry and Relation of Engineer to Management Featured at Many Meetings

THE SUCCESS of the first attempt to focus the simultaneous attention of the Society on one topic is amply proved by the great interest that has been aroused in Management Week. The period from October 16 to 21, 1922, was set aside for the discussion of problems of management and their relation to the engineer and some thirty sections of the Society, coöperating where possible with local sections of the Society of Industrial Engineers and the Taylor Society, held enthusiastic meetings at which interesting papers were heartily discussed. The success of the project, which was instituted to develop public interest in problems of management, is shown by the large amount of attention given to the meetings throughout the country by the daily press.

For the nation-wide success of the Management Week program a large measure of credit is due the Committee on Assistance to Local Sections, a sub-committee of the Management Division of the A.S.M.E., and especially to its chairman, John Younger, of Cleveland Ohio. At a meeting held in April, 1922, this committee drew up the general plan for the holding of simultaneous management sessions throughout the country, in coöperation with the Local Sections and the members of the Society of Industrial Engineers and the Taylor Society. Their plan was heartily endorsed by the executive Committee of the Management Division and approved by vote of the Council at its meeting on May 9.

As we go to press reports are coming in from the Local Sections which establish the fact that meetings of this character can be successfully conducted. The Executive Committee of the Management Division is preparing a résumé of the material presented which will be given more fully in a following issue of MECHANICAL ENGINEERING.

NEW ENGLAND

New England, in nine splendid meetings, observed Management Week with a thoroughness that deserves particular mention. From reports so far received Boston shows the largest number of organizations participating in the program. The New England Section of the Taylor Society, the Industrial Engineers' Club, the Bureau of Commercial and Industrial Affairs of the Boston Chamber of Commerce, the Associated Industries of Massachusetts, the Massachusetts Bankers' Association, the Boston Association of Stock Exchange Firms, the Department of Engineering Administration of the Massachusetts Institute of Technology, the College of Business of Boston University, and the Graduate School of Business Administration and the Committee on Economic Research of Harvard University were all represented on the general committee in charge of the meeting. The subject was Management as Related to the Business Cycle, and the points covered in the main addresses related to retail merchandising, bank credits, forecasting business conditions, the practical application of cyclical forecasts to manufacturing management, and management and sales policies at the present point in the business cycle. The discussion was particularly good as leaders had been chosen for each paper.

Worcester states that its management meeting was the most successful undertaking of the Worcester Section for many months. It was participated in by the Chamber of Commerce, the Rotary Club and the Kiwanis Club. The subject, What are the Standards by which the Work of a Manager may be Measured? was brought out in three addresses and in the discussion the manager's relation to equipment, business forecasting, and particularly to the men whom he directs, were considered.

Six meetings were held in Connecticut, at several of which L. P. Alford's paper on Ten Years' Progress in Management was read and discussed, being presented in person by Mr. Alford at Meriden. At Bridgeport, where the Steel Treaters' Society of Bridgeport participated, the administrative phase of management was discussed. At Hartford Time Studies as a Basis for Rate Setting and Precision Standardization and Production were the subjects of papers.

The meeting at Providence, not yet reported, dealt with the relation of the bank to the manufacturer.

CENTRAL STATES

The Metropolitan Section, meeting with the local sections of the Society of Industrial Engineers and the Taylor Society, heard and discussed Mr. Alford's paper, presented in person, and papers on management in Great Britain and Germany, written by members of the engineering profession in those respective countries.

The keynote of the Syracuse meeting was coöperation. The Technology Club of Syracuse joined in this meeting and the general discussion kept the human element of the management problem in the foreground.

Buffalo reports lively discussion on the subject of industrial management.

Inspection of the Standard Steel Works and the Susquehanna Silk Mills formed apart of the Management Week program of the Central Pennsylvania Section. Mechanical and industrial engineering students from The Pennsylvania State College and Bucknell University attended the meeting. The application of human relations to every business and training men for leaders were the questions around which discussion centered.

The Plainfield meeting, which was based on Mr. Alford's paper, and other meetings in the Central States have not been fully reported.

IN THE SOUTH

The Birmingham Section held a joint meeting with the Alabama Technical Society and the Engineering Department of the University of Alabama, at which industrial management, business management and present-day business conditions were topics under consideration. New Orleans, meeting with the Louisiana Engineering Society, took up the more specific phase of management, that relating to a ship-repair plant.

MANAGEMENT WEEK IN THE MIDDLE WEST

Judging from the wealth of press clippings on meetings in Chicago, Cleveland, Cincinnati, Columbus, and other cities in the Middle West, Management Week was particularly welcome to the general public as well as to the profession. Cleveland, of course, had the benefit of Mr. Younger's assistance in developing its program. The local sections of both the Society of Industrial Engineers and the Taylor Society joined with the Cleveland Section of the A.S.M.E. in the observance of Management Week, and "What about the Man?" was the dominant thought in all the addresses. Failure to consider the human element in industry was cited as one of the main contributory causes of the nation's industrial difficulties. What management means to the business man and the importance of management from his point of view were vital questions considered.

In Columbus constructive action for the future was taken in the formation of a Management Club affiliated with the Chamber of Commerce to study local management problems and to furnish points of contact with local engineers. The matter of taking up some of the problems of management as a post-graduate course at the Ohio State University was also discussed. Three meetings were held in conjunction, respectively, with the Engineering and Commerce classes of Ohio State University, the Columbus Chamber of Commerce, and the Associated Engineers' Club of Columbus, all of which were well attended.

Chicago also observed Management Week on three different occasions. At the first, a joint meeting with the Chicago Association of Commerce, the subject of the address was Business Conditions Abroad as Reflected in American Prosperity. Fellowship between employer and employee, the practical application of management methods, and management control were problems considered at the other meetings.

Cincinnati, in two joint meetings with the local section of the Society of Industrial Engineers, touched also upon the human-relation element and the relation of the manager to his banker.

Modern production methods, and management with a view to the future, were other questions well discussed.

Another note was struck in an address on Citizenship and the Engineer, by Dexter S. Kimball, President of the Society, before the Indianapolis Section. He pointed out that the scope of the engineers' activities must broaden and that they must now study men according to the same forward-looking methods they have employed in studying machinery and be prepared to solve problems involving human relations in industry.

Standards for measuring the work of a manager or of management, the subject considered at Worcester, was also the topic for discussion at a meeting of the Engineers' Club of Dayton to which a number of A.S.M.E. members belong.

Among the other sections of the Middle West which held meetings were the St. Louis, Toledo (with Rotary Club), and Tri-Cities, where Mr. Alford's paper was presented.

Pacific Coast Meetings

The Western Washington, San Francisco, and Los Angeles Sections held strong meetings in observance of Management Week. Mr. Alford's paper formed the basis of discussion at Seattle and Los Angeles, and engineers in management was the subject of the meeting at San Francisco, which was held in conjuction with the Society of Industrial Engineers. The method of the engineer in solving problems was again emphasized, and engineers were urged to qualify for that wider range of activities lying outside the scope of their immediate professional activities.

Exchange Professors for 1922-1923

Emanuel de Margerie, of the University of Strasbourg, and Dean John Frazer, of the University of Pennsylvania, are the exchange professors between France and America for the academic year 1922–1923. This is the second exchange of professors under the scheme inaugurated last fall between the French University Administration and seven American institutions. Dr. A. E. Kennelly, professor of electrical engineering at Harvard University and the Massachusetts Institute of Technology, and Professor Jacques Cavalier, rector of the University of Toulouse, were the first to serve.

Professor de Margerie, who has begun work at Columbia University, where he is lecturing on applied geology, especially as applied to topography, is widely known through his French translation of Eduard Suees' Das Antlitz der Erde. He has published a large number of works on geological subjects, among which should be named Dislocations of the Earth's Crust, written in conjunction with Prof. Albert Reim, of Zurich, fixing the nomenclature of structural geology in French, English, and German; an account of land forms, prepared in conjunction with General de la Noe, of the geographic service of the army; Catalogue of Geology Bibliographies; and his latest work, a monograph on the structural geology of the Jura Mountains of France and Switzerland, written under the auspices of the French Geological Survey.

Professor de Margerie has been for many years in close touch with numerous American geographers and geologists, his first visit to this country being in 1891. In 1912 he was one of the foreign guests invited by the American Geographic Society to participate in its transcontinental excursion, and wrote a paper in English for the memorial volume giving the history of the trip.

Among his many associations are the following: Director of the Geological Survey of Alsace and Lorraine; chief geologist of the Geological Survey of France; vice-president of the French National Research Council; and associate editor of the *Annales de Geographie;* He is a member of the geographical societies of America, London, Paris and France, all of which have conferred special honors upon him, and general secretary of the International Conference on the Map of the World.

Other institutions at which Professor de Margerie will lecture are Harvard, Cornell, Johns Hopkins, Yale, Massachusetts Institute of Technology, and the University of Pennsylvania.

The exchanging of professors between France and the United States is regarded as an important factor in the movement for closer relations between the engineers of the two countries.

Secretary Rice Returns from South America

Just as this issue of Mechanical Engineering went to press, Calvin W. Rice, Secretary of The American Society of Mechanical Engineers, returned from his trip to South America where he represented the A.S.M.E. among other societies at the International Engineering Congress held in conjunction with the Brazilian Centennial Exposition. Speaking informally of his trip Mr. Rice was enthusiastic over the Congress, his courteous and cordial reception everywhere, but particularly over the possibilities of furthering constructive international relations which his trip revealed.

"The resolutions which the International Engineering Congress passed," said Mr. Rice, "were alone sufficient to justify the Congress. They give to engineers of all countries a basis for cooperation and an object of permanent good in each country.

"At the conclusion of the Congress, the United States engineers gave a brilliant banquet at the Jockey Club to the Minister of Public Works, Dr. Pirez do Rio who opened the Congress, the officers of the Congress and of the Club de Engenharia. On account of the magnitude of the engineering construction going on in Brazil the Minister of Public Works is the most important member of the Cabinet. The Club de Engenharia has a most unique position in the nation. Its president, Dr. Frontin, is an engineer of great ability, a kind of popular idol, and a man who has great political power.

"At one of the committee meetings of the United States engineers they pledged themselves to develop a list of all technical words and phrases used in Portuguese, as neither Spain nor Portugal nor any of their colonies has developed a technical vocabulary. A phrase in one city in Brazil often has a different meaning in another city. Vernel L. Havens, as a representative of the McGraw-Hill Book Co., promised to publish the work when completed. Here is a definitely worthwhile job coming out of the Congress.

"In the cities of Santiago, Lima, Montevideo, in fact, everywhere I went, in spite of the briefness of my visit the teamwork was such that there is every reason to believe that engineers in South America are ready to work with engineers of other countries in service to the profession and to the public.

"In every country visited I urged:

1 That every professional man from the United States affiliate with the local engineering society of the country where he is residing, even if only temporarily.

2 That they form within or under the auspices of the local society groups of members of the National Engineering Societies of the United States for purposes of service to the local society.

3 That the local society link up with its government.

4 That the organizations of engineers—members of U. S. societies—link up—

    a With their country's government through the embassy and commercial attaché and with the Inter-American High Commission.

    b With the National Engineering Societies of the United States.

"The reaction that I get from the entire trip is that throughout the world there is the liveliest pride in one's profession and in his society. In fact, it is an inspiration to try to live up to the standard that members establish. As a society we cannot go on unless it be with a devotion to the public good as our definite aim and purpose."

Mr. Rice is preparing a more complete report of his trip. It will appear in the January issue of Mechanical Engineering.

Engineering Foundation Elects Director

The government board of Engineering Foundation, in view of the expanding needs of the organization in its work of industrial search, has created the post of director, to which Alfred D. Flinn, secretary of the Foundation since January, 1918, has been elected. Mr. Flinn will retain his position as secretary of the United Engineering Societies, which he has also held since January, 1918, in order that intimate relations with the Founder societies may continue, but will retire as chairman of the Engineering Division of the National Research Council.

News of The Federated American Engineering Societies

Recent Reports Summarize Services of the Federation to the Nation

TWO recent reports on the work of The Federated American Engineering Societies, one by Edwin S. Carman, chairman of the A.S.M.E. delegates to the American Engineering Council, and the other by L. W. Wallace, executive secretary of the Federation, indicate how well the purpose of the organization, so clearly defined at its organization meetings in 1920, has been achieved. Some seventy delegates, representing over 100,000 engineers, who attended the first meeting, held in June, 1920, were agreed as to the need for some sort of comprehensive organization which (as one editorial stated) "may speak with the authority and prestige of all engineers and groups of engineers, created with the avowed purpose of public service." This sentiment was incorporated in the constitution of the Federation in the words: "Service to others is the expression of the highest motive to which men respond, and duty to contribute to the public welfare demands the best efforts men can put forth, therefore, the object of this organization shall be to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions."

Among the F.A.E.S. activities on which Mr. Carman reported are the twelve-hour shift in American industry, the elimination of waste in industry, the Nolan Patent Bill, the Muscle Shoals problem, the flood-control research laboratory, and standardization work. Concerning the first of these subjects Mr. Carman said: "The public press has corroborated the belief of the American Engineering Council that the Report of the Twelve-Hour Shift in American Industry is doubtless one of the greatest contributions to the welfare of mankind that has yet been made by the engineer." This report, part of which appeared in the October issue of MECHANICAL ENGINEERING, page 681, was made under the auspices of the Committee on Work Periods in Continuous Industries of the F.A.E.S., and was financed by the Cabot Fund. The subject of frequent comment in the public press, it has done much to educate the public to the fact that the engineer is vitally interested in industry's human as well as its material problems. This report will appear in book form in the near future.

The report of the Committee on the Elimination of Waste in Industry and the passage of the Nolan Patent Bill are two outstanding achievements which have engaged the attention of the F.A.E.S., details concerning which have been so widely circulated in both the secular and the technical press as to require no further explanation.

It is in problems of the Muscle Shoals type, Mr. Carman pointed out, that an organization such as The Federated American Engineering Societies is admirably fitted to render unselfish public service by making available the facts relating to the development at Muscle Shoals.

The bill authorizing the establishment of a Research Laboratory for Flood Control was conceived and is backed by the F.A.E.S. The Federation, coöperating with the Department of Commerce, has brought about a standardization of paving bricks which resulted in the elimination of fifty-five of the sixty-six kinds previously used.

Mr. Carman also stressed the value to the individual engineer of the publicity which the Federation is gaining for the profession, quoting President Cooley, who in a recent address on What the Federation is Doing, stated that before the formation of the Federation, the engineer had no vehicle to convey his knowledge to the public in general and that he was known only by his works. The public thought of him as dealing only with material things, with no particular ability to enter any other field than that of directing and handling the forces and materials of nature, from which a bridge or a machine may result. The problems which the F.A.E.S. has already handled and the problems which are now under consideration, with the publicity given to them, have done much to acquaint the public with the engineer's ability in heretofore unoccupied fields that lie within the scope of his profession.

These and other concrete activities into which the ideals of the F.A.E.S. constitution have materialized were enumerated in Mr. Wallace's report. The Federation has supported various items of Federal legislation, among which may be mentioned, in addition to the National Hydraulic Laboratory, the revision of mining laws, embargo on dyes, reclassification and compensation of engineers in Government service, Federal road act, and topographical survey. It has aided the Postoffice Department in the matter of establishing a materials-handling division, the Civil Service Commission in formulating a salary scale, the Ordnance Department in regard to design of equipment, the Bureau of Forestry in reforestation, and various other departments and bureaus in supplying information of miscellaneous character. Through official representation it has participated in conferences on the reduction of styles and sizes of paving bricks, as previously mentioned; on highway construction, for the consideration of letting of fall highway contracts; on unemployment; and on national jurisdictional awards in the building industry.

While not exhaustive, this summary indicates the scope and character of the work of the Federation. The *public recognition* of the value of its services is a point which should receive particular emphasis in such a summary, for the importance of this factor in the continuing success of the organization is obvious, in that it is essential to an ever-broadening field of service.

Engineers on Coal Commission

Among the appointees to the President's Coal Commission are two engineers, John Hays Hammond and George Otis Smith. This is in accordance with a recommendation of the F.A.E.S. that two engineers be named, and Dr. Smith, who has temporarily resigned as director of the Geological Survey to serve on the Coal Commission, is one of several engineers which the Federation suggested for the place.

Other members of the Commission are Thomas R. Marshall, Samuel Alschuler, Clark Howell, Edward T. Devine, Charles P. Neill, David L. Wing, and C. E. Lesher, who will direct engineering investigations. At its organization meeting Mr. Hammond was elected chairman and Edward E. Hunt, who was a member of the Federation's Committee on the Elimination of Waste, was retained as secretary. The Commission will assemble all the essential facts touching the coal industry, to the end that practical measures may be found to insure a constant supply of coal at as reasonable prices as are consistent with fair wages and profits to those engaged in the industry.

The Promotion of Engineering Research

To establish state engineering experiment stations in the states and territories in connection with institutions of higher technical education for the promotion of engineering and industrial research as a measure of industrial, commercial, military, and naval progress and preparedness in times of peace or war, is the purport of a bill recently introduced in the House of Representatives. According to the provisions of this act such stations would be established under the direction of and in connection with some university, engineering school, or land-grant college, the state legislatures to designate and appoint those institutions best equipped and organized to conduct such researches. The far-reaching benefits to be derived from the experiments and investigations conducted in such stations will be evident to the engineering profession.

Among the subjects in connection with which researches, investigations, and experiments shall be conducted are those relating to transportation, road building, drainage, flood protection, aeronautics, aerodynamics, fuels, power, lighting, heating, refrigeration, ventilation, sanitation, architecture, and war activities.

The responsibility for the initiation and conduct of research shall rest with the individual engineering experiment station, but through the exchange of reports and the assistance of the Department of Commerce care will be taken to secure practical uniformity of methods, efficiency, and economical expenditure of funds, and to avoid useless duplication of research work.

Engineering and Industrial Standardization

The Main Committee of the A.E.S.C. Holds Its Fall Meeting

MANY matters of vital interest were discussed and acted on at the quarterly meeting of this Committee which was held in the Engineering Societies Building on October 19. A morning and afternoon session were necessary to complete the business on the agenda for the meeting. Thirty of the fifty-two members now forming the Committee were present and Mr. Charles D. Young, general supervisor of stores of the Pennsylvania System, Stores Department, Philadelphia, Pa., was announced as the successor to Mr. Alfred W. Gibbs, deceased, one of the representatives of the American Society for Testing Materials.

Mr. S. J. Williams, chairman of the Safety Code Correlating Committee, reported in behalf of his Committee which had held a meeting on the previous day. On recommendation of the S.C.C.C., sponsorship for the Safety Code for Tanneries and the Safety Code for Mechanical Power Control were assigned to the National Bureau of Casualty and Surety Underwriters. The second important recommendation of this Committee was that separating the Safety Code for Exhaust Systems from the Safety Code on Ventilation; both of which subjects had already been assigned to the American Society of Heating and Ventilating Engineers as a sponsor body.

Sheet- and Plate-Metal Working and Forging and Hot Stamping

As a natural development of the work on the recently completed Safety Code for Punch Presses, the Safety Code Correlating Committee now proposes the formulation of safety codes on Sheet- and Plate-Metal Working, and on Forging and Hot Stamping. The American Engineering Standards Committee, while considering favorably this recommendation, referred it back for further consideration and investigation, with the suggestion that possibly the code for forging should be separated from the code for hot stamping.

In accordance with the recommendation of a special committee of which Dr. L. W. Chaney was chairman, the Safety Code for Power Presses submitted by the Sponsor, the National Safety Council, was ordered submitted to letter-ballot of the Main Committee for approval as a Tentative American Standard.

Sponsorships and Personnel Approved

The Code for Electricity Meters having been previously approved as an American Standard, the Main Committee at this meeting designated the Association of Edison Illuminating Companies, the National Electric Light Association, and the Bureau of Standards as joint sponsors for future revisions of the code under the regular procedure of the American Engineering Standards Committee. In the same manner the specification entitled Methods for the Chemical Analysis of Alloys of Lead, Tin, Antimony and Copper was approved as a Tentative American Standard for submission to letter ballot of the entire Committee and the American Society for Testing Materials was designated as Sponsor for this subject.

Votes were taken on the personnel of the following seven Sectional Committees which had been previously circulated to the members of the Main Committee and were all approved as submitted by the Sponsors: Code on Protection against Lightning, Aluminum for Electrical Conducting Purposes, Gas Safety Code, Electrical Installations on Shipboard, Electrical Power Control, Safety Code for Building Exits, and Safety Code for Mechanical Refrigeration.

Legal Penalties Not to be Included in Approved Safety Codes

For some time it has been the opinion both of the men engaged in the formulation of safety codes and of practically all state officials that legal penalties for failure to conform to approved safety codes and methods of enforcement can be worded best by the industrial board of each state as it adopts the standard code.

On the recommendation of the Safety Code Correlating Committee, therefore, the American Engineering Standards Committe has established the policy to exclude from all safety codes developed under its auspices all clauses relating to legal penalties or to methods of enforcement.

Cooperation with the Federal Specifications Board

As chairman of a special committee which had investigated this subject, Mr. A. A. Stevenson outlined the present and proposed relations between the American Engineering Standards Committee and this Board. He stated that the purpose of the Federal Specifications Board is to unify Government specifications, and to bring them into line with the best commercial practice. Before adoption by the Board the proposed specifications are being submitted to the American Engineering Standards Committee, at first informally, to determine their acceptability to industry, and for criticism. It was hoped that in future revisions many if not most of them would go through the regular American Engineering Standards Committee procedure. The special committee felt that the action of the Federal Specifications Board presented an opportunity to the A.E.S.C. to render a notable service both to the Government and to industry, and that a forward step in national industrial standardization should result.

Seven specifications have already been submitted. These are: Hose Specifications, Specifications for Wood Screws, Specifications for Sterilizing Equipment, Specifications for Numbered Cotton Duck, Specifications for Pig Lead, Specifications for Silicon Copper, and Specifications for Phosphor Tin. These are being handled informally, by committees organized somewhat upon the lines of those handling projects submitted for approval under Section R-4 of the Rules of Procedure.

The recommendations of the special committee were discussed at length. After a detailed consideration of each of the recommendations of the committee, and upon motion by Mr. A. A. Stevenson, the following action was taken by unanimous vote:

> In order to assist the Federal Specifications Board in bringing the Government specifications into line with the best commercial practice be it—
>
> *Resolved*, That the American Engineering Standards Committee will use its facilities and its contacts to obtain for the Federal Specifications Board the reaction of industry to the various specifications which may be submitted;
>
> *Resolved*, That this be done through the organizations which speak for the branch of industry concerned in any particular specifications, and through outstanding individuals;
>
> *Resolved*, That the work be carried out under the general direction of a small committee advisory to the Chairman of the American Engineering Standards Committee;
>
> *Resolved*, That all of the detailed work on each specification be done informally and with such minimum machinery as may be determined by the aforesaid committee in each case;
>
> *Resolved*, That the American Engineering Standards Committee will not concern itself with the details of any of the specifications.

It was agreed that the special committee should be discharged and that the work on specifications to be submitted by the Federal Specifications Board hereafter should go forward under the general direction of the small committee provided for in the Resolutions which are to be appointed by the Chairman.

A.E.S.C. Handling 106 Projects

Of the projects which have official status before the A.E.S.C., 20 are concerned with mechanical engineering; 17 are civil engineering projects; 15 are electrical; 3 are automotive; 10 are concerned with transportation; 10 with ferrous metals; 11 with chemical; 5 with non-ferrous metals; 4 with mining; 2 with textiles; 1 with shipbuilding; and 8 projects are of general interest.

Twenty-four standards or safety codes have been approved and 36 are up for approval. The remaining 46 projects represent codes and standards which are either in the process of formulation, or which are now being considered by committees of representatives, designated by the various bodies, industrial technical and governmental, interested in each particular subject. In this way more than 200 such bodies are officially participating in the work of the A.E.S.C. through their accredited representatives.

A regular interchange of information as to the status of work under way is maintained by the American Engineering Standards Committee with the national standardizing bodies of Austria, Belgium, Canada, Czechoslovakia, France, Germany, Great Britain, Holland, Italy, Japan, Sweden, and Switzerland. This information is issued in the form of quarterly reports and includes a statement of the status of each project on which work is actively under way.

Thirteen Specifications Submitted under Rule R-4

The American Society for Testing Materials submitted to the A.E.S.C. in due form its specifications on the subjects which are listed below.

Specifications for Carbon-Steel and Alloy-Steel, Blooms, Billets and Slabs for Forgings (A17–21)
Specifications for Cold-Rolled Steel Axles (A22–21)
Specifications for Carbon-Steel Bar for Railway Springs (A14–16)
Specifications for Helical Steel Springs for Railways (A61–16)
Specifications for Elliptical Steel Springs for Railways (A62–16)
Specifications for Welded and Seamless Steel Pipe (A53–21)
Specifications for Welded Wrought-Iron Pipe (A72–21)
Specifications for Refined Wrought-Iron Bars (A41–18)
Specifications for Wrought-Iron Plates (A42–18)
Specifications for Staybolt, Engine Bolt and Extra Refined Wrought-Iron Bars (A84–21)
Method of Test for Unit Weight of Aggregate for Concrete (C29–21)
Method of Test for Voids in Fine Aggregate for Concrete (A30–22)
Method of Test for Organic Impurities in Sands for Concrete (C40–22)

These proposals are now before the members of the American Engineering Standards Committee, and Dr. P. G. Agnew, Secretary of the Committee, will be glad to receive as much information as possible concerning the use and general approval of these thirteen standards.

Conference on Numbering of Steel Called by A.E.S.C.

A conference to consider the desirability of providing a system of designating qualities or kinds of steels by code numbers, has been called by the American Engineering Standards Committee at the request of the U. S. Bureau of Standards. The conference will be held in Room 704, Department of Commerce Building, Nineteenth Street and Pennsylvania Avenue, Washington, D. C., at 10 a.m., December 6.

The subject of this conference is a matter of great importance to all manufacturers of steel and to all users of steel in large quantities. This conference will attempt to determine the desirability of applying a uniform numbering system to forging steels, casting steels, structural steels, including plates, tool steels or other steels not so classified.

While the American Engineering Standards Committee has invited to this conference representatives of all technical and industrial associations known to be interested in the subject, any organization which feels that it should be represented in the conference, but has received no formal invitation, is urged to communicate with the American Engineering Standards Committee, 29 West 39th Street, New York City.

The Society of Automotive Engineers has already formulated a system now in wide use, applying to the steels used in automotive practice, and there has been considerable discussion as to the advisability of applying such a system more generally.

The following are the agenda which were suggested for this conference, at an informal meeting in New York on September 15, 1922, of persons interested in the topic:

1 Address by W. A. Durgin, Chief, Division of Simplified Practice, Department of Commerce, Washington, D. C.
2 Election of Chairman, Alternate and Secretary.
3 Résumé of present American Practice and of the steps leading to the conference.
4 Résumé of European practice by L. H. Fry.
5 Is it desirable to have a uniform numbering system for forging steels?
6 Is it desirable to have a uniform numbering system for casting steels?
7 Is it desirable to have a uniform numbering system for structural steels, including plates?
8 Is it desirable to have a uniform numbering system for tool steels?
9 Is it desirable to have a uniform numbering system for any other steels?
10 What should be the basis of classification for such a numbering system: chemical composition, physical properties, or heat treatment?
11 Are there systems existing which can be used as a basis for any or all of the above groups?
12 What, if any, are the limitations of systems now in use or proposed?
13 Are there special steels that will not fit a numbering system?
14 Can a system be worked out to permit of varying tolerances?
15 Can brand names be accommodated to and associated with a numbering system?
16 Are there other recommendations that the conference wishes to make to a continuing or sectional committee?

Standardization of Shafting

Through its chairman, Prof. A. H. Beyer, the Sub-Committee of this Sectional Committee which is standardizing the technique of shafting design has reported the completion of Part 1 of its report. As outlined below, this part is a highly technical discussion of the theory involved in this project. Owing to this fact it has not been deemed advisable to manifold this analysis, but typewritten copies are available for loan to those persons especially interested.

Part 1—The Application and Limitation of Shafting Formulas. This is a résumé of the many formulas heretofore advanced, with special emphasis on their proper application to the design of shafts under various conditions of loading to which a shaft may be subjected. The application and limitations of these formulas are discussed in detail from the standpoint of the many theories of elastic failure advanced from time to time for material under combined stress. The report concludes that under complex stress distribution the maximum intensity of the shear stress is the factor which ultimately determines elastic failure. As a result, comparatively simple formulas based upon the maximum shear theory of elastic failure are recommended as standard.

Part 2—Technique of Shafting Design. The second part of the Sub-Committee's report now in preparation will set forth in detail in accordance with the conclusions set forth in Part 1 the formulas recommended as standard for the design of shaft under the varying loading conditions. Definite unit working stresses for the different shafting steels will be recommended, and as far as possible the technique of shafting design will be standardized.

John Bergoyne Foote Dies

In the death of John B. Foote on October 12, 1922, the gear-manufacturing profession lost one of its most active members. Beginning at the age of fourteen as die setter for the Chicago Stamping Co., he had advanced step by step to the office of presidency of the Foote Brothers Gear & Machine Co., Chicago, and had become in that time thoroughly familiar with all branches of his profession.

Mr. Foote took a keen interest in anything that would further efficiency in machine operation. He was a pioneer in making cut-steel, case-hardened, tough-cored gears for heavy-duty work. He was one of the first to invent and build enclosed types of transmission for reducing electric-motor speeds and in connection with the development of the present light-weight type of farm tractor was the inventor of the enclosed transmission and live-axle drive. He also invented numerous automatic machines for making cans and was regarded as a foremost authority on special machinery.

In addition to his position as president and treasurer of the Foote Company, he was also a director of the Barton Spider Web Reenforced Concrete System; president and director of the Illinois Tractor Co.; treasurer of the American Tractor Association; director of the American Gear Manufacturers' Association; and a member of the Society of Automotive Engineers and various fraternal and athletic clubs.

NEWS OF OTHER SOCIETIES

Society of Industrial Engineers

The theme of the ninth national convention of the Society of Industrial Engineers held in New York, October 18, 19, and 20, 1922, was Economics in Industry, and the program was devoted to the study of the fundamentals necessary to obtain maximum production with minimum effort, waste, and cost. Among the specific subjects were economics in the formation of a policy of business administration, the economic background necessary for a business executive, the relation of fatigue elimination to other activities, the budget and the financial forecast, the importance of the elimination of waste to the economic structure, reduction of production costs, keeping workers contented, industrial accounting, reducing sales costs, scientific selection of people for jobs, and materials handling.

Prof. Joseph W. Roe, president of the society and head of the Department of Industrial Engineering at New York University opened the convention with an address on the relation of economics to industry. The economist, he said, is essential to all large-scale industry. He collects and studies masses of facts covering wide areas and long periods of time and understands and can deal with forces of which the manager is conscious but with which he is not trained to cope. In the case of wages, for instance, studies covering nominal and real wages in all the major industries and in all countries, back to the Middle Ages, the trend of prices and the history and causes of periodic fluctuations, enable the economist to meet intelligently the conditions surrounding each recurrent cycle. Professor Roe advocated more general reading on economics, industrial history, and labor relations by industrial executives and labor leaders, the introduction of courses on these subjects in colleges and schools, and the development of a systematic study of the sources, quantities, and prices of industrial materials and the means of making such information more generally available.

Discussing the part of economics in the formation of a policy of business administration, J. H. Pardee, president of the J. G. White Management Corpn., New York City, pointed out that in fixing the relation of selling price to production costs, the rate at which the public will buy must be carefully considered, and emphasized the need of common units and methods of measurements. The development of rational standards in regard to the latter he believed to be a big opportunity for service.

The education group of the society took up the question of the economic backgound necessary for a business executive. Among the speakers were Dr. Lee Galloway, Ronald Press, New York, Prof. F. D. Fairchild, Department of Social and Political Science, Yale University, and Prof. E. H. Schell, Department of Economics, Massachusetts Institute of Technology, who described the aims and methods of training administrative engineers in that institution.

A new and inexpensive device designed by Dr. Frank B. Gilbreth, Montclair, N. J., to eliminate fatigue in the transference of skill or in studying methods of performing work, was described by him. By means of this, details of the methods of an expert worker can be studied from moving-picture photographic prints in a leisurely manner without personal contact. Among the speakers on the subject of the relation of fatigue elimination to other activities were Dr. L. I. Harris, Department of Health, New York City, Prof. K. Spooner, Polytechnic Institute of London, and Dr. Uyeno, University of Tokio.

R. B. Wolf, consulting engineer, New York, and vice-president A.S.M.E., emphasized the need for a budget for the workman in an address on the importance of the elimination of waste to the economic structure. He defined waste as essentially the time which has passed when constructive thinking was absent, to reduce which the creativeness of the worker must be stimulated. Comparative performances enable the worker to see the possibilities of the future, and production cost records will help him to understand his relations to his fellow-workmen and to the plant as a whole.

Sherman Rogers, speaking on Short Cuts to Industrial Sanity, agreed with this policy, stating that no workingman will make a one hundred per cent effort until he understands the rules of the game he is working under.

A session was devoted to discussing how to reduce production costs and how to keep workers contented. J. A. Faust, Waltham Watch Co., Waltham, Mass., presented the executive viewpoint on the first of these questions. The executive, he pointed out, must have the ability properly to conduct financing, production, and sales. He took up the specific problems of reducing inventories, decreasing turnover, establishing best production methods, reducing the line of products, and compensating labor so as to secure the best returns. The worker's viewpoint was presented by William Geiger, Keratol Co., Newark, N. J. He advocated the better use of the worker's time and skill and a fifty-fifty basis for both work and pay, and commended the piece-work plan as easy to understand and practical to use if the operation is repeated. Charles Cheney, Cheney Brothers, South Manchester, Conn., believes in the efficiency of the credit-rating plan for keeping workers contented. This provides for putting the worker into a grade or class in which the base rate has been fixed, and adding to this rate for qualities which render him especially valuable as an employee, such as a record for quality and quantity of production, length of service, record of attendance, versatility, etc.

The industrial relations division of the society held a meeting, the subject of which was how to develop a more scientific method of selecting people for jobs. Earl B. Morgan, manager of employment and service, Curtis Publishing Co., Philadelphia, emphasized the importance of a pleasant stage setting for interviewing employees, the superiority of practical tests over written examinations, and the fairness of competition for employees as well as for business. Discussion at this meeting brought out the value of analyzing the characteristics of both executives and employees so that they may be fitted into the places where they work together to the best advantage and the most harmonious relations may be maintained. The foreman's part in selecting and dismissing employees was also discussed.

Ernest F. Du Brul, general manager of the National Machine Tool Builders' Association, made some pointed remarks concerning the economic aspects of production. In economics, he said, production means, not the fabrication of physical goods, but the creation of utility, whether of time or place or form, and presupposes adequate demand. Production, if increased beyond the point where a use or a profitable market can be found for the goods, is wasted effort and capital. Mere fabrication does not necessarily create value, for the price obtained for the goods is measured by the value to the buyer at the time of sale, not the cost to the producer. If the manufacturer does not rightly forecast the demand at the time of manufacture and adjust the supply to meet it, he must sell at a loss. It is also true that greater output may not mean lower cost and greater profit. Mr. Du Brul commended the man who takes business risks for the sake of the world's progress.

The final session of the convention was on the subject of materials handling. The special phase considered was the application of economics to materials handling for the purpose of reducing cost and increasing production. R. A. Wentworth, manufacturing manager of Barrett Co., New York, spoke on the shortage of man power since the war, and pointed out the opportunities for service in developing machinery for materials handling. M. R. Dennison, superintendent of the stores division of the Studebaker Corpn., described some of the crane equipment and special hoisting devices in use at the South Bend works of his company. Hand labor has been practically eliminated in this plant, especially in the handling of waste material, which is one phase of material handling usually overlooked. In the South Bend plant a tunnel equipped with a conveyor receives the borings and turnings which are delivered to trucks. One tractor is devoted to this use and cranes are used to place the boxes in the cars.

M. W. Potts, construction engineer, presented a paper on portable elevators or tiering machines, and showed motion pictures of the process of the handling of dies from storage to the punch presses and the handling of tote boxes at the plant of the Seng Co., Chicago. The loading of wire on cars at the works of the Interstate Iron & Steel Co. was also shown, this installation being said to have reduced the time of loading a car from two and one-half hours to one hour.

An illustrated talk on the use of steel belt conveyors was given by Harry Carlson, Sandvik Steel, Inc., New York, in which he

outlined the ease of installation, the rust-resisting properties of the belt, and the simplicity with which material can be discharged at any point along the conveyor without the use of expensive trippers. The speed of the steel belt varies from 135 to 300 ft. per min., the average being 200 ft.

The final address on the program was made by W. P. Stivey, Philadelphia, who discussed the design and use of gravity conveyors. Mr. Stiver emphasized the need for selecting machines suitable for the work they have to perform, such as using light units for light work. Mr. Stiver advocated the use of more boosters than are usually found, and explained the principle underlying the action of helical chutes. In conclusion, he gave eight principles underlying the successful installation of gravity conveyors. The use of conveyors requires a knowledge of various types of equipment available so that the one best adapted to the particular use may be selected. Routing conditions must also be studied and the layout for the conveyors considered when the buildings are being planned. The use of the equipment should be thoroughly understood and some one person should be responsible for keeping it in condition.

In connection with the convention an exhibition of various products, particularly materials-handling equipment, was held. A miniature model of a conveyor system made up of a helical chute, belt and gravity conveyors, inclined-slat conveyor and an automatic straight-lift elevator, was displayed by the Standard Conveyor Co., of North St. Paul, Minn. The Lamson Co., of Boston, showed patented differential curve and various pneumatic-tube carriers used in connection with its conveyor. Sandvik Steel, Inc., New York, exhibited a model of an actual installation of a steel-belt conveyor, with all units one-twentieth actual size, and combining inclined and horizontal drive in one unit. A portable scoop conveyor was shown in operation by the Portable Machinery Co., Passaic, N. J., a telescoping portable elevator was demonstrated by the Economy Engineering Co., Chicago, and a large exhibit of scales of various kinds was displayed by the Toledo Scale Co. Among other exhibits were industrial systems for inventories, production and machine control, and signal and telephone systems for shop use.

Joint Meeting of Steel Treaters and Forgers

The joint convention of the American Society for Steel Treating, the American Drop Forging Institute, and the Drop Forge Supply Association, held in Detroit, Mich., together with an international steel exposition, during the week of October 2, 1922, eclipsed all previous conventions of this nature, both in attendance and scope. The total attendance was estimated at 18,000. The exhibition and the entertainment and social features of the convention were participated in jointly by the steel treaters and forgers, but the technical sessions, with one exception, were held separately. The program of the American Society for Steel Treating included only about one-third as many papers as have been presented at former meetings, so that there was ample time for discussions. There were sessions on carburizing, heat treating, and tool steel, symposiums on metallurgical education, hardness testing, and research, and three round-table discussions on the subject of heat treating.

The opening technical session included three papers on carburizing. H. B. Knowlton, Milwaukee Vocational School, discussed carburizing and decarburizing factors determining the success or failure of the case-hardening methods used in commercial practice. The temperature of the lining of the furnace and the ratio of the weight of the charge to the weight of the lining, he said, were important factors in determining the speed of heating. The carbon content of the case was treated in some detail. Irregularities in case-hardening were summarized in a paper by E. W. Ehn, metallurgist, Timken Roller Bearing Co., Canton, Ohio, who said that many failures, especially in reference to soft spots, are due to abnormal steel. Carefully made and deoxidized steel is essential to successful results. A. H. d'Arcambal, metallurgist, Pratt & Whitney Co., Hartford, Conn., described tests on low-carbon steel treated with cyanide. Due to its lower hardness, plain carbon steel will show a higher impact reading than an alloy steel.

In a general session on heat-treating problems held October 4, heat treating in lead, furnace atmospheres and scale, electric furnaces for steel treating and chrome-vanadium steels were discussed. R. B. Schenck, metallurgist, Buick Motor Car Co., presented a paper on the first of these subjects in which he stated that the lead pot can produce better work than any other form of heating unit and gave reasons therefor. A paper by G. C. McCormick, assistant metallurgist, Crompton & Knowles Loom Works, Worcester, Mass., presented experimental data from which it was concluded that under certain conditions oxidizing, neutral and reducing atmospheres permit the formation of scale in furnaces. The advantages of electric furnaces for steel treating were enumerated by C. L. Ipsen, designing engineer, Industrial Heating Department, General Electric Co., who also showed lantern slides illustrating various types of furnaces.

Among the papers presented at the tool-steel session was one entitled Lathe Breakdown Tests of Some Modern High-Speed Tool Steels, by H. J. French, physicist, U. S. Bureau of Standards, and Jerome Strauss, chief chemist, U. S. Naval Gun Factory. Mr. French classified the steels tested according to chemical composition and used this classification as a basis in discussing the results obtained and conclusions drawn. The effect of structure upon the machining of tool steel was described by J. V. Emmons, metallurgist, Cleveland Twist Drill Co., who stated that conclusions drawn from a period of observation covering five years had been confirmed by successful application to commercial work during the last seven years. A knowledge of the structure the speaker held to be as important as a knowledge of the hardness. Various machining operations were considered and general conclusions made as to the most favorable structure for each.

The hardness-testing symposium was held under the direction of the hardness testing committee of the National Research Council and included an interesting paper on methods of hardness testing at present in use. Pertinent suggestions as to metallurgical education and research in relation to executives, engineering societies, and the Government were made at other symposiums.

A joint session of the American Society for Steel Treating and the American Drop Forging Institute was held October 4, and included addresses on labor matters and anti-trust laws. Employee-representation plans were advocated as one of the fundamentals of successful coöperation which will not be to the detriment of individualism. Other papers at sessions of the Forging Institute dealt with power-plant costs and the flow of metals in forgings.

The steel exposition covering over 50,000 ft. of floor space in the General Motors Building, showed heat-treating equipment and processes of over 100 exhibitors. Machinery and steel company exhibits were numerous, as were also types of furnaces. Pyrometers and other testing apparatus, temperature-measuring apparatus, heat-resisting alloys, refractory and insulating products, forgings of all kinds, and many manufactured products involving heat treatment, made this exposition one of the most impressive ever held.

Inspection trips were made during the week to various motor-car plants in Detroit and vicinity, the Burroughs Adding Machine Company, the Central Forge & Gear Co., the Detroit Steel Products Co., and the Detroit Twist Drill Co.

American Gear Manufacturers' Association

The semi-annual meeting of the American Gear Manufacturers' Association held at Chicago, October 9 to 11, 1922, featured standardization work. Reports and recommendations of its sectional and sub-committees showed splendid progress in this work. The A.G.M.A. sectional committee of the American Engineering Standards Committee reported the status of work on its standard for composite gearing, and its recommended practices for the inspection of gears, for herringbone gears, and for industrial spur gears. A number of other standards affecting the gear industry have been printed[1] and submitted to the sponsor societies for their approval.

The report on straight and bevel gears received particular attention. The basis of the bevel-gear system recommended by the committee is the use of the lowest pressure angle possible without sacrificing strength by introducing excessive under-cut. It was stated that bevel gears cut with a lower pressure angle will operate with less noise than those with a higher angle, other conditions being the same. The system, which applies only to generated gears, pro-

---

[1] Mechanical Engineering, May, 1922, p. 332.

vides three pressure angles, of $14\frac{1}{2}$, $17\frac{1}{2}$, and 20 deg., respectively, for straight-tooth gears in all ratios having ten or more teeth in the pinion. The gear addendum decreases and the pinion addendum increases as the ratios of the numbers of teeth in the gear and pinion become greater.

The report of the metallurgical committee covered recommended practice for carburizing and case-hardening, and for the heat treatment of A.G.M.A. carbon and alloy steels. The inspection committee presented a report on methods of inspecting gears, the use of testing machines, etc., and the nomenclature committee reported that it was assembling nomenclature and symbols in collaboration with other sub-committees.

The measurement of gear noises was the subject of an interesting paper presented by Prof. D. L. Rich, dean of the Department of Physics, University of Michigan. He suggested three methods for the control of gear sounds, namely, absorption of the noise, insulation, prevention.

The question of costs was considered in the report of the cost accounting committee and in that of the commercial standardization committee, the latter stating that the scope of its work is limited because certain commercial practices cannot legally be standardized.

The report of the industrial relations committee disclosed a great variance in the wages of men on the same work in different cities, and discussed the need for a practical system for training apprentices. The latter subject was also taken up in an address by P. C. Molter, superintendent of the department of industrial education, National Metal Trades Association, who outlined a plan worked out by his association which provides a curriculum, fixes rates of pay, holds periodical examinations, and issues certificates. The question of holding apprentices to their contracts was discussed in some detail. Mr. Molter suggested two methods for doing this, one that of supplying the apprentice with tools as he progresses, so that at the termination of his course he will be in possession of a complete kit, and the other that of giving him a bonus at the completion of the apprenticeship term.

T. W. Owen was elected secretary to succeed F. D. Hamlin. His office will be in Cleveland and he will devote his entire time to the association.

American Society of Civil Engineers

San Francisco was also headquarters for the fall meeting of the American Society of Civil Engineers, held October 4 to 8, 1922. The subject under consideration was the water-power problem, and the program included several strong sessions at which technical papers were presented, local excursions, and a two-day trip to the Hetch Hetchy project.

John A. Britton, vice-president and general manager of the Pacific Gas & Electric Co., San Francisco, delivered the address of welcome, to which John R. Freeman, president of the society, replied. Mr. Freeman compared the modern hydroelectric practice with early developments, describing the Pit River plant in northern California, in which one of the 40,000-hp. units develops more power than the combined output of the 150 installations operating in the vicinity of Lowell and Lawrence, Mass., fifty years ago.

Possibilities in the way of power development in the West were pointed out by several speakers. Arthur P. Davis, director of the U. S. Reclamation Service, in an illustrated talk on the Colorado River development, stated that this is a national problem, involving international rights and with a potential supply of 6,000,000 hp. The best location for a storage reservoir, he said, is the Granite Gorge of Boulder Canyon, which is within transmission distance of large power markets. A reservoir in this gorge would completely eliminate the flood menace of the river and would furnish the regulation and head necessary for a development of 600,000 primary horsepower and fulfill the requirements of irrigation in Arizona and California.

F. H. Fowler, district engineer, U. S. Forest Service, San Francisco, speaking of the water-power potentialities of the Pacific Coast, showed that practically all the western coast is within a 500-mile radius of the two great sources of power, the Colorado and Columbia Rivers.

J. D. Galloway, consulting engineer, San Francisco, stressed the importance of providing for both irrigation and power. The demand for power in California, he stated, has been increasing three or four times as fast as the population, there having been an increase of 138 per cent in nine years. He estimated that the annual energy output will exceed ten billion kilowatt-hours by 1930.

H. W. Dennis and H. A. Barre, both of the Southern California Edison Co., presented a paper telling of the increased services of this company in recent years and plans for future growth.

Among other papers presented was one by F. W. Peek, Jr., consulting engineer for the General Electric Co., Pittsfield, Mass., in which it was stated that the ultimate voltage of transmission would be limited only by sources and markets for power, the cost of high-voltage lines being so great that they can be built only when large amounts of power are to be transmitted.

The social and economic aspects of hydroelectric power production were presented in an address by C. D. Marx, professor of civil engineering, Leland Stanford Jr. University, and past-president of the American Society of Civil Engineers, at an evening meeting on October 5.

The excursion to the Hetch Hetchy project, with a side trip to the Don Pedro Dam, afforded the engineers a splendid opportunity to study the 18-mile tunnel, the concrete and earthen dam, the Moccasin Creek power-house and other units now under construction.

American Iron and Steel Institute

The twenty-second general meeting of the American Iron and Steel Institute was held in New York, October 27, 1922. The general sentiment of the meeting, as expressed by President Gary in his opening address, was that there are no obstacles to continued prosperity in the iron and steel business of the United States except such as may arise from interference with the natural course of supply and demand.

Admiral Vogelgesang, in a dinner address, told of the relation of the navy to the general economic life and particularly to the steel industry of the country.

Nine technical papers were presented, covering the principal activities of the industry. H. Foster Bain, director of the Bureau of Mines, discussed modern methods of mining coal, and showed the Bureau's reel on The Story of Coal, which portrays the operation of mining, both above and below ground. Dr. John A. Mathews, president of the Crucible Steel Company of America, read a paper entitled the Present Status of the Electric Furnace in Refining Iron and Steel, which gave reasons for worldwide expansion of the use of the electric furnace, particularly its versatility and the importance of clean steel.

The economic importance of the power plant in the steel industry was discussed by Edward F. Entwisle, assistant general manager of the Steelton plant of the Bethlehem Steel Co. He pointed out that in many cases the development of the plant's own power supply has not kept pace with the peak power demand, so that electric current frequently must be purchased. He also emphasized the importance in steel manufacture of knowing the cost of every item, raw materials, labor, repairs, transportation, etc., and their relation to each other.

W. P. Chandler, Jr., fuel and experimental engineer for the Carnegie Steel Co., at Duquesne, Pa., in an address on Heating Furnaces for Blooms, Slabs and Billets, described the continuous recuperative furnace and the non-continuous regenerative furnace, pointing out their respective merits, and discussed various methods of firing metallurgical heating furnaces.

The Thermal Efficiency of the Open-Hearth Furnace was the subject of a paper by C. L. Kinney, Jr., and G. R. McDermott, both of the Illinois Steel Co. This paper dealt with the design of a proposed 100-ton open-hearth furnace.

Henry T. Chandler, metallurgist for C. H. Wills & Co., Marysville, Mich., enumerated the steel requirements of the automotive industry, classifying steels as they are used in various parts of motor cars.

A joint paper by John V. Freeman, U. S. Steel Corpn., and Harry H. Stock, professor in mining engineering at the University of Illinois, dealt with the precautions which are necessary in the piling and draining of bituminous coal and with other factors essential to its safe storage.

Other papers presented at the technical sessions were Fluorspar and Its Uses, by G. H. Jones, president of the Hillside Fluorspar Mines, Chicago, and The Use of Liquid Fuel in Metallurgical Furnaces, by R. C. Helm, director of the Worcester Research Laboratory of the American Steel and Wire Co.

The American Institute of Mining and Metallurgical Engineers

The 126th meeting of the American Institute of Mining and Metallurgical Engineers was held in San Francisco, September 25 to 29, 1922. The technical sessions were confined to the first day of the meeting and the interest centered about ore-hunting geology and modern ore-dressing methods. At the mining geology session Wilbur H. Grant described the United Comstock mines which he said had produced 3,000,000 tons of ore and $100,000,000 in precious metals. These mines were visited by some 250 engineers on their way to the convention and the paper concerning them was discussed with much interest. The Aztec mine was also described in a paper presented at this session.

At the mining methods session the underground system of handling ore was outlined in a paper by John R. Reigart, superintendent of mines at the United Comstock Mines Co., and a paper on Metal Mine Ventilation in the Southwest was presented by Chas. A. Mitke, of Bisbee, Ariz.

The milling session included two papers on milling methods and metallurgy at the Comstock mines, paper on the mathematical study of basic principles of gravity concentration, and one on research on phenomena in flotation in which surface tension and adsorption play the principal parts.

On Tuesday, September 26, a number of engineers left for the Hetch Hetchy Valley, where the dam which will hold water sufficient to furnish San Francisco and neighboring cities with 400,000,000 gal. daily is partly built. The engineers also visited the lowest power house, at Rattlesnake Creek, where a reservoir is being constructed which will hold a two days' supply of water, the upper power house at the intake of the 18-mile tunnel which will carry the water down from the mountains, Big Creek shaft, an intermediate point on the tunnel line, from the bottom of which the tunnel has been driven over a mile both north and south, and Mather, where the lumber which is being used in the project is being sawed.

There were also excursions during the week to the University of California and Leland Stanford, Jr. University, and an inspection of modern methods employed in the silver refinery at the Selby smelter.

National Machine Tool Builders' Association

Marking the completion of its twentieth year as an organization the National Machine Tool Builders' Association held an unusually strong annual meeting at Lenox, Mass., October 3 to 5, 1922. The retiring president, A. H. Tuechter, president of the Cincinnati Bickford Tool Co., reviewed the work of the association, discussing the problems which it has met and indicating future policies which it should follow in order to be most influential in developing industrial stability. Mr. Tuechter gave considerable attention to cost systems, discussing in particular the cost of unavoidable idleness in the machine-tool industry, and said that one of the most constructive pieces of work that a trade association may undertake is the exposure and elimination of trade abuses.

E. J. Kearney, secretary of the Kearney & Trecker Co., Milwaukee, Wis., was elected president to succeed Mr. Tuechter, and Ernest F. Du Brul, of Cincinnati, was reelected secretary and general manager.

The feature which contributed in a large measure to the success and value of the meeting was the large number of round-table discussions. The topics considered were wide in scope, including thirteen administrative subjects, five technical subjects, thirty sales subjects, and four dealer problems. These discussions formed the major part of the program. Among the few papers which were presented at the meeting was one on the worth of patents to the machine-tool industry, by Joseph K. Schofield, chief of patent department, Niles-Bement-Pond Co., and one on conditions that create unprofitable prices, by O. B. Iles, president of the International Machine Tool Co.

The Institute of Economics

The Carnegie Corporation of New York, in founding the Institute of Economics in Washington, has established another agency for the elimination of waste. The announcement of its formation states that the Institute will endeavor to ascertain the causes of avoidable economic losses and to point the way to their elimination. It will assemble and interpret the economic data which form the bases of national and international policies and present them in as untechnical a form as possible, through books, pamphlets, and special articles. Among the subjects which will receive the attention of the Institute are: international policies; questions of domestic and international finance; the relations of government to business; problems of agriculture, taxation, and transportation; and the various issues relating to industry and labor.

Noted English Engineer Visits United States

William Henry Patchell, vice-president of the Institution of Mechanical Engineers of England and widely known in the central-station field, has been a recent visitor to this country. Mr. Patchell is particularly noted for the design and construction, some seventeen years ago, of the large boiler with 20,000 sq. ft. of heating surface for the Bow Street Station in London. This boiler established a new standard and marked the starting point of modern large boiler practice. Mr. Patchell's experience has extended beyond power-plant work however, and his visit has afforded a remarkable opportunity for American engineers to exchange news on a great variety of engineering subjects.

At a recent dinner given in his honor by a group of central-station designing and operating engineers and executives, Mr. Patchell emphasized the importance of international understanding and coöperation between individual engineers and also between engineering organizations.

He told of the steps being taken in Great Britain where a Joint Council has been formed with representation of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects and the Institution of Electrical Engineers. Mr. Patchell spoke particularly of the A.S.M.E. Boiler Test Code and stated that a joint code was being developed in Great Britain to supersede the old code of the Civil Engineers. He expressed the hope that work on the American code would permit consideration of an international code. In speaking of engineering society activities in England, Mr. Patchell emphasized the importance of the steps taken by the English engineering societies to maintain a high standard of membership qualifications.

First Pan-Pacific Commercial Conference Held in Honolulu

The Pan-Pacific Union, which is "an organization directed by representatives of all Pacific races, supported in part by government appropriation, coöperating with chambers of commerce, boards of education, and kindred bodies in working for the advancement of Pacific interests, bringing together leaders in all lines of thought and action in Pacific lands, and organizing them into friendly coöperative effort," sponsored the first Pan-Pacific Commercial Conference, held at Honolulu, Hawaii, October 25 to 31, inclusive.

The conference was opened with papers indicating the significant Pan-Pacific commercial problems of each country. The general topics for discussion were communication and transportation, development and conservation of natural resources, finance and investments, and international relations in the Pan-Pacific area.

Participation in this conference was especially urged by the press of the Orient, where the work of the Pan-Pacific Union in directing scientific, educational, and press conferences has met with great appreciation. Pan-Pacific associations are among the most progressive organizations in Shanghai and Tokio, and the Union has branches in a number of the cities of the Orient.

The engineers of the United States were represented at the conference by J. A. Steinmetz, a member of the firm of Janney, Steinmetz & Co., of Philadelphia, and by the delegate of The Federated American Engineering Societies. The American Society of Mechanical Engineers was officially represented by S. N. Castle, consulting engineer, of New York and Honolulu.

LIBRARY NOTES AND BOOK REVIEWS

Aircraft Year Book. 1922. Aeronautical Chamber of Commerce of America, New York, 1922. Cloth, 6×9 in., 251 pp., illus., diagrams, tables, $3.20.

A general review of the year's progress in aviation prepared especially for those interested in its commercial development. Contains a review of commercial aviation during the year, a discussion of the problems of aerial transportation, an account of the comparative effectiveness of aerial and naval armament, a review of aeronautics in different countries and an account of technical progress in construction during the year. The second section contains a collection of aircraft and engine designs, chiefly recent. The appendix contains information upon the aircraft trade associations, the government bureaus dealing with aviation and various commercial and historical tables.

Automotive Repair; Vol. 2 for Electrical-Service Men. By J. C. Wright. John Wiley & Sons, New York, 1922. Cloth, 6×9 in., 417 pp., illus., diagrams, $3.

The second volume of this comprehensive manual for repairmen treats of the electrical equipment of automobiles. It presents carefully detailed instructions for fifty-six electrical repair jobs, covering the derangements that occur most frequently. These are fully illustrated with drawings and photographs. In addition an account of electrical theory is given, sufficient for a thorough understanding of the functions of the electrical equipment of automotive vehicles.

Blast Furnace and the Manufacture of Pig Iron. By Robert Forsythe. Third edition revised by C. A. Meissner and J. A. Mohr. U. P. C. Book Co., New York, 1922. Cloth, 6×9 in., 371 pp., illus., diagrams, tables, $4.

Most recent writers on this subject have, in Mr. Forsythe's opinion, addressed themselves too exclusively to those acquainted with it. He therefore has written this concise statement of general principles, treated on essentially American lines, for beginners. The present edition has been revised by two expert blast-furnace managers, in order that it may present the practice of today.

Chilton Tractor Index. July, 1922. Chilton Company, Philadelphia, 1922. Paper, 7×10 in., 336 pp., illus., $2.

Contains directories of manufacturers of tractors, of farm powermachinery, threshers, plows, cultivators, electric plants, etc., and of tractor parts and equipment. Specifications and prices of the various machines on the market are given and there are indexes of trade names. The Index is a convenient summary of technical and trade information frequently needed by makers and users of tractors and farm machinery.

Condensed Catalogues of Mechanical Equipment. 12th Annual, 1922. The American Society of Mechanical Engineers, New York, 1922. Fabrikoid, 9×12 in., 622 pp., illus., $5.

The twelfth issue of this convenient reference book appears in new form, the book now having a 7×10 in. type page and being printed on thin India paper and bound in flexible covers. In other ways the volume follows the plan of previous years. It contains catalog information, condensed, uniformly presented and illustrated, about the products of 372 manufacturers of mechanical equipment; a classified directory of manufacturers of equipment, in which 4200 firms are listed under 3300 headings; and a directory of consulting engineers, containing the names and addresses of 1000 engineers, under 400 headings. In each of these divisions the new issue shows enlargement and thorough revision.

Cost Control and Accounting for Textile Mills. By Eugene Szepesi. Bragdon, Lord & Nagle Co., New York, 1922. Fabrikoid, 6×9 in., 441 pp., tables, $10.

This book discusses the various factors that contribute to the cost of manufacturing textiles, and methods of determining their several contributions. Describes a system of cost accounting in detail, which is adapted to the needs of manufacturers of textiles.

Cotton Facts. Compiled and edited by Alfred B. Shepperson. Revised and enlarged by C. W. Shepperson. Shepperson Publishing Co., New York, 1921. Cloth, 4×7 in., 180 pp., portraits, map.

A convenient compilation of commercial and financial information required by those engaged in the cotton industry, which has appeared annually for forty-six years.

Davison's Textile "Blue Book." Office edition. Thirty-fifth annual edition, July 1922 to July 1923. Davison Publishing Co., N. Y. Cloth, 7 × 9 in., 1670 pp., $7.50.

Covers all phases of the textile industry, including manufacturers, dealers and commission merchants in every kind of textiles, as well as dealers in textile supplies. The directory entries give concisely the location, officers, number of employees, and products of each mill, arranged geographically. This is the thirty-fifth annual edition, and has been thoroughly revised.

Descriptive Geometry. By George Young and H. E. Baxter. The Macmillan Co., New York, 1921. Cloth, 5×8 in., 310 pp., diagrams., $3.25.

Believing that the chief value of descriptive geometry lies in its imaginative quality, these authors present it so as to develop the imagination; and therefore they encourage intuitive rather than rigidly formal methods. The treatment has been kept purely abstract, in order to avoid the tendency of the subject to degenerate into practical rules and formulas; Introductory matter showing the relation of the principles under discussion to structural work is provided, and exercises to show the application of the abstract ideas to concrete, practical problems are included.

Dust Explosives. By David J. Price and Harold H. Brown. National Fire Protection Association, Boston, 1922. Cloth, 6×9 in., 246 pp., illus., diagrams, tables, $3.

The authors of this book are engineers and chemists connected with the Bureau of Chemistry of the U. S. Department of Agriculture, who have been engaged in an investigation of dust explosions in mines and factories. In the present work they consider the nature and theory of dust explosions, what explosions have done and what has been learned by studying those that have occurred in various industries. They then discuss the measures that have proved most effective in preventing explosions or retarding their development when started. A bibliography is included.

Essais de Soudures Autogène et Electrique de Pièces de Chaudières. By E. Hoehn. Ch. Béranger, Paris, 1922. Paper, 6×9 in., 78 pp., illus., diagrams, 4 fr.

This report gives the results of an extensive series of tests of autogenous and electric welds as applied to boiler construction, carried out in 1921 by the Association Suisse de Propriétaires de Chaudières a Vapeur. The points investigated included the welding of flanges to tubes and boiler shells, the welding of plates at right angles, tensile tests of different forms of welds, the influence of skin on welds, the quasi-arc electric process and the strength of welded tanks.

Export Merchandising. By Walter F. Wyman. First edition. McGraw-Hill Book Co., Inc., N. Y., 1922. Cloth, 6×9 in., 405 pp., illus., $4.

An extended discussion of the principles upon which the American exporter should base his efforts, with advice concerning proper practical methods. Discusses all phases of exporting. Written by an experienced exporter.

Foundrymen's Handbook, based on data sheets from *The Foundry*. First, edition. Penton Publishing Co., Cleveland, 1922. Cloth, 6×9 in. 309 pp., tables, $5.

Since 1907, *The Foundry* has regularly published "data sheets," containing practical information upon matters of interest to foundrymen. The result is a large accumulation of general and scien-

tific data, specifications, formulas and recipes, which are now presented in classified form, with an index, in a convenient volume for reference use.

Hand Book of Casinghead Gas. By Henry P. Westcott. Third edition. Metric Metal Works, Erie, Pa., 1922 Cloth, 5×8 in., 612 pp., illus., tables, $3.75.

The author of this work has endeavored to collect, in one volume of convenient size, all the chemical, physical, and engineering information upon the extraction of gasoline from natural gas which is likely to be needed by the man in the field. It treats of the examination and leasing of gas wells, determination of their capacity and the gasoline content of the gas, gathering lines, measuring gas, compression, absorption, blending, transportation, etc. Although few radical changes in method have been developed since the preceding edition of the book appeared, many minor improvements have been made which are now described.

Handbook of the Petroleum Industry. By David T. Day. John Wiley & Sons, New York, 1922. Fabrikoid, 2 vols., 6×9 in., illus., diagrams, tables, $15.

This work is written with especial reference to the engineers who produce and refine oil, but is also addressed to the public interested in the increase of production and the better utilization of our oil supply. Throughout the book attention has been directed to present conditions, and historical matter has been omitted.

Jigs, Tools and Fixtures, their Drawing and Design. By Philip Gates. D. Van Nostrand Co., New York, 1922. Cloth, 5×7 in, 195 pp., illus., diagrams, tables, $2.50.

This simple book on the drawing and design of jigs, tools and fixtures covers equipment for practically all modern machine tools. Chapters are devoted to drill jigs, milling fixtures, chucks, cutters, taps and dies, gages, press tools, etc. A chapter on office procedure is also given. The subject is presented in a simple, practical manner.

Lumber, Its Manufacture and Distribution. By Ralph Clement Bryant. John Wiley & Sons, New York, 1922. Cloth, 6×9 in., 539 pp. illus., map, tables, $4.50.

A text and reference book for students in lumbering, treats first of the manufacturing plant, discussing its location and arrangement, log storage, sawmill equipment, saws, handling and transfer equipment and power plants. The second section is devoted to lumber manufacture, and deals with labor, sawing and trimming, seasoning, remanufacture of lumber, lumber products, mill refuse, and fire prevention. The concluding section, upon markets and marketing treats of lumber trade associations, grades and inspection, transportation, domestic and foreign markets, import trade and tariffs. The appendix contains a bibliography, a glossary and tables of statistics. Covers a subject upon which few general books are available.

Mechanical Laboratory Methods. By Julian C. Smallwood. Third edition. Van Nostrand Co., N. Y., 1922. Fabrikoid, 5×7 in., 423 pp., diagrams, $3.50.

A handbook for students and mechanical engineers. Part one discusses the calibration and testing of balances, gages, dynamometers, engine indicators, planimeters, meters for gases and water thermometers, calorimeters, etc. Part two gives methods for testing fuels. Part three treats of the testing of power-plant units, such as steam engines, pumps and boilers, condensers, gas producers refrigeration plants, blowers and compressors, and water motors. The new edition has been thoroughly revised and modernized.

Metallurgy of Iron and Steel. Based mainly on the work of Sir Robert A. Hadfield. Sir Isaac Pitman & Sons, Ltd., London and New York, 1922. (Pitman's technical primer series.) Cloth, 4×7 in., 122 pp., illus., tables, $0.85.

This a is brief outline of the discoveries and developments on which is based modern practice in the metallurgy of iron and steel. Stress is laid upon the importance of conservation and the assistance rendered in this direction by progress in metallurgy. The book is based upon Sir Robert Hadfield's published papers, of which a list is given.

Notes Economiques D'un Metallurgiste. By Camille Cavallier. Gauthier-Villars et Cie, Paris, 1921. Paper, 6×9 in., 153 pp., 7 fr.

These brief economic discussions, by a French iron manufacturer, treat various present problems of French industry, particularly metallurgy. Such questions as the comparison between the foreign trade of France and Germany, the participation of manufacturers in national affairs and the relations of the heads of enterprises with capital and labor are treated, and the causes of and remedies for the present economic crisis are discussed in the light of long experience in industry.

Oil Encyclopedia. By Marcel Mitzakis. John Wiley & Sons, New York, 1922. Cloth, 5×9 in., 551 pp., $6.

This encyclopedia covers a wide range of information interesting to those engaged in the oil industry. Brief articles are devoted to engineering and geological subjects, localities where oil occurs, commercial information, and the history of the industry. A brief bibliography is included. The work will be interesting to those engaged in the oil trade.

Patent Essentials. By John F. Robb. Funk & Wagnalls Co., New York, 1922. Cloth, 6×9 in., 436 pp., plates, charts, $5.

Treats of the nature of patents, the mechanism of their procurement, claim drafting, conduct of patent cases and special proceedings, including forms. Is the work of an experienced patent attorney, but is intended for laymen who wish to understand the essentials of law and practise before the Patent Office, rather than for experts.

Power Alcohol. By G. W. Monier-Williams. Frowde, London, 1922. (Oxford technical publications.) Cloth, 5×8 in., 323 pp., illus., diagrams, $7.

A complete, well-balanced account of all the problems—engineering, chemical and economic—associated with the production and utilization of alcohol as a motor fuel.

Properties of Electrically Conducting Systems. By Charles A. Kraus. Chemical Catalog Co., New York, 1922. (American Chemical Society. Monograph series.) Cloth, 6×9 in., 415 pp., diagrams, $4.50.

Professor Kraus here presents a comprehensive systematic account of the more important conclusions reached by the study of ionic phenomena, which have hitherto been available only in scattered form, in periodicals and transactions of scientific societies. His book affords a convenient summary of the contemporary understanding of the subject, useful both to those directly engaged in studying it and to investigators in allied sciences.

Reinforced Concrete Simply Explained. By Oscar Faber. Henry Frowde and Hodder & Stoughton, London, 1922. (Oxford technical publications.) Cloth, 6×9 in., 77 pp., diagrams, $1.70.

Intended for readers who do not aspire to a specialist's knowledge, but want a clear understanding of the general principles involved in reinforced concrete, so as to be able to make simple designs, safe but not necessarily the last word in economy, and to take an intelligent interest in reinforced-concrete construction.

Sience of Purchasing. By Helen Hysell. D. Appleton Co., N. Y., 1922. Cloth, 5×8 in., 261 pp., $2.50.

Discusses the qualifications of a purchasing agent, the principles and policies to be adopted, the legal, economic and ethical principles to be observed, the organization and conducting of purchasing departments.

Six-Place Tables. McGraw-Hill Book Co., Inc., New York, 1922. Fabrikoid, 4×7 in., 124 pp., $1.25.

A selection of tables of squares, cubes, square roots, cube roots, fifth roots and powers, circumferences and areas of circles, logarithms of numbers, logarithms of trigonometric functions, and natural trigonometric functions. Arranged to meet the need for a volume of pocket size containing the tables in regular, continuous use by students and engineers.

Space—Time—Matter. By Hermann Weyl. E. P. Dutton & Co., New York 1922. Cloth, 6×9 in., 330 pp., diagrams, $7.50.

Although many popular introductions to the general theory of relativity have appeared, systematic presentations are not common and for this reason this translation of the leading German work on the subject is welcome. In it are given all the details of the mathemetical reasoning required for a thorough understanding of the subject. The author's extension of the theory to include electromagnetic phenomena is given in full.

Die Statik des Kranbaues. By W. Ludwig Andrée. Third edition. R. Oldenbourg, München, 1922. Paper, 7×10 in., 370 pp., diagrams, 348 marks.

Eighty examples of static calculations for cranes and similar structures. Includes traveling, cantilever, bridge, rotary, gantry, portal, floating, tower and shipbuilding cranes, aerial ferries, cableways, hoist frames, inclined bridges, grab buckets, swing and bascule bridges. This edition is apparently a reprint of the second.

Text-Book of the Materials of Engineering. By Herbert F. Moore. Third edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 315 pp., illus., diagrams, $3.

A concise presentation of the physical properties of the common materials used in structures and machines, with brief descriptions of their manufacture and fabrication. Elementary in character and intended for use in technical schools in connection with courses in the mechanics of materials. Bibliographies are appended to each chapter. This edition has been revised in the light of recent experimental data.

Thomas' Register of American Manufacturers, 13th Year, 1922. Thomas Publishing Co., New York, 1922. Cloth, 9×12 in., 4500 pp., $15.

The Register answers immediately the three usual questions that arise in every purchasing department. It contains lists of the makers of over 70,000 articles and gives the capital rating and address of each. It also furnishes a directory of manufacturers, giving their addresses, lines, branches, etc. Section Three lists over 50,000 trade named articles with the names of their manufacturers. For many years a standard directory, this edition has been carefully revised to the time of issue.

Untersuchungen an Dampfstrahlapparaten. By F. Heinl. Julius Springer, Berlin, 1922. (Forschungsarbeiten auf dem Gebiete des Ingenieurwesens. Heft 256.) Paper, 7×10 in., 23 pp., 20 marks.

Gives the results of an investigation to determine whether the circulation in hot-water heating systems can be maintained by means of one or more injectors fed with high-pressure steam, instead of by the usual methods. The specific points examined were the heat given to the water by the injected steam, under the most favorable conditions, at any given rates of injection and pressure, and the possibility of regulating the apparatus by varying the amount of water. The tests were made upon a model system built for the purpose. A study of the action of injectors is included.

Untersuchungen über Laminare und Turbulente Strömung. By L. Schiller. Julius Springer, Berlin, 1922. (Forschungsarbeiten auf dem Gebiete des Ingenieurwesens. Heft. 248.) Paper, 7×10 in., 36 pp., diagrams, 30 marks.

Gives the results of an exhaustive new investigation of laminar and turbulent flow in pipes, especially of the influence of various factors on the "critical" number. Certain variations from Poiseuille's Law were detected, which had not been noticed by previous investigators, and an explanation is provided for them.

In addition to its theoretical importance, this investigation should be of practical value, for it opens the way for the determination of viscosities by means of short tubes and makes possible the determination of absolute viscosity with the well-known Engler viscosimeter.

Untersuchungen und Neuerungen an Ventilkompressoren. By J. C. Breinl. R. Oldenbourg, München, 1922. Paper, 7×10 in., 110 pp., diagrams, illus., 252 marks.

A record of the results obtained in an extended study of air-compressor valves. Of interest to designers and manufacturers.

A NEW SYSTEM OF HELICAL GEARING FOR USE ON METAL PLANERS

(Continued from page 817)

flanks of the pinion where the tips of the gear teeth rub. Theoretically a spur gear gives tooth contact at all points lying on the line of action, and during part of the time more than one pair of teeth may be in contact. Actually, as soon as the teeth wear, only one pair of teeth will be in contact at a time. Therefore the shorter these teeth the stronger will they be. In the case of helical gearing, because of pitch-line rolling the wear is distributed equally over the entire surface of the tooth and the theoretical number of teeth always remain in contact, the effect of the wear being solely to rectify any errors in cutting and increase the backlash. The strength of helical gearing is therefore not appreciably increased by using stub teeth, since lengthening the teeth increase the effective lineal contact, which is equivalent to increasing the width of face of a spur gear. On the other hand, the greater number of teeth in contact and the longer arc of action give much smoother tooth action. Furthermore, the lower specific pressures increase the efficiency, have less tendency to break down the oil film, and greatly reduce the wear.

The 20-deg. pressure angle seems to have certain theoretical advantages over the form adopted which do not bear the test of experience. The higher pressure angle eliminates interference, reduces relative sliding and consequent friction, and gives a stronger form of tooth. However, these same advantages inhere in the tooth form adopted, and it is found that the lower-pressure-angle gears give smoother and more satisfactory action. The reason for this is threefold: In the first place, variations in friction produce much less marked variations in the direction and amount of the forces between the teeth. In the second place, the lower pressure angle reduces the objectionable vertical component of the vibration. In the third place, the low pressure angle gives a longer arc of action, more teeth in contact, and a greater effective lineal contact. The actual advantages were found to lie with the low pressure angle.

It is obviously desirable that the faces of the gears should be as wide as possible in order to increase the strength of the gearing, and reduce the specific contact pressure. Furthermore, with the low helical angle chosen for this design, wide-faced gears are necessary to secure overlapping tooth action. In order to permit of gears of maximum width of face, the rack is offset so that its center line lies to one side of the center line of the table. This permits the rack to be widened about 40 per cent and also permits the intermediate gear to be widened. The center line of the rack is placed toward the right-hand side of the planer, since the right-hand side head is the one generally used and since narrow work placed on the table is generally placed close to the operating side of the machine. In this manner the line of action of the driving force is brought nearer to the line of action of the cutting tools, reducing the tendency of the tool pressure to turn the table in a clockwise direction when viewed from above. Incidentally, the vertical component of the bull-wheel pressure tends under the usual operating conditions to counteract the downward component of the tool pressure, which, it is readily seen, would otherwise bear more heavily on the right-hand V.

Table 1, which gives the kinematic dimensions of a bull pinion, bull gear, and rack designed in accordance with the foregoing principles, will be of interest.

TABLE 1 KINEMATIC DIMENSIONS OF A PLANER BULL PINION, BULL GEAR AND RACK DESIGNED ACCORDING TO THE AUTHOR'S SYSTEM OF HELICAL INVOLUTE GEARING

	Pinion	Gear with Pinion	Gear with Rack	Rack
No. of teeth	20	80	80	∞
Pressure angle (transverse)	14°34′	14°34′	6°51′	6°51′
Base-circle diam., in.	4.862	19.45	19.45	∞
Helix angle (at pitch line)	5°40′	5°40′	5°32′	5°32′
Pitch diameter, in.	5.024	20.097	19.597	∞
Circular pitch (transverse), in.	0.78926	0.78926	0.76962	0.76962
Addendum, in.	0.375	0.125	0.375	0.125
Dedendum, in.	0.125	0.375	0.125	0.375
Angle of approach	10.9°	......	6.35°	.....
Angle of recess	21.5°	......	10.6°	.....
No. of teeth in action	1.8	1.8	3.75	3.75
Actual width of face, in.	8½	8½	8½	8½
Effective lineal contact, in.	15.3	15.3	32	32
Hand of helix	left	right	right	left

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Industrial. Industrial Accidents and Hygiene. Monthly Labor Rev., vol. 15, no. 3, Sept. 1922, pp. 178–195. Problem of dust phthis in granite-stone industry and in printing industry. Heart disease in industry. Safety activity of large motor company. Mine accidents in Alaska, 1921. Fatal accidents in British coal mines, 1874–1920.

Iron and Steel Industry. Causes and Prevention of Accidents in the Iron and Steel Industry, 1910–1919, Lucian W. Chaney. U. S. Bur. of Labor Statistics, no. 298, June 1922, 398 pp., 89 figs. Results of study of accidents which have been going on in Bur. of Labor Statistics during last 10 years.

AERONAUTICAL INSTRUMENTS

Altitude. Altitude Instruments. Nat. Advisory Committee on Aeronautics. Aeronautic Instruments, Report no. 126, 1922, 64 pp., 83 figs. Part I: Altimeters and barographs. Part II: Precision altimeter design. Part III: Statoscopes and rate-of-climb indicators. Part IV: Aerographs and strut thermometers.

Power-Plant Instruments. Power Plant Instruments. Nat. Advisory Committee for Aeronautics, Aeronautic Instruments, section 5, report no. 129, 72 pp., 76 figs. Part I: Airplane tachometers. Part II: Testing of airplane tachometers. Part III: Thermometers for aircraft engines. Part IV: Air pressure and oil pressure gages. Part V: Gasoline depth gages and flowmeters for aircraft.

AIR COMPRESSORS

Design. Principles of Design of Air Compressors, William Reavell. Instn. Mech. Engrs. Proc., no. 4, June 1922, pp 833–854, 15 figs., also Power House, vol. 15, nos. 17 and 18, Sept. 5 and 20, 1922, pp. 22-25 and 22–23, 15 figs. Influence of different types of valves; relation of clearance volume to cylinder volume; efficient cooling; single- and multiple-stage compression. Turbo-compressors and their characteristics.

Hydraulic. Producing Compressed Air by Hydrocompressors (Presslufterzeugung durch Hydrokompressoren), Carl Heirich. Bergbau, vol. 35, no. 33, Aug. 17, 1922, pp. 1177–1180, 4 figs. Necessity for compressed air in mining; construction and operation of hydro-compressors and their use in various countries.

Rotary. The Planche Rotary Compressor. Engineer, vol. 134, no. 3481, Sept. 15, 1922, p. 280, 7 figs. Describes new compressor of volumetric type and gives particulars of results obtained under test. Translated from Génie Civil.

AIRCRAFT

Design. The Preliminary Design of Aircraft. Aviation, vol. 13, no. 13, Sept. 25, 1922, pp. 381–382. Specification for an aircraft and its contradictory requirements; principal characteristics; flight characteristics of airplanes; sources of error in wind tunnel tests. Translated from Aéronautique.

AIRCRAFT CONSTRUCTION MATERIALS

Brass, Forged and Cast. Investigation of Forged and Cast Brass. Air Service Information Circular, vol. 4, no 335, Apr. 1, 1922, 6 pp., 8 figs. Investigation to determine suitability of forged brass in gasoline pipe line and tank fittings for service use on airplanes, and to compare soundness of forged and cast brass fittings.

Radiological Inspection. Radiological Inspection Work, V. E. Pullin. Aeronautical Jl., vol 26, no. 141, Sept 1922, pp. 336-340 and (discussion) 340–348, 11 figs. Shows present position of radiology with regard to its usefulness in affording means of inspection of various materials, with special reference to materials and parts used in airplane construction.

AIRPLANE ENGINES

Aeromarine U873. Aeromarine Model U873 Engine, E. A. Ryder. Aviation, vol. 13, no. 16, Oct. 16, 1922, pp. 499-501, 4 figs. Model is 77 lb. lighter than U8D although of 18-per cent bigger displacement and is rated at 250 hp.

Curtiss. Curtiss Model D12 Aeronautical Engine, Arthur Nutt. Aviation, vol. 13, no. 16, Oct. 16, 1922, pp. 496–498, 4 figs. Details of new 450-hp. engine.

Fuels, Doped. Investigations of the Effect of Doped Fuels on Fuel System. Air Service Information Circular, vol. 4, no. 308, Mar. 15, 1922, 6 pp., 8 figs. Investigation to determine effect of airplane fuels, dopes, and doped fuels on fuel system, with particular attention to problem of corrosion prevention.

Packard. The Packard Model 2025 Engine. Aviation, vol. 13, no. 16, Oct. 16, 1922, p. 503, 1 fig. Details of 12-cylinder 600-hp. engine.

Radiators. Radiators for Aircraft Engines, S. R. Parsons and D. R. Harper. U. S. Bur. of Standards Technologic Papers, vol. 16, no 211, May 26, 1922, pp. 247-430, 152 figs. Consideration of characteristics which determine value of radiator in discharging its functions. Measurements of air flow through core, of head resistance, cooling power, and geometrical characteristics; relations between these and conditions under which radiator operates, and characteristics of form and construction. Work based on special laboratory investigations, including laboratory tests of over 100 types of radiator core.

Types. Airplane Engines (Les Moteurs d'Aviation), Martinot-Lagarde. Aérophile, vol. 30, nos. 9-10, 11–12 and 13–14, May 1-15, June 1-15 and July 1-15, 1922, pp 135-139, 171-174 and 196–200, 14 figs. Present requirements and status of research. Describes some commercial and military engines, including Hispano, Lorraine, Renault, Bristal Jupiter, Napier, Lorraine-Dietrich, Panhard-Levassor, etc., future of commercial engine; engines for high altitudes; new cycles.

AIRPLANE PROPELLERS

Experimental Research. Experimental Research on Air Propellers, W. F. Durand and E. P. Lesley. Nat. Advisory Committee for Aeronautics, Report no. 141, 1922, 82 pp., 52 figs. Results of general analysis and review of series of experimental observations of previous reports, nos. 14, 30 and 64.

Variable-Pitch. Variable-Pitch Propellers (Les hélices à pas variable), M. Lamé. Aéronautique, vol. 4, no. 38, July 1922, pp. 215-218, 7 figs. Variable-pitch propellers for different speeds, for slowing down and reversing; describes Levasseur variable-pitch propeller.

AIRPLANES

Aerofoils. Report of Wind Tunnel Tests on Aerofoils: Dayton-Wright Nos. TT-1 and TT-2, Dayton-Wright Nos. 5 and 6, and Gottingen No. 387. Air Service Information Circular, vol. 4, no. 328, Mar. 15, 1922, 24 pp., 18 figs. Tests of aerofoils to determine lift, drag, L/D center of pressure, and moments about leading edge.

The Ideal Airplane and the Junker Aerofoil (Ideal-Flugzeug und Junkersscher Flügel), G. Meyer. Motorwagen, vol. 25, no 23, Aug. 20, 1922, pp. 436-439, 4 figs. Author points out that an ideally constructed airplane must consist of lift as well as drag-producing parts, and claims that the nearest approach to these conditions has been achieved by the Junker aerofoil.

Commercial. Report on the General Design of Commercial Aircraft, Edward P. Warner. Nat. Advisory Committee for Aeronautics Tech. Notes, no. 113, Sept. 1922, 19 pp., 1 fig. Author records his experiences during recent travels on European air lines, with regard to noise, seating arrangments, baggage accommodation, interior arrangement of cabins, pilot's position, view from cabin, safety, lavoratory accommodations, etc.

Design. Airplane Design and Performance Improvements Since the Armistice, C. N. Monteith. Soc. Automotive Engrs. Jl., vol. 11, no. 4, Oct. 1922, pp. 320–322. Outline of various features of airplane-development investigation that have been prosecuted. Discusses four specific requirements for increasing speed, rate of climb and ability to reach great altitudes. Notes on variable-area and variable-camber wings; all-metal construction.

Dornier. Aerodynamic Improvement of Airplanes (Aerodynamische Verfeinerung der Flugzeuge). Motorwagen, vol. 25, no. 27, Sept. 30, 1922, pp. 525–527, 1 fig. Details of wing frame of the Dornier Comet airplane.

Gliders. Third Rhone Competition (Le troisième concours de la Rhön), S. Y. Dime. Aéronautique, vol. 4, no. 40, Sept. 1922, pp. 281–286, 16 figs. partly on p. 280. Gives short description of gliders, together with table giving manufacturer, type, length, surface, weight and other data.

Sailplanes of the First Experimental Congress of Engineless Aviation (Les planeurs du Premier Congrès expérimental d'Aviation sans moteur), Charles Dollfus. Aéronautique, vol. 4, no. 39, Aug. 1922, pp. 243–250, 14 figs. Describes gliders by Dewoitine, Deshayes, Montagne, Potez, and others; table of data of 50 gliders.

Hangars. See HANGARS.

Landing Stations. How to Lay Out and Build an Airplane Landing Field, Archibald Black. Eng. News-Rec., vol. 89, no. 13, Sept. 28, 1922, pp. 504–507, 5 figs. Notes on shape and size of plot, runway details, type and arrangement of buildings, drainage of field, best kind of grass and proper marking to aid plots.

Low-Powered. Glider Results Point Way to Sport Plane Development, Edward P. Warner. Automotive Industries, vol. 47, no. 15, Oct. 12, 1922, pp. 722–723, 5 figs. Wing weight per sq. ft. cut in half as result of soaring-flight experiments. 2-hp. engine would maintain winning German machine in level flight in still air, allowing for propulsive efficiency of 70 per cent. Lessons for low-powered airplane design.

Potez X-A. The Potez X-A Triple-Engine Airplane Under Test (Le Potez X-A Trimoteur, aux éssais). Aérophile, vol. 30, no. 13–14, July 1–15, 1922, pp. 209–211, 4 figs. Hispano-Suiza 180-hp. engine; load per horsepower, 6.90 kg.; speed, 170 km. per hr. Detailed description.

Pressure Distribution. Pressure Distribution Over the Rudder and Fin of an Airplane in Flight. F. H. Norton and W. G. Brown. Nat. Advisory Committee for Aeronautics, Report no. 149, 1922, 9 pp., 10 figs. Investigation carried out to determine loads which occur on vertical tail surfaces under various conditions of flight.

Racers. Characteristics of the Aircraft Entered in the Pulitzer Trophy Race. Aviation, vol. 13, no. 14,

---

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Oct 2, 1922, pp 416–420, 6 figs Details of Navy-Curtiss and Army-Curtiss racers, Navy-Curtis triplane, Bee-Line (Booth), Loening, Thomas Morse and Verville-Sperry racers

Ribs, Trussed Design of Large Trussed Ribs Air Service Information Circular, vol 4, no 312, Mar 15, 1922, 17 pp, 10 figs Describes satisfactory methods of design Includes appendix in which example is worked out in detail, namely, a duralumin trussed rib for 4760-lb corps observation airplane.

Rudder Control The Effect on Rudder Control of Slip Stream Body and Ground Interference, H I. Hoot and D L Bacon Nat Advisory Committee for Aeronautics Tech Notes, no. 110, Sept 1922, 7 pp, 6 figs Investigation undertaken to determine relative effects of these factors which may interfere with rudder control of airplane, with especial reference to process of landing.

Seaplanes. See SEAPLANES.

Spars. Reinforced Ply-Wood Web Spars. Air Service Information Circular, vol. 4, no 313, Mar. 15, 1922, 7 pp, 6 figs Work conducted to determine adaptability of reinforced plywood web construction to spars, and also to compare relative merits of solid-web to trussed-web types

Stability. The Effect of Longitudinal Moment of Inertia upon Dynamic Stability, F H Norton and T Carroll Nat Advisory Committee for Aeronautics Tech Notes, no 115, Oct. 1922, 3 pp, 2 figs. Results of free flight tests to show whether longitudinal oscillations of standard S E 5A airplane are noticeably affected if its longitudinal moment of inertia is increased

Struts Reserve Bending Strength of Struts, R. A. Miller Air Service Information Circular, vol 4, no 333, June 1, 1922 5 pp, 1 fig Investigation to determine comparative strength in bending of columns of various materials.

Taking Off and Landing. A Study of Taking Off and Landing an Airplane, T. Carroll Nat Advisory Committee for Aeronautics, Report no. 154, 1922, 7 pp, 11 figs. Results of investigation carried out for purpose of discussing various methods of effecting take-off and landing, and to make direct analysis of control movements, accelerations, and air speeds during these maneuvers.

ALLOY STEELS

American Industry. Growth of American Alloy Steel Industry, Edwin F Cone Iron Age, vol. 110, no. 13, Sept 28, 1922, pp. 791–793, 2 figs Statistics since 1909. Record in alloy-steel castings; output from electric furnaces; role of heat treatment.

Characteristic Curves. The "Characteristic Curves" of a Nickel Steel and a Chromium Steel (Die "kennzeichnenden Kurven" eines Nickelstahles und eines Chromstables), H. Jungbluth. Stahl u. Eisen, vol. 42, no 36, Sept. 7, 1922, pp 1392–1396, 10 figs. Discusses curves developed by Protevin and Chevenard, significance of curves.

Experimental Production. Experimental Production of Alloy Steels, H. W. Gillett and E. L. Mack. U. S. Bur. of Mines, Bul., no. 199, 1922, 79 pp., 10 figs. Deals with preparation of ingots on any of the series of steels. Describes indirect-arc furnace used in experiments. Photomicrographs.

Physical Properties. Standardization of Methods Leading to Comparative Physical Properties of Alloy Steels, R. M. Bird. Am. Soc. for Steel Treating, Trans., vol. 2, no. 12, Sept. 1922, pp. 1213–1218, 15 figs. Describes procedure adopted at Bethlehem plant of Bethlehem Steel Co. which is said to yield more truly comparable results than previous systems.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Bearing Metals. See BEARING METALS.

Nickel. See NICKEL ALLOYS.

Shrinkage-Testing Apparatus. New Forms of Apparatus for Determining the Linear Shrinkage and for Bottom-Pouring of Cast Metals and Alloys, Accompanied by Data on the Shrinkage and Hardness of Cast Copper-Zinc Alloys, F. Johnson and W. Grantley Jones Inst Metals advance paper for meeting Sept. 20–22, 1922, 28 pp., 11 figs.

Strontium-Lead. The Diagram of State for Strontium-Lead (Beitrag zum Zustandschaubild Strontium Blei), E. Piwowarsky. Zeit. fur Metallkunde, vol. 14, no. 7, July 1922, pp. 300–301, 3 figs. Notes on alloys of lead with heavy alkalis. Preliminary and main tests for plotting a diagram of state for strontium-lead up to content of 12-per cent strontium.

Study of. The Art of Alloying, W. Guertler. Brass World, vol. 17, nos. 8 and 9, Aug. and Sept. 1922, pp. 229–234 and 257–259, 10 figs. Method of production by fusion of technically possible and impossible alloys. Account of mixed crystal formations and their importance. Description of appearance of compounds and their effects. Physical properties as affected by increasing miscible ratios. Chart for constructive purposes and design of utilizable alloys. Translated from Zeit. für Metalkunde, no. 9, June 1921.

White Metals. White Metals, A. H. Mundey, C. C. Bissett and J. Cartland. Inst Metals advance paper for meeting Sept. 20–22, 1922, 25 pp., 10 figs. Review of principal classes of white metals, their composition and physical properties, chiefly in relation to their uses and manufacture. Deals with anti-friction alloys and other white metals. Photomicrographs. See also Engineering, vol. 114, no. 2962, Oct. 6, 1922, pp. 441–443, 10 figs.

ALUMINUM

Overheating, Effects of. The Effects of Over-Heating and Repeated Melting on Aluminium, W. Rosenhain and J. D. Grogan. Inst. Metals advance paper for meeting Sept. 20–22, 1922, 11 pp., 3 figs Investigation to determine whether certain forms of treatment in melting and remelting of aluminum would bring about in metal deterioration approximating condition generally described as "burnt" aluminum Part of research carried out for Aeronautics Research Committee See also Engineering, vol 114, no 2961, Sept 29, 1922, pp. 414 415 3 figs

ALUMINUM ALLOYS

Aluminum-Copper. The Copper-Rich Aluminium-Copper Alloys, David Stockdale. Inst Metals advance paper for meeting Sept. 20–22, 1922, 14 pp., 37 figs Two general methods of making investigations were used—the taking of cooling curves and micro-examination of quenched specimens. See (abstract) in Engineering, vol. 114, no. 2961, Sept. 29, 1922, pp 396–398, 7 figs.

Aluminum-Molybdenum. The Adaptability of Molybdenum for the Refinement of Aluminum Alloys (Die Verwendbarkeit des Molybdäns zur Veredlung von Aluminiumlegierungen), H. Reimann. Zeit fur Metallkunde, vol 14, no. 5, May 1922, pp. 195 203, 19 figs. Investigation of a series of aluminum alloys with low molybdenum content and small additions of Mg, Cu and Zn, with regard to their casting, working and rolling properties, hardness, toughness, tensile strength, structure and conductivity.

Aluminum-Silicon. Properties and Manufacture of Aluminum-Silicon Alloys, Junius D. Edwards. Chem. & Met. Eng., vol. 27, no. 13, Sept. 27, 1922, pp. 651–655, 1 fig. Presents values for number of physical properties of aluminum-silicon alloys, pertinent to their commercial application.

Analysis. The Complete Analysis of Aluminium Alloys, E. W. Sheel. Metal Industry (Lond.), vol. 21, no. 9, Sept. 1, 1922, pp. 193–194. Describes process which has been used in laboratory under author's supervision, and with which he claims to have obtained excellent results. Determination of silicon, copper, tin, zinc, magnesium, iron, manganese and nickel.

Castings. Inclusions in Aluminum-Alloy Sand Castings, R. J. Anderson. U. S. Bur. of Mines, Tech. Paper, no. 290, 1922, 25 pp., 23 figs. Investigation of hard spots in connection with Bureau's work on casting losses in aluminum-alloy foundry practice. Notes on experiences at foundries; kinds and characteristics of hard spots, causes and factors affecting occurrence, composition and identification. Photomicrographs.

[See also DURALUMIN.]

AMMONIA

Specific Heat. Measurement of Specific Heat of Superheated Ammonia, E. E. Mueller. Refrig. Eng., vol. 9, no. 1, July 1922, pp. 1–3, 4 figs. Results of measurements to determine specific heat at constant pressure to an accuracy comparable with other total heat elements already determined, namely, latent heat of vaporization and specific heat of liquid.

AMMONIA COMPRESSORS

Feather-Valve. Feather-Valve Compressors of Three Types, Construction and Operation, F. L. Fairbanks. Refrig. Eng., vol. 9, no. 3, Sept. 1922, pp. 85–90 and (discussion) 90–92, 94, and 101–102, 11 figs. Test data of Boyle compressor alone, Boyle compressor with booster, motor-driven compressor, and uniflow steam-engine-driven compressor.

AMMONIA CONDENSERS

Large. The Advantages of a Large Ammonia Condenser, L. C. Miller. Power, vol. 56, no. 15, Oct. 10, 1922, pp. 568–570. Includes tables showing capacity of double-pipe condensers. Operating with high pressures.

APPRENTICES, TRAINING OF

Foundry. The Training of Molding and Foundry Apprentices in the Augsburg-Nuremberg Machine Factory, Nuremberg Works (Die Ausbildung der Former- und Gieszerlehrlinge in der Maschinenfabrik Augsburg-Nürnberg A.-G. Werk Nürnberg), Theodor Seyfried. Werkstattstechnik, vol. 16, nos. 14, 15 and 16, July 15, Aug. 1 and 15, 1922, pp. 405–414, 437 442 and 471–475, 42 figs. Detailed description of instruction course and methods.

Systems. Apprenticeship Training Program of a Large Corporation, J. F. Biehl. Indus. Management, vol. 64, no. 4, Oct. 1922, pp. 209–212 and 220, 4 figs. Describes plan of Worthington Pump Co.

AUTOMOBILE ENGINES

Air-Cooled. Air Cooled Engines Not Inherently More Economical, A. Ludlow Clayden. Automotive Industries, vol. 47, no. 12, Sept. 21, 1922, pp. 569–570. Maximum desirable mean cylinder, temperature not known. Lack of data on this and other factors accounts largely for numerical superiority of designs using water cooling. Data on area of cooling fins

Atomizers. The Hazet Atomizer (Der Hazet-Zerstäuber), Wa. Ostwald. Allgemeine Automobil-Zeitung, vol. 23, no. 29, July 22, 1922, pp. 36–37, 7 figs. Construction and operation; has shape of cartridge which can be easily inserted above vaporizer; originally designed to eliminate back firing.

Carburetors. See CARBURETORS.

Cylinders. See CYLINDERS, Machining.

Ignition. See IGNITION.

Piston Pins. Tubing vs. Solid Stock as Material for Piston Pins, C. B. Fraser. Automotive Industries, vol. 47, no. 15, Oct. 12, 1922, pp. 713–719. Comparison of manufacturing costs difficult. Experience shows solid stock cheaper in small pins. No difference in quality when same grade of steel is used.

Pistons. See PISTONS.

Rochas. Recent Progress in Light Explosion Engines (Progrès recents du moteur léger à explosions), Charles Faroux Bul. de la Societe d'Encouragement pour l'Industrie Nationale, vol 134, no. 7, July 1922, pp 622 635, 3 figs Discusses 4 stroke automobile engines of Rochas cycle, their mechanical efficiency, distribution of valves, balancing of shafts, etc.

Supercharger. A Super Charger Engine. Autocar, vol 49, no 1406, Sept 29, 1922, pp. 596 597, 5 figs. Details of Wilson single sleeve valve engine in which both two cycle and four cycle principles are employed

AUTOMOBILE FUELS

Alcohol. Motor Tests with Alcohol, Roy Alden. Oil News, vol 10, no 17, Sept 5, 1922, p 37. Exhaustive tests in India on single-cylinder engine show alcohol makes better motor fuel than gasoline; detonation eliminated. (Abstract) Report of Imperial Motor Transport Council of India.

Detonation. Detonation Characteristics of Several Blended Motor Fuels, Thomas Midgley, Jr and T. A. Boyd. Nat. Petroleum News, vol 14, no. 27, July 5, 1922, pp 59 60, 63 64 and 67–68, 5 figs. Benzol, alcohol, and kerosene combinations decided by bouncing-pin apparatus.

Types. The National Automobile Fuel (Le Carburant National), A. Mailhe. Journal des Usines à Gaz, vol. 46, no. 17, Sept. 5, 1922, pp. 257 259. Importance assumed by automotive fuels; types of fuels developed in France and Germany.

Vaporization. Vaporization of Motor-Fuels, P. S. Tice. Soc. Automotive Engrs. Jl., vol. 11, no. 4, Oct. 1922, pp. 307–314 and (discussion) 314–319 and 332, 7 figs. Summary of conditions surrounding and controlling fuel vaporization in cycle of operation of throttle-controlled internal-combustion engine fitted with intake manifold and carburetor.

[See also BENZOL; GASOLINE.]

AUTOMOBILES

Ariel. The New Ariel Nine. Autocar, vol. 49, no. 1405, Sept. 22, 1922, pp. 545–547, 7 figs. Water-cooled, two-cylinder, three-seater small car, introduced by well-known motorcycle makers.

Bignan. The 12.1 H.P. Bignan. Autocar, vol. 49, no. 1403, Sept. 8, 1922, pp. 453–454, 3 figs. French chassis having no brakes operating on rear wheels; four-cylinder engine.

Calculation. Automobile Calculations, James Watt. Automobile Engr., vol. 12, nos. 164 and 165, June and July 1922, pp. 183–191 and 216–223, 23 figs. Algebraic treatment. Calculation of engine, gear-box, clutch, axles, steering gear, road springs, brakes, frame and frame mountings, weights, etc.

Delaunay-Belleville. New 12 hp. Delaunay-Belleville. Autocar, vol. 49, no. 1405, Sept. 22, 1922, pp. 556–557, 4 figs. Little change externally, but many chassis modifications, including front-wheel brakes and overhead valve engine.

Electric Equipment. The Midgley-Scholey Electric Equipment for Motor Vehicles. Engineering, vol. 114, no. 2961, Sept. 29, 1922, pp. 392–393, 11 figs. Details of electric apparatus for starting and lighting, including dynamo, magneto, controller, starter, junction box, switchboard, battery, head, side and tail lamps.

French. New French Light Car Has Four-Cylinder Air Cooled Engine, W. F. Bradley. Automotive Industries, vol. 47, no. 12, Sept. 21, 1922, pp. 567–568, 3 figs. The S. A. R. A. represents first departure in France from conventional water cooling. Belt-driven centrifugal blower, mounted in front, forces air through cast aluminum jacket.

Lancia. New Frameless Lancia Feature of Paris Show, W. F. Bradley. Automotive Industries, vol. 47, no. 15, Oct. 12, 1922, pp. 706 708, 3 figs. Body from sheet-metal stampings so designed as to require no chassis frame; novel front axle, with helical springs in steering pivots, and exceptionally short 4 cylinder V-type engine. See also Autocar, vol. 49, no. 1406, Sept. 29, 1922, pp. 578 580, 7 figs.

Mass Production. Mass Production in British Motor Industries, Henry Obermeyer and Arthur L. Greene. Am. Mach., vol. 57, no. 14, Oct. 5, 1922, pp. 524–526, 1 fig. British manufacturers beginning to see difference between mass and standardized production. Plans to utilize facilities of big Austin plant.

Paris Show. Paris Automobile Show Largest Ever Held in France, W. F. Bradley. Automotive Industries, vol. 47, no. 15, Oct. 12, 1922, pp. 701–704, 9 figs. Tendency toward slight increase in price; smaller models; lighter reciprocating parts, especially aluminum pistons; four-wheel brakes.

Single-Track Two-Wheel. The Mauser Single-Track Automobile (Das "Einspurauto-Mauser"). Motorwagen, vol. 25, no. 25, Sept. 10, 1922, pp. 485–486, 2 figs. Describes two-wheel single-track automobile with lateral supporting wheels, which can be turned at any time into a triple-track car, by lowering the side wheels.

Springs. See SPRINGS, Automobile.

Steam Cars. Some Points on Steam Cars, F. Strickland. Autocar, vol. 49, no. 1403, Sept. 8, 1922, pp. 451–452, 3 figs. Reviews salient features of design and makes certain suggestions for possible lines of future development.

Suspensions. The Problem of Suspension, Louis Coatalen. Autocar, vol. 49, no. 1405, Sept. 22, 1922, pp. 537–541, 3 figs. Describes simple but ingenious method of ascertaining spring action, which may lead to extremely important results.

Technical Studies. Studies of the Automobile, G. B. Upton. Sibley Jl., vol. 35, nos. 4, 5–6 and 9–10, Apr., May-June and Sept.-Oct 1921 and vol. 36, nos. 4, 5 and 6, Apr., May and June 1922, pp. 58–60

and 71, 80–81 and 10, 120–124, 58–65 and 74, 78–90 and 100 and 108–118, 17 figs. Apr.: Past and problem of present time. May-June: Load-carrying capacity of tires on hard roads. Sept.-Oct.: Tractive resistances of sand and soft soils. Apr., May and June. Power required to run a car.

Transmissions. New Electric Transmission Provides for Direct Drive. Automotive Industries, vol. 47, no. 15, Oct. 12, 1922, pp. 711–714, 5 figs. Sperry transmission has five speeds forward, two in reverse and electric braking. Direct drive obtained by automatic, electrically operated friction clutch.

Unit Construction. Some Notes on Unit Construction, F. A. Stepney Acres. Autocar, vol. 49, no. 1404, Sept. 15, 1922, pp. 401–493, 6 figs. Practical and manufacturing advantages which outweight drawbacks.

Wheel Wobble. Wheel Wobble and Other Faults in the Steering System, A. Ludlow Clayden. Automotive Industries, vol. 47, no. 14, Oct. 5, 1922, pp. 667–670, 3 figs. Explanation of several puzzling phenomena. Wobble is held to be impossible with vertical steering pivots or pivots in central plane of wheel.

AVIATION

Canada. Some Technical Aspects of Aviation in Canada, E. W. Stedman. Aeronautical Jl., vol. 26, no. 141, Sept. 1922, pp. 349–375, 24 figs. Discusses different kinds of work that can be carried out by aircraft in Canada; country to be traversed; type of machine; winter flying; engine cooling, lubrication and starting; propellers; protection of crew; temperature effects on rigging and instruments; landing on snow.

AXLES

Manufacture. Manufacturing Car and Locomotive Axles, Nathan S. Frohman. Am. Mach., vol. 57, no. 13, Sept. 28, 1922, pp. 473–477, 11 figs. Steel specifications and machining operations; inspection and tests; forging under hydraulic presses; hollow boring and heat treating. Methods employed by Pollak Steel Co.

B

BALANCING MACHINES

Rotative Bodies. New Principles in Rotative Balance, Amos F. Moyer. Soc. Automotive Engrs. Jl., vol. 11, no. 4, Oct. 1922, pp. 368–372, 9 figs. Describes balancing machine by B. L. Newkirk, of research department of Gen. Elec. Co., for measuring directly resultants for two separate ends of rotative body, without necessity of separating the standing from running balance.

BEARING METALS

Genelite. Genelite—A New Bearing Material, E. G. Gilson. Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, pp. 123–124, 2 figs. Bronze material containing graphite evenly distributed throughout entire mass.

BEARINGS

Anti-Friction. New Anti-Friction Bearings. Times Trade & Eng. Supp., vol. 11, no. 220, Sept. 23, 1922, p. 41, 1 fig. Describes new form of bearing invented by German engineer which is being introduced on large scale for industrial and railway purposes; consists of white metal in which special stones are embedded.

BEARINGS, BALL

Advantages and Applications. Ball Bearings, Their Advantages and Principal Applications in Brazil (Os mancaes de espheras, suas vantagens e principaes applicaçoes no Brazil), Leopoldo Franca. Revista Brasileira de Engenharia, vol. 4, no. 1, July 1922, pp. 18–24, 8 figs. Stribeck and SKF types; reducing accidents; etc.

Roller and. Ball and Roller Bearings With Details of Their Installation, G. A. Van Brunt. Indus. Engr., vol. 80, no. 9, Sept. 1922, pp. 420–429 and 459–460, 34 figs. The various designs and construction and directions for installing them on lineshafts and machines.

BEARINGS, ROLLER

Contact Type. Rolling Contact Bearings, Tobias Dantzig. West. Machy. World, vol. 13, nos. 6 and 7, June and July 1922, pp. 216–217, 247–248. Classification of anti friction bearings; ideal bearing, efficiency and capacity. Principles of design and construction.

Roller Inspection. Inspecting Bearing Rollers by Machine. Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, pp. 94–95, 3 figs. Describes machine developed by Bock Bearing Co., Toledo, O., which automatically inspects and sorts rollers at rate of 3000 per hr.

Tapered. Can Tapered Roller Bearings be Run at High Speeds? T. V. Buckwalter. Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, p. 107. Results obtained in running tapered roller bearings economically and efficiently at speeds exceeding 10,000 r.p.m.

BELT DRIVE

Maintenance-Cost Reduction. Overcoming Heavy Costs of Belt Maintenance, J. H. Rodgers. Power House, vol. 15, nos. 13 and 14, July 5 and 20, 1922, pp. 29–31 and 21–22 and 24, 11 figs. Transmission problems should be in charge of competent man; inspection should be made regularly, importance of proper alignment; lacing of joints should be carefully performed.

BENZOL

Gasoline vs. The Comparative Merits of Benzol and Gasoline as Engine Fuels, W. O. Hinckley. Soc. Automotive Engrs. Jl., vol. 11, no. 4, Oct. 1922, pp. 359–360 and (discussion) 360–362, 1 fig. Describes benzol manufacturing process; and compares specification for motor benzol with specification for gasoline; comparisons between motor benzol and gasoline in regard to end point, heat value and vapor tension. Comparative engine tests made with motor benzol and gasoline as fuel.

BLAST-FURNACE GAS

Treatment. Blast Furnace Gas. Gas & Oil Power, vol. 17, nos. 203 and 204, Aug. 3 and Sept. 7, 1922, pp. 179–180 and 197–198, 3 figs. Its treatment for use with gas engines.

BLAST FURNACES

Electric-Power Application. Utilization of Electric Power About the Blast Furnace, Gordon Fox. Elec. Jl., vol. 19, no. 9, Sept. 1922, pp. 369–371, 3 figs. Deals with application of electric power to blowing, pumping, material handling and accessories.

Modern Practice. The Bases of Modern Blast-Furnace Practice, A. K. Reese. Engineering, vol. 114, no. 2958, Sept. 8, 1922, pp. 312–316, 2 figs. Writer discusses four prime factors in modern blast-furnace practice, namely, (1) preparation of materials; (2) furnace design; (3) auxiliary equipment; and (4) method of operation. Paper read before Iron & Steel Inst.

BOILER EXPLOSIONS

Prevention. High-Pressure Steam Boiler Explosions (Du danger des cassures dans les conges des fonds emboutis des corps cylindriques), L. Cauchois. Chaleur et Industrie, vol. 3, nos. 26 and 27, June and July 1922, pp. 1377–1380 and 1448–1451, 18 figs. June: Boiler construction from standpoint of safety against explosion; describes explosion of a tubular boiler. July: Explosion of Steinmüller boiler in Finland, and of Buttner boiler; discusses boiler inspection with view to avoiding accidents.

BOILER FEEDWATER

Analysis and Purification. Rapid Analysis, Purification and Control of Industrial Waters (Analyse rapide, épuration et contrôle des eaux industrielles), P. de Vadder. Outillage, vol. 6, no. 39, Sept. 30, 1922, pp. 1280–1282. Analysis of boiler feedwater; temporary and permanent hardness; water softening.

Degasification. Corrosion—Its Cause and Cure. Power, vol. 56, no. 14, Oct. 3, 1922, pp. 532–533, 2 figs. Discusses corrosion as found in power plants and describes Kestner process and degasser, as example of European corrosion method of removing oxygen from boiler feedwater.

The Degasification of Boiler Feedwater, J. R. McDermet. Mech. Eng., vol. 44, no. 10, Oct. 1922, pp. 648–650, 7 figs. Fundamental laws governing separation of dissolved gases from water by air-tension control, and extent of their application to conventional types of feedwater-heating equipment.

Treatment. Corrosion of Walls in Steam Generators (Intorno alle corrosioni delle pareti interne dei generatori di vapore), Giuseppe Gianoli. Industria. vol. 36, no. 14, July 31, 1922, pp. 261–262. Tests made by Rauch on effect of sodium chromate and bichromate on feedwater.

Critical Study of Different Boiler-Feedwater-Purification Processes (Kritik der verschiedenen Methoden der Reinigung von Kesselspeisewasser), B. Preu. Wärme-u. Kälte-Technik, vol. 24, no. 17, Sept. 1, 1922, pp. 197–201. Writer discusses various processes and describes new process and plant, by use of which water containing large amount of soluble salts can be used as feedwater.

Extensive Boiler-Water Treating on C., M. & St. P. Ry., C. Herschel Koyl. Eng. News-Rec., vol. 89, no. 14, Oct. 5, 1922, pp. 560–562, 4 figs. Chemical treatment in bad-water district improves operating conditions. Savings soon pay for numerous plants.

Solving the Feed-Water Problem at New Orleans, O. P. Adams and Paul F. Hoots. Power, vol. 56, no. 16, Oct. 17, 1922, pp. 596–599, 2 figs. The 50,000-kw. plant of New Orleans Railway & Light Co. uses Mississippi River water for makeup with practically no trouble from scale or priming, although boilers operate at high rating. This is accomplished by lime-soda-copper as treatment in steam-heated tank and by using periodic water tests.

BOILER OPERATION

Combustion. Combustion for the Boiler Room Operator, T. H. Fenner. Power House, vol. 15, nos. 17, 18 and 19, Sept. 5, 20 and Oct. 5, 1922, pp. 19–21, 24–26 and 25–27, 7 figs. Sept. 5: Amount of oxygen necessary to burn 1 lb. of coal, draft and its measurement in inches of water. Sept. 20: Drop in pressure through brick setting of boiler; use of draft gage. Oct. 5: Formation of carbonic acid and carbon monoxide in furnace gases.

Fuel Burning and. The Economic Operation of Boilers and Burning of Fuels, Frank C. Parker. Pacific Mar. Rev., vol. 19, no. 10, Oct. 1922, pp. 564–567. Analysis of heat transfer problems and of combustion factors governing furnace, tube and stack design. Paper read before Am. Soc. Mar. Engrs.

Low-Draft Maintenance. The Draft Over the Fire, E. M. Eliot. Power, vol. 56, nos. 12 and 14, Sept. 19 and Oct. 3, 1922, pp. 446–448 and 523–526, 5 figs. Sept. 19: Importance of maintaining constant low draft over fire in case of boilers operating under forced draft. Oct. 3: How to find actual saving obtainable by various methods of maintaining it.

BOILER PLANTS

Heppenstall Co., Pittsburgh. Modern Steam Generating Plant, R. F. Keifer. Blast Furnace & Steel Plant, vol. 10, no. 10, Oct. 1922, pp. 509–519, 8 figs. Details of boiler plant of Heppenstall Forge & Knife Co.; description of building, coal bunker; coal-handling equipment; coal crusher; boilers; feedwater pumps and treatment.

BOILERS

Bent-Tube vs. Straight-Tube. Bent Tube vs. Straight Tube Boilers, Walter N. Flanagan. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 7, July 1922, pp. 321–343 and (discussion) pp. 344–355, 12 figs. Presents principles involved in selection and observations of author.

Calculation. Application of Stefan's Law to Boiler Calculation (Aplicación de la ley de Stefan al calculo de calderas), Vicente Burgaleta. Anales de la Asociación de Ingenieros del Instituto Católico de Artes e Industrias, vol. 1, no. 1, Jan. 1922, pp. 39–45, 5 figs. Advocates its substitution for formulas formerly used; application to locomotives, etc.

High Pressures. Very High Pressures in Modern Practice. Power House, vol. 15, no. 19, Oct. 5, 1922, pp. 23–24, 1 fig. Central station of public-service company uses boiler pressure of 400 lb. per sq. in., marking new advance in engineering practice on American continent.

Waste-Heat. British Practice in Waste-Heat Utilization, C. H. S. Tupholme. Power Plant Eng., vol. 26, no. 20, Oct. 15, 1922, pp. 994–996, 2 figs. Information on waste-heat boilers, including details of new improved Spencer-Hopwood deep-nest boiler and new Kirke patent gas-fired boiler. Uses for gas-fired boiler.

BORING MACHINES

Automatic. Automatic Boring and Facing Machine. Machy. (Lond.), vol. 20, no. 522, Sept. 28, 1922, pp. 787–790, 7 figs. Details of machine developed by Butterworth & Co. for automatically performing boring, facing and similar turning operations that can be confined to tools mounted in a turret heat.

BRAKES

Kunze-Knorr. The Kunze-Knorr Freight-Train Brake (Die Kunze-Knorr Güterzugbremse), Kurt Wiedemann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 38, Sept. 23, 1922, pp. 905–919, 16 figs. Describes design of brake and points out its superiority over other types.

BRASS

Hardness. The Hardness of the Brasses, and Some Experiments on Its Measurement by Means of a Strainless Indentation, F. W. Harris. Inst. Metals advance paper for meeting Sept. 20–22, 1922, 27 pp., 12 figs. Tests to determine position of hardness-composition curve at certain points in phase field.

BUSES

Design. Some Fundamental Characteristics of Present-Day Buses, R. E. Plimpton. Soc. Automotive Engrs. Jl., vol. 11, no. 2, Aug. 1922, pp. 163–172, 12 figs. Enumeration of distinctive features of buses designed for city, inter-city and country service. Discussion of steam and electric motive power, chassis components for bus service, types of bus body, problems of heating, lighting and ventilation, fare-collection devices, etc.

[See also MOTOR BUSES.]

C

CABLEWAYS

Germany. Two Noteworthy Cableways (Zwei bemerkenswerte Drahtseilbahnen), Wernekke. Fördertechnik u. Frachtverkehr, vol. 15, no. 19, Sept. 15, 1922, pp. 248–253, 12 figs. Details of construction and operation of cableway at Cologne for conveying coal and briquettes to locomotive coaling shed; length 735 m. Cableway of German Luxemburg Mining and Metallurgical Co. at Dortmundfeld for conveying slag, coke, etc.

Gilboa Dam. Aerial Tramways Serve Mixing Plant at Gilboa Dam, Charles K. Traber. Eng. News-Rec., vol. 89, no. 15, Oct. 5, 1922, pp. 604–606, 4 figs. Rugged country makes surface roads difficult. Air lines reliable and cost less. Lines have surplus capacity. Operation undisturbed by rain or snow.

CARBURETORS

Ford. Can We Afford the Ford? George Granger Brown. Jl. Indus. & Eng. Chem., vol. 14, no. 10, Oct. 1922, pp. 972–973. Points out that average Ford touring car, driven under average conditions, gives not more than 17.5 mi. per gal. One cause for this inefficiency is said to be present carbureting system which, it is claimed, can be so improved that average Ford will give 25 mi. per gal. and operate as economically as more expensive cars.

Fuel Head. Effect of Fuel Head at Carburetor, on Brake Horsepower and Brake Specific Fuel Consumption. Air Service Information Circular, vol. 4, no. 336, Apr. 1, 1022, 6 pp., 4 figs. Investigation to determine relation between fuel head at carburetor and horsepower and fuel consumption of engine, and maximum and minimum practicable heads for several types of service carburetors.

CARS

Oscillation-Recording Instrument. Oscillation

Recording Instruments in Use on the Great Northern Railway. Ry. Gaz., vol 37, no. 10, Sept. 8, 1922, pp. 314-316, 8 figs. Details of device known as "Enregistreur Hallade," and illustration of records made therewith.

Recording Riding Qualities of Cars, F. Crocker. Ry. Rev vol 71 no 14 Sept 30, 1922, pp 437 439, 12 figs. Describes instrument devised by author for recording oscillations Investigation conducted on English railway equipment of car-riding qualities.

CARS, FREIGHT

Gondola. 70-Ton D. & R G W. General Service Gondola Car Ry Mech Engr , vol. 96, no 9, Sept 1922, pp. 517-520, 7 figs Describes high-capacity car of unusual design for miscellaneous bulk freight

Steel. The Design of Modern Steel Freight Car Equipment, John A Pilcher. Ry. Rev., vol. 71, no. 15, Oct. 7, 1922, pp 467 475, 7 figs General principles that should govern in steel freight-car design, suggestions for improving certain features in design, continual addition of material to enable cars to withstand rough handling detracts from earning power. Paper read before Ry. Club of Pittsburgh.

CARS, PASSENGER

Heating. A Thermostatic Control of Car Heating. Ry. & Locomotive Eng., vol 35, no. 9, Sept 1922, pp. 234-236 8 figs. Electrothermostatic control developed by Vapor Car Heating Co., Chicago, principle of which consists in use of electric current whose circuit is made or broken by thermometer placed in car, to regulate flow of steam to heating pipes.

Sleepers The New Sleepers of the International Sleeping-Car Company (Les nouvelles voitures-lits de la Compagnie internationale des Wagons-Lits). Génie Civil, vol. 81, no 12, Sept. 16, 1922, pp. 249-253, 14 figs. Design and construction; framework, chassis, roofing, etc.

CASE-HARDENING

Carburizing and Decarburizing. Carburizing and Decarburizing in Case Hardening, H. B. Knowlton. Am. Soc. for Steel Treating Trans , vol. 2, no. 12, Sept. 1922, pp. 1155-1166, 16 figs Discussion of carburizing and decarburizing actions which make for success or failure of case-hardening method in commercial practice. Photomicrographs.

Failures Due to Improper Steel. Irregularities in Case Hardened Work Caused by Improperly Made Steel, E. W. Ehn. Am. Soc. for Steel Treating Trans., vol 2, no. 12, Sept. 1922, pp. 1177-1202, 55 figs. Gives experiences which are results of research work during last few years in metallurgical department of the Timken Roller Bearing Co. Photomicrographs.

Materials for, Tests of. Tests of Carburizing Materials, O. A. Knight and T. C. Kern. Forging & Heat Treating, vol. 8, no. 9, Sept. 1922, pp. 420-425. Results of exhaustive series of tests on five commercial compounds, indicating decided superiority of one.

Tests. Case Hardening, A. H. d'Arcambal. Am. Soc. for Steel Treating, Trans., vol. 2, no. 12, Sept. 1922, pp. 1111-1124, 23 figs. Study of chemical reactions taking place in cyanide process of case hardening. Results of Izod notched-bar tests on well-known types of case-hardening steels.

CAST IRON

Growth during Repeated Heatings. On the Growth of Gray Cast Iron during Repeated Heatings and Coolings, Tario Kikuta. Science Reports of Tôhoku Imperial Univ., 1st series, vol. 11, no. 1, Apr. 1922, pp. 1-17, 16 figs. partly on supp. plates. Three periods of growth: (1) due to decomposition of cementite; (2) due to resisting effect of gas pressure to contraction; (3) yielding to pressure of occluded gases at high temperatures. 57th Report of Iron & Steel Research Inst.

Tensile Tests. Tensile Tests of Cast Iron at Various Temperatures, J. F. Harper and R. S. Mac Pherran. Iron Age, vol. 110, no. 13, Sept. 28, 1922, pp. 793-794, 5 figs Results of work done on annealed bars in special apparatus. Comparison with steel under similar conditions.

CASTING

Centrifugal. Chromium Alloy Steel Cast Centrifugally, L. Cammen. Iron Age, vol. 110, no. 11, Sept. 14, 1922, p. 655, 1 fig. Annealed, it has same structure as mechanically worked metal, from ingots cast in stationary molds; dendritic structure absent and grain structure small.

McConway Centrifugally Cast Steel. Foundry Trade Jl., vol. 26, no. 319, Sept. 28, 1922, pp. 257-258, 1 fig. Describes new process for production of steel disks by centrifugal and hydraulic methods direct from molten steel.

CASTINGS

Silicon-Iron. Silicon-Iron Acid-Resisting Castings, Wm. Mason. Metal Industry (Lond.), vol. 21, no. 14, Oct. 6, 1922, pp. 323-325, 6 figs. Discusses nature and uses of silicon-iron acid-resisting alloys, extensive substitution of parts made of it for earthenware in chemical plant, and scope for manufacture of castings.

CENTRAL STATIONS

Solar-Heat. Solar Heat Central Stations (Centrali elettriche ad energia solare), Carlo Boggia. Industria, vol. 36, no. 13, July 15, 1922, pp. 245-246. Describes method depending on operating turbine with CO_2 from generator heated by sun.

Superpower. The Gennevilliers Electric Power Station. Engineer, vol. 134, nos. 3480, 3481 and 3482, Sept 8, 15 and 22, 1922 pp 242 243, 1 fig., 270 272, 7 figs and 294, 4 figs on supp plate. Full description of station, including particulars of Babcock boilers, electric plant and equipment; buildings, etc.

CHIMNEYS

Calculation. Chimney Calculation (Schornsteinberechnung), H. de Grahl Glasers Annalen, vol. 91, no 4, Aug. 15, 1922, pp 54 56 and (discussion) 56-62, 3 figs. Includes table showing comparison of 11 different calculating methods Hoffmann's calculating method and values obtained.

CHROMIUM STEEL

Hardness. Variation of Hardness in Chromium Steels (Hårdhetens variation med värmebehandlingen hos ett kromstål), H. Rowsing and J Sissener. Jerknontorets Annaler, vol. 107, no 8, 1922, pp. 382 388, 8 figs Discusses recent experiments of Portevin and Chevenard.

COAL

Patent-Fuel Manufacture. Notes on Patent Fuel, Arthur Grounds. Fuel in Sci. & Practice, vol. 124, nos. 3213, 3214 and 3221, July 28, Aug 25 and Sept. 22, 1922, pp 119-122, 149-151 and 174 177. July 28 Deals with various binding materials proposed as suitable for agglomeration of fine coal for manufacture of briquettes and ovoid fuel. Aug. 25: Selection of coals for briquetting and grinding of coal and pitch. Sept. 22: Research on manufacture of briquettes.

COLD STORAGE

Freezing Point of Fruits and Vegetables. Freezing Points of Fruits and Vegetables, D. B. Carrick. Ice & Refrigeration, vol. 63, no. 4, Oct. 1922, pp. 180-181. Results of investigations conducted to determine freezing point and freezing injury; description of apparatus and methods used; conditions under which experiments were conducted; data obtained on apples and potatoes.

Humidity Control. Humidity Control in Cold Storage Warehouses, Milton W. Browne. Ice & Refrigeration, vol. 63, nos. 3 and 4, Sept. and Oct. 1922, pp. 140-142 and 181-183, 2 figs. Is as important as temperatures in handling of fruits and food products in cold storage; heating capacity of air depends upon quantity of water vapor mixed with it; absolute and relative humidity; humidity, temperature and dewpoint effect; relative humidity, hygrometrical and conversion tables.

COMPRESSED AIR

Reheating. The Reheating of Compressed Air, C. R. Richards and J. N. Vedder. University of Ill. Bul., vol. 19, no. 41 (bul. no. 130), June 5, 1922, 88 pp., 22 figs., 12 tables. Investigation undertaken to determine thermodynamic efficiencies resulting from heat expended in reheating process, efficiency of external and internal combustion reheaters, performance of engine using air expansively under wide variety of operating conditions, and performance of same engine operating with steam alone, and with mixtures of air and steam.

CONDENSERS, STEAM

Corrosion of Tubes. Brass as Material for Condenser Tubes (Messing als Werkstoff für Kondensatorrohre), A. Schimmel. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 36, Sept. 9, 1922, pp. 837-840, 9 figs. Discusses kinds of corrosion, causes and nature of phenomenon, and preventive measures.

Performance. Report of an Investigation of Condenser Performance in the St. Louis Water Department, L. A. Day. Am. Water Works Assn. Jl., vol. 9, no. 5, Sept. 1922, pp. 696-702, 1 fig. Study of condensing apparatus with view of increasing vacuum on pumps.

CONVEYORS

Assembling by. Assembling by Conveyor, Warren Ordway. Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, pp. 103-106, 4 figs. Recently developed assembly system for increasing production and reducing manufacturing costs.

Belt. Belt-Conveyor System in Plant of By-Products Coke Corp. (S. Chicago), H. Hilman Smith, Jr. Belting, vol. 21, no. 3, Sept. 1922, pp. 17-22, 7 figs. Many large belts used in handling coal and coke, some in open, others housed. All purchased on guaranteed-tonnage basis. Service records of belts.

Belt Conveyors in the Coal Mine, Anton M. Oliver. Coal Industry, vol. 5, Sept. 1922, pp. 405-407, 2 figs. Factors affecting carrying capacity; determination of belt pull and number of plies. Points out that belt specifications should be left to manufacturer.

Gravity. What It Pays to Know About Material Handling, W. T. Spivey. Factory, vol. 29, no. 4, Oct. 1922, pp. 395-397, 450, 452 and 454, 6 figs. Use of gravity roller conveyors.

Workshop, Railless. Railless Conveyances for Work-Shops, Richard Hänchen. Eng. Progress, vol. 3, no. 10, Oct. 1922, pp. 232-235, 11 figs. Advantages of transport without rails; hand-operated conveyances without rails; universal and lifting transport barrows; platform lorries; lifting transport lorries; portable and dirigible shop cranes; electric transport lorries.

COPPER

Elastic Limits under Stress. Elastic Limits of Copper Under Cyclical Stress Variations, H. Gough. Engineering, vol. 114, no. 2958, Sept. 8, 1922, pp. 291-293, 5 figs. Describes author's method and machine for determining fatigue range of stress from test on single specimen. Summary of report to Elasticity and Fatigue Panel of Aeronautical Research Committee.

CORROSION

Firearms. Corrosion Under Oil Films, with Special Reference to the Cause and Prevention of the After-Corrosion of Firearms, Wilbert J Huff. U. S. Bur. of Mines, Tech. Paper, no 188, 1922, 26 pp., 5 figs. Account and results of experiments.

Iron and Steel. The Corrosion of Iron and Steel, Robert Hadfield. Roy. Soc Proc , vol 101, no. A713, Sept 1, 1922, pp 172 186, 2 figs. Refers to wastage of world's iron and steel due to corrosion, and describes number of recent experiments carried out by author with regard to copper-steel It is shown that small copper content, say 0 16 to 0.25 per cent, is beneficial, provided condition is that of bare metal exposed to atmospheric corrosion.

COST ACCOUNTING

Alignment Charts. The Graphical Solution of Cost and Production Problems, Ludwig Weindling. Indus. Management, vol 64, no. 3, Sept. 1922, pp. 151 152, 2 figs Gives examples of application of alignment charts to solution of cost and production problems.

Factory Expense Distribution. Engineering Methods Applied to Cost Finding, Robert S. Denham. Indus. Management, vol. 64, no. 3, Sept. 1922, pp. 155-159. Factory survey and expense distribution.

COUPLINGS

Flexible. Flexible Couplings, John J. Serrell Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, pp. 91 93, 4 figs. Where and how they should be used.

CRANES

Double. Double Cranes for Harbours. Eng. Progress, vol. 3, no. 10, Oct. 1922, pp. 213-215, 4 figs. Describes construction of double cranes put on market by German Machine Factory Corp. (Demag), which are particularly suitable for accelerating handling of goods.

Port-Terminal. The Port Terminal Crane, H. McL. Harding. Port & Terminal, vol. 2, no. 8, Sept. 1922, pp. 11-13, 7 figs. Discusses types of dock cranes and advantages of special port-terminal type.

CUPOLAS

Air Heaters. Heat Utilization in Cupolas with Air Heaters (Wirkungsweise und Wärmeausnutzung im Kupolofen mit Winderhitzer), H. Hörnig. Wärme, vol. 45, no. 30, Aug. 4, 1922, pp. 369-371, 2 figs. Notes on cupolas with preheated air; air heating according to regenerative system; advantages over older types. See also Giesserei-Zeitung, vol. 19, no. 36, Sept. 12, 1922, pp. 521-525 and (discussion) 525-527, 4 figs. Address before Assn. German Foundrymen.

Automatic Charging. Progress in the Construction of Automatic Cupola Stokers (Fortschritte im Bau selbsttatiger Kupolofenbeschickungen), A. F. Hager. Giesserei-Zeitung, vol. 19, no. 38, Sept. 26, 1922, pp. 553-555, 2 figs. Discusses automatic charging elevators adapted to present conditions.

Heat Balance. Heat Balance in the Cupola Furnace (Remarque sur les bilans thermiques de cubilots à fonte), J. Seigle. Révue de Métallurgie, vol. 19, no. 7, July 1922, pp. 406-415, 4 figs. Errors made in analyses of flue gas; difficulties in utilizing measures of volume or measures of pressure.

Schuermann. New Development in Cupola Construction, E. Hellmund. Iron Age, vol. 110, no. 16, Oct. 19, 1922, pp. 991-992, 3 figs. Schuermann equipment in Germany involves preheating blast and shortening time of melting. Translated from Giesserei, no. 18, 1922.

CUTTING TOOLS

Stress Determination in. An Account of Some Experiments on the Action of Cutting Tools, E. G. Coker and K. C. Chakko. Instn. Mech. Engrs. Proc., vol. 1, no. 3, 1922, pp. 567-592 and (discussions) 593-621, 28 figs. Describes experiments made by aid of polarized light to determine stresses and stress distribution in cutting tools.

CYLINDERS

Machining. Machining the Stutz D. H. Motor Cylinder and Head, Robert Mawson. Can. Machy., vol. 28, no. 14, Oct. 5, 1922, pp. 37-38, 9 figs. Jigs and fixtures used in holding parts; twelve cylinders milled at one setting; pieces easily and quickly located by means of sliding supports and spring dowels.

D

DIESEL ENGINES

Double-Acting Two-Cycle. New Double-Acting Two-Cycle Diesel Engine. Mar. Engr. & Naval Architect, vol. 45, no. 540, Sept. 1922, pp. 361-365, 5 figs. Describes experimental engine built by North British Diesel Engine Works, whose successful results have encouraged builders to proceed with construction of large unit of 2250 i.hp.; test results.

German 4-Cycle. The New M. A. N. Diesel Engine. Mar. Eng., vol. 27, no. 8, Aug. 1922, pp. 509-510, 2 figs. Four-cycle type now being built in Germany; first units to be installed on Hansa freighter.

Hydroelectric Plants, Application to. The Diesel Engine, Its Economic Value Compared With That of Other Prime Movers (Les moteurs Diesel. Leur valeur économique comparée à celle d'autres machines motrices), Alfred Buchi. Bul. Technique de la Suisse Romande, vol. 48, nos. 15, 16, 17 and

20, July 20, Aug. 5, 19 and Sept. 30, 1922, pp. 169–173, 186–189, 193–197 and 229–235, 16 figs. July 20: Application of Diesel engines in hydroelectric plants: cost comparison. Aug. 5: Comparison of Diesel engines and hydraulic power for production of alternating current. Aug. 9: Diesel engine is more economical where spare units can be used; hydraulic power is preferable for constant loads. Sept. 30: Most advantageous proportion in distribution of energy to be furnished by a system which has a Diesel-engine central station; calculation of cost of production per kw-hr.

Waste-Heat Utilization. Utilization of Exhaust-Gases, S. Snuyff. Motorship, vol 7, no. 10, Oct. 1922, pp. 770–771, 1 fig. Investigates possibilities of effective use of Diesel-engine waste heat.

DURALUMIN

Economical Use. The Economical Use of Duralumin as a Substitute for Steel in Compression. Air Service Information Circular, vol. 4, no. 337, Apr. 1, 1922, 11 pp., 6 figs. Report, embodying study of weight ratios for common loads, lengths, and fixities, to enable designer to choose readily between duralumin and steel for lightest weight.

E

EDUCATION, ENGINEERING

Future of. The Future of Engineering Education, Chas. F. Scott. Eng. Education, vol. 13, no. 1, Sept. 1922, pp. 2–9. Points out that it should include preparatory and high school and also first few years after graduation. Lack of intelligent understanding among teachers of preparatory schools and among parents as to what engineering really is. Presidential address.

Mining and Metallurgy. Mining and Metallurgy at Yale University, George J. Young. Eng. & Min. Jl.-Press, vol. 114, no. 16, Oct. 14, 1922, pp. 682–684, 4 figs. Curricula provide for selection of fundamental subjects. Method of presentation given particular attention. Specialization subordinated to broad study.

Post-War. Engineering Education after the War, Arthur M. Greene, Jr. U. S. Bur. of Education, Bul., vol. 50, 1922, 27 pp. Deals with Students' Army Training Corps; proposed schedule of studies for four engineering courses as proposed by Committee on Educational and Special Training; schedule of studies submitted by Rensselaer Polytechnic Inst.; later developments; business administration; junior college; data from replies and catalogues.

ELECTRIC FURNACES

Aluminum-Melting. A Simple Electric Crucible Furnace for Melting Aluminium, A. Glynne Lobley. Am. Electrochem. Soc. advance paper, no. 17, for meeting Sept. 21–23, 1922, pp. 169–172, 1 fig. Describes case in which electricity was applied to melting and keeping molten of aluminum for die-casting small objects.

Closed-Crucible. New Type of French Electric Furnace, R. Sylvany. Iron Age, vol. 110, no. 12, Sept. 21, 1922, pp. 763–764. Describes furnace, based on idea of T. Levoz, used during war for production of high-speed steel. Closed crucible with only one opening for charging material and additions for pouring finished metal. Girod, Keller and Hewitt types compared. (Abstract.) Paper before Am. Foundrymen's Assn.

Design. Electric Heat, Its Generation, Propagation and Application to Industrial Processes, E. F. Collins. Am. Electrochem. Soc. advance paper, no. 22, for meeting Sept. 21–23, 1922, pp. 233–260, 13 figs. Discusses more important laws of furnace design. Overall cost of electric heating.

Electrodes. Regulation of Electrodes in Electric Arc Furnaces (La regulación de los eléctrodos en los hornos electricos de arco), Jose M. Navarrete. Anales de la Asociación de Ingenieros del Instituto Católico de Artes e Industrias, vol. 1, no. 1, Jan. 1922, pp. 13–19, 7 figs. Necessity of regulating electrodes and difficulties attending it.

Heroult. The Heroult Furnace and Its Smelting Operation (Der Heroult-Ofen und sein Schmelzbetrieb), K. Kerpely. Giesserei-Zeitung, vol. 19, nos. 34 and 35, Aug. 29 and Sept. 5, 1922, pp. 487–491 and 509–513, 10 figs. Deals with electrical conditions; lining; electric equipment; electrodes; starting fire in furnace; removal of clinker; deoxidation and desulphurization; hot charge.

High-Temperature. Principles of High Temperature Furnace Design, E. L. Smalley. Am. Electrochem. Soc., advance paper, no. 10, for meeting Sept. 21–23, 1922, pp. 77–88. Discusses attributes which electric furnaces should have, judged from viewpoints of highest quality of products, lowest cost of operation and maintenance, and greatest safety in operation at high temperatures.

Iron Founding. Melt and Anneal Electrically, Herbert R. Simonds. Foundry, vol. 50, no. 15, Aug. 1, 1922, pp. 609–612 and 621, 8 figs. Steel and malleable iron are melted in arc furnace and resistance type is employed for annealing castings.

Refractories for. Refractory Materials for Electric Furnaces, Alfred B. Searle. Beama, vol. 11, no. 4, Oct. 1922, pp. 664–670. Shows what has been done as regards refractory materials for electric furnaces and in what directions further research may usefully be conducted. It is found that newer and, as yet, not fully developed refractory materials, such as carborundum, fused alumina, zirconium and zircon, may in time replace some of those at present largely used.

Tagliaferri. Tagliaferri Furnaces in the Ansaldo Steel Works (Les fours Tagliaferri aux aciéres Ansaldo). Journal du Four Électrique et des Industries Électrochimiques, vol. 31, no 11, Aug. 1–15, 1922, pp. 84–85, 1 fig. Operation of furnaces Nos. 4 and 5 of capacity of 6 and 10 tons, respectively, which have proved entirely satisfactory.

ELECTRIC LOCOMOTIVES

High-Speed Passenger. North-Eastern Railway Electrification. Elec. Rev., vol. 91, no. 2340, Sept. 29, 1922, pp. 436–437, 2 figs. Details of first high-speed passenger locomotives for service on British trunk-line railway.

Swiss. Electric Locomotives of the Federal Swiss Railways, Type 1B1-Bi, Constructed at Secheron Works (Locomotives électriques des Chemins de fer fédéraux suisses, type 1B1-Bi, construites par les Ateliers de Sécheron), G.-L. Meyfarth. Génie Civil, vol. 81, no. 7, Aug. 12, 1922, pp. 149–155, 16 figs. partly on supp. plate. Mechanical and electrical equipment of locomotives intended for Gothard line.

ELECTRIC RAILWAYS

Switzerland. Electric Traction on the Gottard Line (La trazione elettrica sull'intiera linea del Gottardo). Revista Tecnica della Svizzera Italiana, vol. 11, no. 6, June 1922, pp. 64–69. Advantages; principal data of construction work; hydroelectric plants; substations; electric locomotives; etc.

ELECTRIC RAILWAYS, TRACK

Urban. Urban Electric Railway Tracks, E. J. McIlrath. Eng. & Contracting, vol. 58, no. 12, Sept. 20, 1922, pp. 279–281. Principles of construction. Paper presented at City Paving Conference, Philadelphia.

ELECTRIC WELDING

Spot, Machine for. Things That Can Be Done in High-Speed Welding of Small Parts, E. H Hubert. Indus. Engr., vol. 80, no. 9, Sept. 1922, pp. 413–415, 5 figs. Describes semi-automatic electric spot welding machine used, with procedure whereby 1000 welds an hour are made in plant of E. N. Garrison Mfg. Co., Bridgeport, Conn.

ELECTRIC WELDING, ARC

Mild Steel and Gray Castings. Experiments with Electric Arc Welding of Mild Steel and Gray Castings (Versuche über elektrische Lichtbogen-Schweissung von Flusseisen und Grauguss), H. Neese. Stahl u. Eisen, vol. 42, no. 26, June 29, 1922, pp. 1001–1013, 20 figs. For mild steel, gives experiments to determine most favorable strength of current, different methods of welding, welding apparatus, influence of composition of welding wire and power; for gray castings, experiments on difference between hot and cold welding.

ELEVATORS

Cables, Replacing. Replacing Cables on a Two to One Traction Elevator Machine, F. A. Annett. Power, vol. 56, no. 10, Sept. 5, 1922, pp. 372–375, 11 figs. Describes method which has been used successfully for number of years in cabling two-to-one traction elevators, eliminating much of hard work generally attendant with such jobs.

EMPLOYEES' REPRESENTATION

Plan. Telling Workers All About Business, George Smart. Iron Age, vol. 110, no. 15, Oct. 12, 1922, pp. 917–919, 2 figs. Employee representation has proved successful in periods of depression and prosperity at plant of American Multigraph Co.

EMPLOYEES, TRAINING OF

Edison School. Results Obtained from the Technical Courses of the Brooklyn Edison Company, F. N. Fenninger. Personnel Administration, vol. 10, no. 3, July 1922, pp. 9–11. History of plan; attendance in 1921; training and promotion; costs versus results.

EMPLOYMENT MANAGEMENT

Labor Policy. The Function of a Labor Policy, Ernest C. Gould. Indus. Management, vol. 64, no. 3, Sept. 1922, pp. 153–154 and 161. Analysis and definite statement of aims.

Personnel Planning. Organization Personnel Planning, B. A. Franklin. Indus. Management, vol. 64, no. 3, Sept. 1922, pp. 181–183. Problem of planning and scheduling personnel work.

Psychotechnical Methods. Industrial Psychotechnology (Industrielle Psychotechnik). Werkstattstechnik, vol. 16, no. 18, Sept. 15, 1922. Contains following articles: The Kinds of Adaptability Tests, W. Moede, pp. 521–530, 15 figs. The Executive Problem, G. Schlesinger, pp. 530–534. Position and Duties of an Executive from His Own Viewpoint, H. Herwig, pp. 534–537. Advertising as Educational Medium in Factory, K. A. Tramm, pp. 537–542, 9 figs. Safety in Industrial Plants, A. Haag, pp. 542–544. Psychotechnology and Advertising, Maria Schorn, pp. 544–547, 7 figs. Psychotechnical Work and Factory Management, Adolf Friedrich, pp. 547–551. Physician and Psychotechnology, H. Chajes, pp. 551–552, 2 figs. Latest Results of Psychotechnical Adaptability Tests for Telephone Service, Oskar Klutke, pp. 553–555, 3 figs. Application and Results of Psychotechnical Methods in the Osram Works, Walter Levy and Curt Piorkowski, pp. 555–559. Switchboard Operator and Switchboards, Rudolf Bronner, pp. 560–562, 3 figs. Psychotechnology in Radiotelegraphy, Rudolf Blumenthal, pp. 562–563, 1 fig. Improvement in Typewriter Design Based on Psychotechnical Principles, Alfons Schilling, pp. 563–568, 7 figs.

Small Factory. A Small Employment Department for a Small Factory. Factory, vol 29, no. 4, Oct. 1922, pp. 392–394, 2 figs. Describes plan used by 150-man plant.

Testing for Placement. Placement of Operators through Tests, Arthur L. Mann. Personnel Administration, vol. 10, no. 2, June 1922, pp. 11–17. Describes practice of Kodak Part Works of Eastman Kodak Co. in testing young women for placement. Notes on job analysis, method of measurement, calibration of tests, establishing minimum standards, job classification, etc.

ENGINEERS

Licensing. Engineers in Many Fields Discuss Licensing. Eng. News-Rec., vol. 89, nos. 12 and 15, Sept. 21 and Oct. 12, 1922, pp. 470–472 and 616–617. Extracts from letters commenting on editorial discussion of subject published in same journal, July 6.

ENGINEHOUSES

Rectangular Concrete. New Engine House Construction on the Southern Pacific. Ry. Rev., vol. 71, no. 13, Sept. 23, 1922, pp. 405–407, 4 figs. Two rectangular concrete enginehouses, one at Mojave, Cal., and other at Indio, Cal., presenting departure from conventional design.

EVAPORATORS

High- and Low-Pressure. Evaporators in the Stationary Power Plant. Power, vol. 56, no. 12, Sept. 19, 1922, pp. 449–454, 10 figs. Deals with high-pressure and low-pressure systems, describing apparatus and showing how layout is determined by heat balance of particular plant.

F

FANS

Design. Fan Blower Design, H. F. Hagen. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 5, July 1922, pp. 491–504, 9 figs. Describes methods by which forms and proportions of silentvane fan designed by author were determined. Design of fans based on theories of hydrodynamics.

FEEDWATER HEATERS

Testing. Test of a Cochrane Open Feed Water Heater, P. J. Searles. Am. Soc. Nav. Engrs. Jl., vol. 34, no. 3, Aug. 1922, pp. 430–437, 2 figs. Describes simple method of test which can be used in any power plant, is easily adaptable to any type of heater, and sufficiently accurate for all practical purposes.

FIRE PREVENTION

Equipment. Fire Protection for Industrial Plants, Charles L. Hubbard. Southern Engr., vol. 37, no. 6, Aug. 1922, pp. 46–51, 17 figs. Details regarding kind of apparatus to use for protection as applied to any building of similar type.

Fireproof Buildings. The Effects of Fire on Fireproof Buildings, Charles E. Fox. West. Soc. Engrs. Jl., vol. 27, no. 9, Sept. 1922, pp. 255–262 and (discussion) 262–266. Conclusions reached from examination of fire in 16-story Burlington building in Chicago, Mar. 15, 1922.

Recommendations. Fire Prevention and Fire Protection in Relation to the Public Water Supply, Frank C. Jordan. Am. Water Works Assn. Jl., vol. 9, no. 5, Sept. 1922, pp. 731–740 and (discussion) 740–742. Comparison of conditions in America and Europe. Author recommends elimination of shingle roofs, clean-up programs, and makes other suggestions for prevention of fires.

FLIGHT

Soaring. Gliding Experiments in Europe—1922, Edward P. Warner. Aviation, vol. 13, no. 13, Sept. 25, 1922, pp. 376–380, 17 figs. Particulars of aircraft entered and results achieved at recent French and German gliding meets.

FLOW OF WATER

Kutter's Formula. Flow in Tennessee Checked against Hydraulic Formulas, Benjamin E. Hones. Eng. News-Rec., vol. 89, no. 15, Oct. 12, 1922, pp. 610–612, 4 figs. Study of these and Irrawaddy River curves indicate that Ganguillet and Kutter's formula does not allow fully for effect on C of slope and hydraulic radius.

FLUE-GAS ANALYSIS

Testing Apparatus. Heating-Gas Tester to Determine CO_2 Content and Gas Loss [Duplex-Mono (Heizgasprüfer auf CO_2-Gehalt und Gasverlust)], K. Münzer. Wärme, vol. 45, no. 31, Aug. 11, 1922, pp. 377–379, 9 figs. Describes Duplex-Mono testing apparatus for constant control of flue-gas composition. Test results with original diagrams drawn from practice.

FOREMEN

Training. Experiences in Foremen Training, John Calder. Personnel Administration, vol. 10, no. 2, June 1922, pp. 3–10. Summary of experiences. Analysis of methods. Outline and results of training program.

FORGE SHOPS

Heppenstall Co., Pittsburgh. Works of the Heppenstall Forge and Knife. Forging & Heat Treating, vol. 8, no. 9, Sept. 1922, pp. 388–398, 15 figs.; 399–409, 8 figs.; 410–411, 2 figs.; and 412–413, 2 figs. First article describes modern forge plant designed and equipped to specialize in large and medium-sized forgings. Plan of plant layout shows position of equipment in each department, relation of departments and means of routing during manufacture. Second article, by R. F. Keifer, describes steam-

generating plant Third article describes new oil-fired forge heating furnaces Fourth article describes offices, laboratories and cafeteria See also Iron Trade Rev , vol 71, no. 13, Sept 28, 1922, pp 843-851, 9 figs.

FOUNDRIES

British. A Modern British Foundry Eng Production, vol 5 no. 103, Sept 21, 1922, pp 271–273, 13 figs Notes on plant and methods of Sterling Metals, Ltd , Coventry, England

FUELS

Economy Report on Fuel Economy Colliery Guardian, vol 124 no 3220, Sept 15, 1922, pp 641 642 Fifth report of committee appointed by Brit. Assn. for investigation of fuel economy, utilization of coal, and smoke prevention Deals with oil fuel supplies, chemistry of coal, brown coal and lignites, domestic heating and cooking appliances, steam raising and power production, smoke abatement See also Iron & Coal Trades Rev , vol 105, no. 2846, Sept. 15, 1922, pp 380–381.

Pacific Coast Problems. The Fuel Problems of the Pacific Coast. Mech Eng , vol 44 no 10, Oct 1922, pp 655 659 Abridgments of following papers The Future Fuel Supply of California, C H Delany, The Railway Fuel Problem of the Pacific Coast, J. C. Martin, The Marine Fuel Problem of the Pacific Coast, D Dorward, Jr.; Conservation of the Fuel Supplies of the Pacific Coast, F H Sibley

[See also COAL, OIL FUEL; PULVERIZED COAL.]

FURNACES

Doors. Furnace Doors, H. J. Trupin Machy (Lond.), vol 21, no 523, Oct. 5, 1922, pp 20 21, 9 figs. Their design and suitability.

FURNACES, BOILER

Flue-Dust Losses. Flue-Dust Losses in Boiler Operation (Flugaschenverluste im Dampfkesselbetriebe), L. Finckh. Wärme, vol. 45, no. 25, June 23, 1922, pp. 309 311. Describes new type of baffle plates for prevention of flue-dust deposits, which is said to overcome unfavorable effect of draft.

Forced-Draft. Cast-Iron Sectional Boilers with Forced-Draft Grates (Gusseiserne Gliederkessel mit Unterwindfeuerung), Mór Réti Gesundheits-Ingenieur, vol. 45, no. 29, July 22, 1922, pp. 373–376, 4 figs. Writer gives account of successful experiences during two years with use of forced-draft grates attached to different types of sectional boilers, for use of low-grade fuel.

Mechanical Draft. Mechanical Draft, A. W. Binns. Power Plant Eng , vol 26, no. 19, Oct. 1, 1922, pp. 939–942 10 figs. Its control, relation to heat transfer, gas velocity and difficulties experienced in specific installation.

Moist-Fuel Grates. Grates for Moist Fuel, Zuce Kogan. Power Plant Eng., vol. 26, no. 20, Oct. 15, 1922, pp. 989–993, 10 figs. Practical and theoretical considerations involved in design and operation.

FURNACES, ENAMELING

Gas-Fired. A New Type of Gas-Fired Vitreous Enameling Furnace, H. H. Clark. Am. Ceramic Soc. Jl., vol. 5, no. 8, Aug. 1922, pp. 478–487, 8 figs. Intermittent-type furnace having working chamber 4 ft. wide, 3 ft. high and 10 ft. long, heated by 10 burners, can be brought to working temperature in less than an hour and will turn out from 12 to 24 loads of work an hour.

The Intermittent Gas-Fired Enameling Furnace, Frederic C. Mackey. Am. Gas Jl., vol. 117, no. 12, Sept. 16, 1922, pp. 245–249 and 256, 7 figs. Compares electricity, gas, coal and oil in vitreous enameling industries, showing advantages of direct-fired gas furnace; figures compiled from production results obtained by using intermittent-type furnace.

FURNACES, HEATING

Regenerative Pit. Pit Reheating and Soaking Pit Furnaces, W.-E. Groume-Grjimailo. Iron Age, vol. 110, no. 16, Oct. 19, 1922, pp. 1013–1014, 4 figs. Removal of waste gas a primary consideration rarely achieved; principles governing rational design. From "The Flow of Gases in Furnaces," Wiley & Co., publishers.

G

GALVANIZING

Hot. Hot Galvanizing, Claude O. Kell. Am. Mach., vol. 57, no. 16, Oct. 19, 1922, pp. 605–607, 3 figs. Methods employed; design and construction of plant with suggested layout; selection and care of equipment.

Modern. What Is the Matter with Modern Galvanizing? J. A. Singmaster and G. F. Halfacre. Min. & Metallurgy, no. 190, Oct. 1922, pp. 15–16. Results of investigation show waste of materials caused by insufficient coating.

GAS ENGINES

Blast-Furnace. British Blast-Furnace Gas Engines. Power, vol. 56, no. 16, Oct. 17, 1922, pp. 608–609, 2 figs. Notes on design of large gas engines; large British engines; double-acting engines; ignition systems; future of gas engine in Great Britain.

British Blast-Furnace Gas Engines, P. Johnstone-Taylor. Iron & Coal Trades Rev., vol. 105, no. 2847, Sept. 22, 1922, pp. 422–424, 9 figs. Relation of design to reliability and efficiency. Main field of large gas engines is said to be a connection with driving blowing engines for blast furnaces, and in utilizing waste gases therefrom for power production

Coke-Oven-Gas-Driven. Utilisation of Coke-Oven Gas by Large Gas Engines Iron & Coal Trades Rev vol 105, no 2848, Sept 29, 1922 p. 461, 2 figs Details of one of largest coke-oven gas power stations in Germany, installed at Zollverein coal mine

GAS PRODUCERS

German. New Types of Fixed- and Revolving-Grate Gas Producers (Neue Festrost- und Drehrostgaserzeuger Bauarten), H. Gwosdz Wärme, vol 45, no 31, Aug. 11, 1922, pp. 380 381, 10 figs. Details of new types designed by Goehtz and built by Keula Steel Works, Berlin-Schöneberg.

Morgan. The Morgan Gas Producer (La machine à gazeifier Morgan), L. Moutton. Arts et Metiers, vol 75, no 19, Apr. 1922, pp. 100–103, 3 figs. Operation and advantages.

Preheated-Air. Burning Fuel in Gas Producers with Preheated Air (L'utilisation des combustibles dans les gazogènes à fusion des cendres soufflés au vent chaud), Auguste Dessemond. Révue Universelle des Mines, vol 14, no. 3, Aug. 1, 1922, pp. 201 214, 6 figs partly on supp. plate. Describes plant successfully run by Saint Etienne coal mining company for burning coal waste containing over 50 per cent ash

Stokers for. Modern Mechanical Stokers and Ash-Removal Arrangements for Gas Producers, Especially for Those with Long Shafts (Neuere mechanische Roste und Aschenaustragvorrichtungen fur Gaserzeuger, insbesondere fur solche mit langgestrecktem Schachte), H Gwosdz. Feuerungstechnik, vol. 10, no 24 Sept. 15, 1922, pp. 269 273, 22 figs. Describes various new domestic and foreign arrangements

GAS TURBINES

Hepburn-Forbes. Gas Turbine Controversy. Practical Engr., vol. 66, no. 1857, Sept. 26, 1922, p. 205. In writer's belief, Holzwarth turbine is overrated. Discusses proposed new Hepburn-Forbes system, in which sub-atmospheric, single-fluid constant-pressure cycle has been adopted.

GASOLINE

Natural Gas as Source. Design and Operation of a Low-Pressure Absorption Plant, W. P. Dykema and A. A. Chenoweth. U. S. Bur. of Mines Tech. Paper, no. 263, 1922, 42 pp.,16 figs. Deals with construction, operating methods, many changes necessitated, and difficulties encountered in recovery of gasoline from rich casing-head natural gas by absorption at low pressure. Describes large plant in Cushing oil field in Oklahoma. Bibliography on natural gas.

GEAR CUTTING

Automatic Lathes. Basic Principle and Use of Automatic Gear-Cutting Lathes (Grundsatz und Anwendung der Abwälzfräsautomaten), C. E. Berck. Werkstattstechnik, vol. 16, no. 15, Aug. 1, 1922, pp. 442–446, 16 figs. It has been shown that entirely satisfactory results can be obtained with use of automatic gear cutter on lathes.

Bevel Gears. Considerations Affecting the Design and Operation of Bevel-Gear Machines. I. H. Wright. Machy. (Lond.), vol. 21, no. 523, Oct. 5, 1922, pp. 13–15, 7 figs. Templet-formed gear teeth.

Cutting Bevel Gears. Machy. (Lond.), vol. 20, nos. 516 and 520, Aug. 17 and Sept. 14, 1922, pp. 612–615 and 735–738, 12 figs. Aug. 17: Principles governing operations of generating planers and general methods of setting up and adjusting Bilgram machine for cutting bevel gears. Sept. 14: Setting up Gleason bevel-gear generators; time required for cutting gears of different sizes and pitches.

Cutting Large Bevel Gears, Franklin D. Jones. Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, pp. 116–122, 15 figs. Methods of stocking out and finishing bevel gears on single- and two-tool planers of form-copying or templet types.

GEARS

Bevel. Spiral Bevel Gears, I. H. Wright. British Machine Tool Eng., vol. 2, nos. 14, 15 and 16, Mar.-Apr., May-June and July-Aug. 1922, pp. 460–464, 490–495 and 525–528, 23 figs. Evolutionary forms of Citröen double helical, spiraloid, and spiral-type bevel gears, and their various objections and disadvantages as against true Archimedean spiral bevel. May-June: Explains mechanism of machine for cutting spiral bevel gears of Archimedean spiral type. July-Aug.: Mode of operation of Smith & Coventry spiral bevel gear planer.

Calculation. Rear-Axle Gear Calculations by the Compressive-Stress Method, Joseph Jandasek. Soc. Automotive Engrs. Jl., vol. 11, no. 4, Oct. 1922, pp 375–379, 1 fig. Formulas for calculating greatest allowable load on pitch line for spur and bevel gears; investigation of capacity and strength of gears with straight and helical teeth; formulas for checking pitch and for computing number of teeth when compressive and bending stresses are equal.

Grinding. Gear Tooth Grinding. Machy. (Lond.), vol. 21, no. 523, Oct. 5, 1922, pp. 10–12, 7 figs. Loading of gear teeth; tooth pressure; importance of accuracy; types of machines.

Herringbone. Design of Herringbone Gears, N. Leerberg. Am. Mach., vol. 57, no. 16, Oct. 19, 1922, pp. 597 604, 10 figs. Methods of cutting; involute and cycloidal tooth forms; determination of strength and wear factors; care of gears.

Hot-Rolled. Producing Spur and Bevel Gears with Hot-Rolled Teeth. Automotive Industries, vol. 47, no. 13, Sept. 28, 1922, pp. 618–621, 5 figs. Describes machines used and methods followed in manufacture of hot-rolled gears by Anderson Rolled Gear Co., Cleveland, Ohio Herringbone type of bevel gear among varieties made by this process See also Eng. Production, vol 5, no 102, Sept 14, 1922, pp 253–257, 11 figs ; and Iron Age, vol 110, no. 14, Oct. 5, 1922, pp. 861 863, 6 figs.

Teeth, Strength of. Strength of Internal Spur Gear Teeth, Douglas T. Hamilton. Machy. (N. Y.), vol 29, no. 2, Oct. 1922, pp. 109 111, 5 figs Brief review of improved method for determining strength. Factors governing strength; determining initial point of tooth contact; application of Lewis formula.

Tooth-Measuring Machine. Machine for Measuring Gear Teeth Engineering, vol. 114, no 2961, Sept. 29, 1922, p. 410, 9 figs. partly on p. 411. Describes machine for measuring errors.

GRAIN ELEVATORS

Concrete, Reconstruction. Concrete Grain Elevator Rebuilt at Chicago. Eng. News-Rec., vol. 89, no 12, Sept 21, 1922, pp. 483 485, 3 figs. Extensive repairs to foundations and bins of 10,000,000-bu. Northwestern elevator wrecked by explosion. New dust-removal apparatus.

GRINDING

Camshafts. Accurate Camshafts Produced by Grinding, R. Harrison. Can. Machy., vol 28, no 11, Sept. 14, 1922, pp. 20 22, 5 figs. Treatise on British methods; location of master cams; points to consider in obtaining accurate work.

Foundry and Steel-Mill. Grinding in Foundry and Steel Mill. Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, pp. 126 130, 9 figs. Types of grinding machines used in foundries; wheel selection for snagging; arrangement of cleaning room; wheel efficiency and grinding costs; records of wheel costs; billet grinding.

Small Tools. Grinding in the Small Tool Industry. Machy. (Lond.), vol. 20, no. 519, Sept. 7, 1922, pp. 696–702, 19 figs. Grinding straight edges; sharpening cutters; grinding plug gages, micrometer parts, etc.

H

HANDLING MATERIALS

Chemical Plants. Safe Handling of Materials in Chemical Plants, W. G. Whitman. Chem. Age (N. Y.), vol. 30, no. 9, Sept. 1922, pp. 377–379. Non-chemical hazards; handling of gases and liquids; overflowing tanks; explosions. Paper read before Nat. Safety Council.

Factories. Handling the Finished Products of Industry, Graham L. Montgomery. Chem. & Met. Eng., vol. 27, no. 16, Oct. 18, 1922, pp. 779–783, 3 figs. Layout of Baltimore refinery of American Sugar Refining Co. Deals with packing bulk sugar in barrels, handling empty and filled barrels, loading bulk sugar in bags, delivering sugar to automatic package equipment, automatic filling of paper cartons, etc.

Tiering Machines. Tiering Machines. Engineering, vol. 114, no. 2959, Sept. 15, 1922, pp. 321–325, 8 figs. Describes models of portable elevators developed by Economy Engineering Co. of Chicago. Examples of use of tiering machines.

Unloading Plants. Elfa Unloading Appliances, K. Fölsche. Eng. Progress, vol. 3, no. 10, Oct. 1922, pp. 228–230, 4 figs. Describes design and mode of action of mechanical appliances designed for unloading railway trucks by means of jet of liquid arranged to be directed as required and, evidently, possessing sufficient force to fulfill desired aim.

HANGARS

Belleville, Ill. The Army Airship Shed at Belleville, Ill. Aviation, vol. 13, no. 13, Sept. 25, 1922, pp. 383–384, 2 figs. Huge building, now under construction, to be 923 ft. long, 206 ft. wide and 170 ft. high; represents greatest advance to date in airship shed design.

Metal. The New Metal Hangars for Airplanes at Orly, France [Les nouveaux hangars métalliques pour avions du Centre d'aviation d'Orly (Seine)], F. Tayssier. Génie Civil, vol. 81, no. 9, Aug. 26, 1922, pp. 189–191, 11 figs. partly on supp. plate. Design, construction and iron framework of the three hangars for the military aviation center.

HARDNESS

Testing. An Accurate Method of Determining the Hardness of Metals, with Particular Reference to Those of a High Degree of Hardness, R. L. Smith and G. E. Sandland. Instn. Mech. Engrs. Proc., vol. 1, no. 3, 1922, pp. 623–641, 12 figs. By knowing impression given by standard load, it is claimed to be possible, by means of a formula, to obtain ball-hardness figures, which are proportional to load required to give standard impression; this ball test fails at about 525 Brinell or 550 modified ball hardness. Includes five appendices.

HEALTH

Physician in Industry. The Physician in Industry. Nat. Indus. Conference Board, Special Report, no. 22, June 1922, 98 pp. Symposium of following articles: The Physician in Industry, C. C. Burlingame. The Physician in Industry and His Relation to Community Problems, C. E. Ford. The Medical Department in Industry, William A. Sawyer. Physical Examinations, C. H. Watson. Training for First Aid, Loyal A. Shoudy. Industrial Medical Records, E. H. Ingram. Dental Work in Industry, Voyle A. Paul. Tuberculosis and Heart Disease among Industrial Workers, W. Irving Clark, Jr.

Epidemic Diseases Among Industrial Workers, Royal S. Copeland. Standardization of End Results Following Injury, John J. Moorhead. Relation of Physician in Industry to Workmen's Compensation Laws, Frank L. Rector. Proper Recognition of Medical Opinion in Consideration and Settlement of Compensation Cases, W. B. Fisk. Eye Injuries from Compensation Standpoint, John A. Jackson. Back Injuries from Compensation Standpoint, F. E. Schubmehl. Hernia from Compensation Standpoint, Sidney M. McCurdy. Occupational Diseases from Compensation Standpoint, Frank L. Rector. Rehabilitation of Industrially Handicapped, T. Lyle Hazlett. Part of Industrial Management in an Industrial Medical Program, Magnus W. Alexander.

HELIUM

Production. Present State of Production of Helium (L'état actuel de la fabrication de l'hélion), N. Kirilov. Vie Technique et Industrielle, vol. 3, no. 36, Sept. 1922, pp. 370–371, 1 fig. Describes plant and manufacturing processes at Calgary for production of 97 per cent helium.

HUMIDITY

Equilibria of Common Substances. Humidity Equilibria of Various Common Substances, Robert E. Wilson and Tyler Fuwa. Jl. Indus. & Eng. Chem., vol. 14, no. 10, Oct. 1922, pp. 913–918, 13 figs. Discusses various types of humidity equilibrium curves, and gives curves for various substances arranged in groups of related materials, as follows: natural and artificial textile fibers, pulp and paper fibers, foodstuffs, absorbents, various forms of carbon and inorganic solids.

HYDRAULIC TURBINES

Axial Thrust. Axial Thrust in Turbines (Poussée axiale et Couple moteur dans une turbine), A. Gay. Annales de l'Énergie, vol. 2, no. 4, July-Aug. 1922, pp. 133–135, 3 figs. Equations on axial thrust of Francis turbines.

Draft Tubes Notes on the Draught Tube of a Water Turbine, Otogorô Miyagi. Soc. Mech. Engrs., Tokyo, Japan—Jl., vol. 25, no. 74, June 1922, pp. 39–50, 4 figs. Investigation of losses of energy; consideration of minimum loss and determination of best form of draft tube.

Improvements. Improvements in Design of Hydraulic Turbines (Neuerungen im Wasserturbinenbau), H. Donath. Elektrotechnischer Anzeiger, vol. 39, nos. 91, 92, 93 and 94, June 8, 10, 13 and 14, 1922, pp. 743–744, 751–752, 759–760 and 769–770, 18 figs. Describes recent patented improvements in turbines for low head and comparatively low cost.

Kaplan. Kaplan Turbines (Kaplan-Turbinen), Gustaf Molinder. Teknisk Tidskrift, vol. 52, no. 37, Sept. 16, 1922, pp. 593–601, 19 figs. Theory of Kaplan and Francis Turbines; details of efficiency tests made.

Pelton Wheels. Experiments on a Pelton Wheel and Needle-Nozzle, A. H. Gibson. Instn. Mech. Engrs. Proc., vol. 1, no. 3, 1922, pp. 643–661, 8 figs. Tests indicate that efficiency of well-designed wheel and nozzle, even of small power, may be surprisingly high.

Problems. The Hydraulic Turbine in Evolution, H. Birchard Taylor and Lewis F. Moody. Mech. Eng., vol. 44, no. 10, Oct. 1922, pp. 633–640, 10 figs. New problems created by turbine evolution. Analysis of flow in high-speed turbine. Correlation of marine propeller with hydraulic turbine. (Abridgment.)

HYDROELECTRIC DEVELOPMENTS

Chile. Hydro-Electric Development in Chile. Engineering, vol. 111, no. 2958, Sept. 8, 1922, pp. 297–298, 6 figs. partly on p. 300. Details of plant under construction in Colorado River valley, which is part of scheme to be developed later.

India. Hydro-Electric Power in India, Arthur T. Arnall. Beama, vol. 11, nos. 1 and 2, July and Aug. 1922, pp. 465–473 and 546–553, 2 figs. July: Survey of water-power resources, including details of rainfall and run-off; problems of storage, irrigation and hydraulic works. Aug.: Characteristic schemes; water power and coal; future development.

Manitoba, Canada. Great Falls Development of Manitoba Power Co., F. H. Martin. Can. Engr., vol 43, no. 11, Sept. 12, 1922, pp. 337–341, 5 figs. Ultimate development on Winnipeg River of 168,000 hp planned, power house being built for initial installation of three 28,000-hp. units; operating head 56 ft.; maximum height dam 70 ft.; concrete center-cone draft tubes.

HYDROELECTRIC PLANTS

California. Caribou 165,000-Volt Development, J. A. Koontz. Elec. World, vol. 80, no. 13, Sept. 23, 1922, pp. 648–652, 12 figs. Notes on 15,000-hp. impulse wheels, high-voltage lines over exceptionally rugged country and method of handling work and distributing material.

First Pit River Power Project Is Completed. Eng. News-Rec., vol. 89, no. 14, Oct. 5, 1922, pp. 570–571, 3 figs. Highest unit in continuous river development totals 90,000 hp. 202,000-volt power line 202 miles long.

Queenston-Chippawa. Queenston Chippawa Power Development, T. H. Hogg. Engrs. & Eng., vol. 39, no. 9, Sept. 1922, pp. 310–324, 16 figs. Engineering features of development with permanent works designed for installation of 550,000 hp. How maximum efficiency was secured in use of water under 305 ft. head. Details of waterway 13 mi. long with unique type of intake to prevent ice troubles, concrete-lined canal section 8 mi. long, hydraulic turbines of 55,000 hp. cap., etc.

The Queenston-Chippawa Hydro-Electric Development. Elec. Jl., vol. 19, no. 8, Aug. 1922, pp. 312–328, 27 figs. Contains general description, by F. A. Gaby; description of 55,000-hp. turbines, F. H. Rogers; the 45,000-kva waterwheel generators, H. U. Hart; switching equipment, L. B. Chubbuck.

Switzerland. Large Modern Hydroelectric Plants in Switzerland (I grandi impianti idroelettrici moderni in Svizzera), Giovanni Rodio. Industria, vol. 36, nos. 6, 7 and 10, Mar. 31, Apr. 15 and May 31, 1922, pp. 101–105, 122–125 and 181–186, 25 figs. Describes plant at Broc; hydraulic construction features, including barrage dam, reservoirs, and water-level regulation.

I

IGNITION

Electric. The Principles of Electrical Ignition, W. M. Thornton. Beama, vol. 11, no. 2, Aug. 1922, pp. 524–529, 3 figs. Notes on electric ignition by jump sparks; oscillating coil sparks; break spark ignition; condenser discharge sparks.

Induction Coils and Magnetos. Electrical Ignition Apparatus for Internal-Combustion Engines, E. O. Turner. Engineering, vol. 114, no. 2960, Sept. 22, 1922, pp. 375–378, 6 figs. The induction coil is examined first, and the magneto is then considered as special type of induction coil.

IMPACT TESTING

Loads on Track Bolts. Some Interesting Tests of Impact Loads on Track Bolts. Ry. Maintenance Engr., vol. 18, no. 8, Aug. 1922, pp. 279–281, 5 figs. Describes unique method developed to determine stresses induced by train, engine and pull of wrench.

INDUSTRIAL MANAGEMENT

Charts. Measuring Growth and Shrinkage by Means of Ratio Charts, Bert E. Holmes. Indus. Management, vol. 64, no. 3, Sept. 1922, pp. 165–168, 3 figs. Said to be simplest means of graphically illustrating rate of increase or decrease in any continuing factor of industrial activities, such as sales, production, inventories, etc. Presents table for quickly placing "rate of change" lines on ratio charts.

Charting as an Aid in Stabilizing Profits, Percy A. Bivine. Indus. Management, vol. 64, nos. 3 and 4, Sept. and Oct. 1922, pp. 175–179 and 213–215. Sept.: Development of graphic service. Oct.: Control, establishment and cost of charting organization.

Cost Analyses. Establishing a Rational Basis for Industrial Analyses, Harrington Emerson. Chem. & Met. Eng., vol. 27, no. 13, Sept. 27, 1922, pp. 644–646. Analysis of costs involved in equipment, personnel and materials. Method illustrated from statistics of U. S. railroads.

Dennison Mfg. Co. The Outstanding Features of Dennison Management, H. Feldman. Indus. Management, vol. 64, nos. 2, 3 and 4, Aug., Sept. and Oct. 1922, pp. 67–73, 3 figs., 145–150 and 225–230, 4 figs. Aug.: Analyzing and anticipating cyclical movements. Sept.: Sales engineering and operation. Oct.: Production technique and personnel administration.

Inspection. Problems and Importance of Factory Inspection, John P. Meade. Monthly Labor Rev., vol. 15, no. 1, July 1922, pp. 13–23. Specific problems connected with inspection work. Paper read before Convention of Governmental Labor Officials of United States and Canada.

Labor Records. Labour Records for Small Factories, H. W. Rose. Indus. Management (Lond.), (formerly Eng. & Indus. Management), vol. 8, no. 6, Oct. 5, 1922, pp. 181–183, 7 figs. Explains systematic method of recording engagements, transfers, advancements, discharges, so as to enable works manager or other official to ascertain at all times numbers and particulars of employees in each department.

Paper-Box Factory. Description of a Department for Making Rough Boxes, H. V. S. Tingley. Taylor Soc. Bul., vol. 7, no. 5, Oct. 1922, pp. 183–193, 12 figs. Workers keep material flowing steadily through machines and piece workers complete jobs in average of 75 per cent of time allowed. Details of manufacture of box, routing, floor layout, production control, wage system and cost accounting.

Production Control. Production Control in a Tire Manufacturing Plant, W. B. Mendenhall. India-Rubber World, vol. 66, no. 5, Aug. 1, 1922, pp. 729–732, 4 figs. Notes on what has been done in standardizing and controlling product in one plant. Outline of system employed.

Production Planning. Effective Production Planning for the Drop Forge Shop, C. Oliver Wellington. Forging & Heat Treating, vol. 8, no. 9, Sept. 1922, pp. 418–420. Describes simple and economical system of production planning that controls operation not only of hammer units, but of preparatory and finishing processes during manufacture.

Purchasing. Aiding Purchasing through Production Studies, P. M. Marshall. Management Eng., vol. 3, no. 4, Oct. 1922, pp. 199–203, 8 figs. How buying is influenced by sources and supplies of materials.

The Purchasing Department, C. H. Bernard. Eng. Production, vol. 5, no. 101, Sept. 28, 1922, pp. 290–293, 9 figs. Details of system for recording essential data.

Quality Control of Products. Control of Quality of Manufactured Goods as Affected by Size of Plant, G. S. Radford. Management Eng., vol. 3, no. 4, Oct. 1922, pp. 193–198, 4 figs. Outlines methods according to which large factories can more nearly approximate advantages of smaller ones while still retaining favorable opportunities peculiar to strong establishments.

Raw-Material Control. Control of Raw Material to Suit Output, Gilbert L. Lacher. Iron Age, vol. 110, no. 12, Sept. 21, 1922, pp. 713–716 and 761–762, 9 figs. Management problems solved at Woodstock Typewriter Co. Close coördination of purchases and production. Shows forms or cards used in controlling raw and finished materials and movement through processes of manufacture.

Small Factories. Establishing a Small Engineering Works, A. Whitehead. Eng. & Indus. Management, vol. 7, nos. 16, 17 and 18, June 15, 29 and July 27, 1922, pp. 502–506, 540–542 and 571–573 and vol. 8, nos. 1, 2, 3 and 4, July 27, Aug. 10, 24 and Sept. 7, 1922, pp. 3–5, 39–41, 75–77 and 121–123, 13 figs. Planning of organization; choice of suitable site and layout of building; useful information on lighting, heating and ventilation; drawing office. Organization and system employed in some works.

Stocktaking. Perpetual Stocktaking Systems, H. W. Ross. Eng. & Indus. Management, vol. 8, no. 5, Sept. 21, 1922, pp. 147–148, 2 figs. Their value as recording accurate and reliable information.

Toolroom Organization. The Brass Check Versus the Triplicate Slip System. Indus. Management, vol. 64, no. 4, Oct. 1922, pp. 232–235. How loss of tools and loss of time may be diminished.

INDUSTRIAL RELATIONS

Improvements, Suggestions for. Industrial Relations, Carleton F. Brown. Indus. Management, vol. 64, no. 3, Sept. 1922, pp. 185–188. Suggests principles as forming nucleus for better understanding between capital and labor, and as foundation for development of other policies dictated from time to time by circumstances. Paper read before Indus. Relations Assn.

Industrial Democracy. New Spirit Guides Management, William Baum. Iron Trade Rev., vol. 71, no. 15, Oct. 12, 1922, pp. 996–998. True democracy in industry underlying principle of system which treats worker as intelligent personality. Remuneration is on basis of efficiency and quality of product. Mutual-benefit system successful. (Abstract.) Address before Soc. Indus. Engrs.

INSPECTION

Methods. Inspection Methods. Eng. & Indus. Management, vol. 7, nos. 16 and 18, June 15, and July 13, 1922, pp. 509–512 and 577–580 and vol. 8, nos. 1, 2, 3, 4 and 5, July 27, Aug. 10, 24, Sept. 7 and 21, 1922, pp. 8–12, 42–45, 78–81, 113–115 and 159–161, 35 figs. Necessity for inspection; duties of inspector; location of department. Inspection of gears; inspection gages. Tensile and hardness tests. Notched-bar tests.

INSULATORS, HEAT

Bagasse, Lumber. An Insulating Lumber from Bagasse, S. G. Roberts. Compressed Air Mag., vol. 27, no. 10, Oct. 1922, pp. 291–292, 4 figs. Notes on fabrication of celotex from sugar-cane waste. Its value as insulating material.

Refractory. Need for More Refractory Heat Insulators, Robt. D. Pike. Am. Ceramic Soc. Jl., vol. 5, no. 8, Aug. 1922, pp. 554–563, 4 figs. Commercial value of high-temperature thermal insulators, and numerical example of problem in designing flue for conducting hot gases; tentative specifications for refractory and insulating properties; proposed conductometer for measuring thermal conductivity.

2-Point. New Heat Insulating Material, G. Henry Katz. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 7, Oct. 1922, pp. 733–738, 2 figs. Describes development, structure and composition of 2-Point, made of asbestos and diatomaceous earth, and portrays its effectiveness as heat insulator. Reprinted from Asbestos, June 1922.

INTERNAL-COMBUSTION ENGINES

Compound. What Can We Expect from the Compound Gas Engine? W. J. Wohlenberg. Power, vol. 56, no. 15, Oct. 10, 1922, pp. 560–562, 4 figs. It is shown that intercooling during compression in internal-combustion engine will increase its thermal efficiency and will also increase power developed by engine by 50 per cent.

Cycles. Cycles of Internal-Combustion Engines (Les cycles du moteur à combustion interne), Pierre Lorain. Technique Moderne, vol. 14, no. 8, Aug. 1922, pp. 337–344, 18 figs. Examines possible engine diagrams; comparison of cycles of Diesel and explosion engines; mixed cycles and their efficiency.

Design. The Fundamentals of Internal-Combustion-Engine Design, L. H. Pomeroy. Soc. Automotive Engrs. Jl., vol. 11, no. 4, Oct. 1922, pp. 328–332 and (discussion) 354. Factors affecting performance of four-stroke-cycle engines; thermal efficiency and power obtainable from given engine said to be dependent upon compression-ratio, other things being equal; engine speed and friction losses. Author favors short-stroke engine.

Gaseous Detonation. The Chemical Control of Gaseous Detonation with Particular Reference to the Internal-Combustion Engine, Thomas Midgley and T. A. Boyd. Jl. Indus. & Eng. Chem., vol. 14, no. 10, Oct. 1922, pp. 894–898, 1 fig. Discusses bearing of gaseous detonation on operation of internal-combustion engines, and progress made in controlling it by chemical means.

Rotary, Forces in. Forces in Rotary Motors, Karl H. White. Mech. Eng., vol. 44, no. 10, Oct. 1922, pp. 643–647 and 654. Deals with determination of forces in rotary motor caused by reciprocation of pistons and connecting rods and by rotation of motor as a whole, in which novel methods of calculation are employed.

Vegetable Oils for. Using Vegetable Oils in Internal-Combustion Engines (Note au sujet de l'utilisation des huiles vegetales dans les moteurs à combustion interne). Bul Technique du Bureau Veritas, vol. 4, no. 7, July 1922 pp. 159-161, 3 figs Results of tests carried out with engines by Gardner, Kromhout, Ansaldo, and Anglo-Belgian Co

[See also AIRPLANE ENGINES, AUTOMOBILE ENGINES DIESEL ENGINES, GAS ENGINES, OIL ENGINES.]

IRON

Mechanical Properties. Mechanical Properties of Commercial Iron. Zay Jeffries and R S Archer Chem & Met Eng, vol 27, no. 14, Oct 4 1922, pp 694 697, 1 fig. Definitions of various terms used in art of testing materials, and discussion of how various circumstances surrounding test affect results on annealed bars of common structural metals.

IRON ALLOYS

Electrolytic. The Preparation and the Mechanical Properties of Vacuum-Fused Alloys of Electrolytic Iron with Carbon and Manganese, Robert P. Neville and John R Cain. Am. Electrochem Soc advance paper, no. 20, for meeting Sept 21 23, 1922, pp. 203-218, 2 figs. Describes preparation and mechanical properties of extensive series of very pure alloys of electrolytic iron, carbon, and manganese, whose compositions were so chosen as to bring out specific effects on pure iron of additions of carbon and manganese separately or together.

IRON CASTINGS

Annealing. Experiments for the Determination of the Critical Temperature in the Annealing of Gray-Iron Castings (Ueber Versuche zur Bestimmung der kritischen Temperatur beim Gluhen von Grauguss), Emil Schüz Stahl u Eisen, vol. 42, no. 39, Sept 28, 1922, pp. 1484-1488, 7 figs. Influence of phosphorus and graphite on hardness, importance of pearlite; examples of decomposition of cementite; testing arrangement for determination of critical temperature. Practical and theoretical conclusions.

L

LABOR

Production and Efficiency. Production and Efficiency of Labor. Monthly Labor Rev., vol. 15, no. 1, July 1922, pp. 89–92. Idle-day costs in coal-mining industry; production per worker in iron mines of Lorraine; operations of British coal mines, January 1 to April 1, 1922.

Twelve-Hour Shift. F.A.E.S. Report States Facts on Twelve-Hour Shift. Mech. Eng., vol. 44, no. 10, Oct. 1922, pp. 681–686, 2 figs. Committee on work periods in continuous industries presents report, entitled Twelve-Hour Shift in Industry, embodying investigations by Horace B. Drury and Bradley Stoughton.

Two-Shift System. The Twelve-Hour Shift in American Industry. Management Eng., vol. 3, no. 4, Oct. 1922, pp. 205–212, 3 figs. Summary report of special committee of Am. Engineering Council, purpose of which is to show extent of two-shift work and experience of those manufacturers who have changed from two-shift operation to some other system.

LOCOMOTIVE BOILERS

Fireboxes. Relative Value of Steel and Copper Fireboxes, Paul Conté. Boiler Maker, vol. 22, no. 9, Sept. 1922, pp. 253–255, 3 figs. Tests of locomotive boilers on European Railroads indicate that steel fireboxes give longer service. Abstract from Révue Générale des Chemins de Fer.

Tubes. Application and Maintenance of Locomotive Boiler Tubes, G. H. Woodroffe and C. E. Lester. Ry. Rev., vol. 71, no. 10, Sept. 2, 1922, pp. 306–311, 8 figs. Practical suggestions recommended, based on best practice observed on number of railroads.

Water Circulation. Increasing Locomotive Boiler Efficiency by Proper Circulation of Water, F. G. Lister. Boiler Maker, vol. 22, no. 9, Sept. 1922, pp. 256–257. Notes on thermic syphon, Harter circulating plate, washout and refilling system. (Abstract.) Paper read before Int. Fuel Assn.

LOCOMOTIVES

Alloy-Steel Parts. Alloy Steel Reduces Weight of Locomotive Parts, R. J. Finch. Ry. Mech. Engr., vol. 96, no. 10, Oct. 1922, pp. 569–571, 3 figs. Rods, axles and crankpins made lighter and dynamic augment reduced on Union Pacific No. 7000 by using carbon vanadium steel.

Booster. Dynamometer Tests of the Locomotive Booster. Ry. Mech. Engr., vol. 96, no. 10, Oct. 1922, pp. 562–565, 8 figs. Severe trials carried out at Engineering School of Harvard University demonstrate reliability at heavy loads and high speeds. Maximum drawbar pull 11,000 lb.

British vs. American. British and American Locomotive Design and Practice. Some Comparative Comments Thereon from Practical Experience, P. C. Dewhurst. Inst. Mech. Engrs. Proc., vol. 1, no. 3, 1922, pp. 375–423 and (discussions) 424–511, 18 figs. Author discusses comparative methods and practices in regard to structural and detail design, and indicates what in his opinion are best features of two partly opposing systems of locomotive engineering.

Design. Avoidable Waste in Locomotive Operation as Affected by Design, James Partington. Assn. Chinese & Am Engrs. Jl., vol 3, no 4, Apr May, 1922 pp 16–21 Study of design with regard to fuel economy, minimum weight of motive power equipment, and minimum cost of repairs

4 4 0. Rebuilt Express Locomotives London, Brighton & South Coast Railway Ry Gaz, vol 37, no. 11 Sept 15, 1922, pp 338 340, 6 figs Reconstruction of class B4 engines of 4 4 0 type, rendering them suitable for efficiently working heavy, fast passenger trains

Fuel Consumption. Effect of Tonnage and Speed on Fuel Consumption, J. E. Davenport Ry Mech Engr, vol 96, no. 10, Oct 1922, pp. 565 569, 8 figs Ton miles per hour affects fuel rate, economical tonnage for various speeds, effect of grade and car weight (Abstract.) Paper presented before Int. Ry. Fuel Assn.

Internal-Combustion. Gasoline Switching Locomotive with Hydraulic Drive Ry. Mech Engr., vol. 96, no 9, Sept. 1922, pp. 503 506, 7 figs. Universal oil transmission governs speed and direction and is said to give remarkable flexibility of control

Luttermöller. Recent Innovations on Standard Gauge Locomotives for Facilitating the Traversing of Curves, Suren ter Ohanessian Eng. Progress, vol. 3, no 10, Oct. 1922, pp. 230-232, 6 figs. Comparison of Mallet, Klienlindner and Luttermöller types, showing advantages of latter

Mikado. New Michigan Central Mikado Has Many Special Features. Ry. Mech. Engr, vol 96, no. 9, Sept. 1922, pp. 497–501, 5 figs. Details of new Mikado type, no. 8000; special features of construction; comparative data for class 117E and no. 8000.

Some Important Innovations in New Lima Mikado Locomotive. Ry. Rev., vol. 71, no. 10, Sept. 2, 1922, pp. 302–306, 3 figs. Gives outstanding features and principal dimensions of locomotive no. 8000.

The Michigan Central's Mikado (2–8–2) Type Locomotive No. 8000. Ry. & Locomotive Eng., vol. 35, no. 9, Sept. 1922, pp. 227–230, 2 figs. Further details of its design and construction; list of economic and efficiency-producing specialties used on engine; tractive effort with boosters, 74,500 lb., without boosters, 63,500 lb.

Mountain-Type. Service Records of U. P. Mountain Type Locomotives. Ry. Age, vol. 73, no. 16, Oct. 14, 1922, pp. 687–689, 6 figs. Performance indicates that no. 7000 exceeds both theoretical starting and horsepower capacity. Weighs 345,000 lb. and develops 3500 hp. at 50 mi. per hr. See also Ry. Rev., vol. 71, no. 16, Oct. 14, 1922, pp. 509–514, 14 figs.

Pacific. Test of the New "Pacific" Locomotive, No. 1471, on the Great Northern Railway. Ry. Gaz., vol. 37, no. 13, Sept. 29, 1922, pp. 388–389, 2 figs. Hauled test load of 20 passenger coaches, weighing 610 tons, a distance of $105^{1}/_{2}$ mi. in 122 min.

Power Estimation. Locomotive Power, E. C. Poultney. Engineer, vol. 134, no. 3480, Sept. 8, 1922, pp. 248–250, 6 figs. Describes method of quickly obtaining probable drawbar pull of any steam locomotive of conventional design at all speeds usual in practice.

Steam Desaturators. Steam Desaturators Applied to Hungarian Motive Power, Desider Ledacs Kiss. Ry. Rev., vol. 71, no. 15, Oct. 7, 1922, pp. 475–478, 6 figs. Describes Stein desaturator, a water intercepting device located in steam dome, successfully applied to large number of foreign locomotives. Improves locomotive efficiency in bad-water district.

Superheater. Locomotives for the Chemins de Fer du Midi. Engineering, vol. 114, no. 2960, Sept. 22, 1922, pp. 360–362, 14 figs. partly on supp. plate. Details of two-cylinder superheater 4–6–2 locomotives constructed by Société Alsacienne de Constructions Mécaniques, Belfort, France.

Tank. New "Baltic" Tank Locomotives, Glasgow & South Western Railway. Ry. Gaz., vol. 37, no. 3, July 21, 1922, pp. 90–91, 2 figs. Particulars of work performed under test conditions.

Test Results. Results of Tests with Steam Locomotives (Versuchsergebnisse mit Dampflokomotiven), R. Sanzin. Verkehrstechnik, vol. 39, no. 38, Sept. 22, 1922, pp. 481–485. Tests for determination of maximum tractive effort at drawbar; power of cylinders; adhesion and power of boiler; gives types of construction and their dimensions; results of tests for wet and dry steam.

2–8–2. America's Most Efficient Locomotive. Ry. Gaz., vol. 37, no. 12, Sept. 22, 1922, pp. 367–370, 4 figs. 2–8–2-type locomotive introduced on Michigan Central R. R. realizes maximum power development and effects great economy in fuel.

Uniflow. The Una-Flow Locomotive—A Praciteal Possibility. Ry. Rev., vol. 71, no. 11, Sept. 9, 1922, pp. 333–338, 8 figs. Explains basis for superior economy of uniflow engine; what has been accomplished toward practical application of its principle to European motive power; practical maintenance and operating features. Compiled principally from J. Stumpf's book.

LUBRICANTS

Oiliness. The Measurement of the Property of Oiliness, Robert E. Wilson and Danile P. Barnard. Soc. Automotive Engrs. Jl., vol. 11, no. 2, Aug. 1922, pp. 143–157, 17 figs. Describes variety of possible methods of measuring property of oiliness and of throwing light on mechanism of partial lubrication. It is concluded that static-friction test with proper refinements is best single measure of properties of oiliness.

LUBRICATION

Bearings. Bearing Design and Lubrication, William Foot. Elec. Jl., vol. 19, no. 9, Sept. 1922, pp. 367–382, 18 figs. Notes on action of oil films, and of a perfect film, starting conditions; application of lubricant, methods of cooling, oil protection; bearing losses and temperature, insulation of bearing pedestals, protection from dust, dirt and scale

Plant. The Technical Supervision of Plant Lubrication, Allen F. Brewer. Indus. Management, vol 64 nos 3 and 4, Sept and Oct. 1922, pp. 141 144 and 221 223, 6 figs Suggestions to plant lubricating engineer Determination of correct lubricant and minimum amount to use for safe and uninterrupted operation.

M

MACHINE SHOPS

Standardized Equipment. Standardizing machine Shop Equipment, H L. Wheeler. Am Mach, vol. 57, no 14, Oct 5, 1922, pp 520 521, 3 figs. Advantages are said to justify cost, successful method of improving old tools, tapers reduced to one standard and two sizes.

MACHINE TOOLS

Chip Disposal. Chip Disposal, F. Horner. Eng. Production, vol. 5, no. 102, Sept. 14, 1922, pp 247–251, 17 figs. Notes on shape of edge and chip escape; objection to large chips; packing in slots and holes; interference with machine elements; chip-collecting removing devices; chip accommodation in flutes, guards and receptacles; fixed pans versus portable; storage within machine framings.

MALLEABLE CASTINGS

Handling. Handling Malleable Castings, Herbert R. Simonds. Foundry, vol. 50, no. 18, Sept. 15, 1922, pp. 733–736, 4 figs. Methods adopted in prominent Eastern foundry, including use of lift trucks and raised platforms, which have expedited work and reduced operating expenses.

Standardization. The Status of Standardization of Gray-Iron and Malleable Castings (Bericht über den Stand der Normung von Grau- und Temperguss), Rudolf Stotz. Giesserei-Zeitung, vol. 19, no. 37, Sept. 19, 1922, pp. 537–544, 15 figs. Critical discussion of quality regulations for gray-iron castings. Proposals for quality regulations for malleable iron. Foreign standards. Address before Assn. German Foundrymen.

MANGANESE STEEL

Castings. Pearlitic and Sorbitic Manganese Steels, John H. Hall. Iron Age, vol. 110, no. 13, Sept. 28, 1922, pp. 786–788. Plea for castings containing about 1 per cent manganese Their heat treament and properties. Review of literature on subject.

METALS

Behavior in Low Temperature. The Behavior of Solid Bodies in Very Low Temperatures (Das Verhalten fester Körper in sehr tiefen Temperaturen), Walther Meissner. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 36 and 37, Sept. 9 and 16, 1922, pp. 815–847 and 876–878, 2 figs. Points out that at very low temperatures the specific heat, thermal expansion, electrical resistance of pure metals, and thermoelectric energy, become very low; whereas thermal conductivity of metals and crystals and magnetic susceptibility become very great. All of these properties, to extent of our present knowledge, become independent of temperature in vicinity of absolute zero.

Fatigue. Recent Developments in Fatigue of Metals, H. F. Moore and T. M. Jasper. Iron Age, vol. 110, no. 13, Sept. 28, 1922, pp. 779–784, 9 figs. Effects of heat treatment; testing machine now used; endurance limit defined; machine design and localized stress.

Grain Size and Diffusion. Grain-Size and Diffusion, J. H. Andrew and Robert Higgins. Inst. Metals advance paper for meeting Sept. 20–22, 1922, 10 pp., 18 figs. Experiments were conducted which show relation between grain growth and diffusion; diffusion at high temperatures may take place simultaneously with grain growth, while at low temperatures diffusion promotes breakdown in grain size. Photomicrographs.

Mechanical Properties. Effect of Temperature, Pressure and Structure on Mechanical Properties of Metal, Zay Jeffries and R. S. Archer. Chem. & Met. Eng., vol. 27, no. 15, Oct. 11, 1922, pp. 747–751, 5 figs. Study of mechanical properties of single crystals.

Mechanical Properties As Affected by Grain Size, Zay Jeffries and R. S. Archer. Chem. & Met. Eng., vol. 27, no. 16, Oct. 18, 1922, pp. 789–792, 2 figs. Points out that grain boundaries add certain stiffness to metallic aggregate; fine grain therefore generally involves higher tensile strength and hardness, and greater reduction area; maximum elongation requires medium grain size.

Polishing. Principle of Metal Polishing, Bradford H. Divine. Machy. (N. Y.), vol. 29, nos. 1 and 2, Sept. and Oct. 1922, pp. 12–13 and 134–135, 2 figs. Sept.: General principles of metal polishing, polishing wheels and abrasives, methods and equipment, and making of polishing wheels. Examples of polishing practice. Oct.: Properties of glue for polishing wheels.

MILLING

Locomotive Main Rods. Milling Locomotive Main Rods. Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, pp. 98–101, 8 figs. Results of tests made to determine possiblities of reducing costs in railroad shops by milling.

MOTOR BUSES

Trolley. The Railless Trolley Bus. Indian Industries & Power, vol. 19, no. 11, July 1922, pp. 405-407, 6 figs. Details of bus produced by Assoc. Equipment Co., Ltd.

White Coach Body. White's New De Luxe Coach Body Follows Foreign Bus Design. Commercial Vehicle, vol. 27, no. 5, Oct. 1, 1922, pp. 28-29, 4 figs. Has enclosed drawing room and open forward section; seats 24 and carries baggage on roof of enclosed section.

MOTORCYCLES

Audiometers for Detecting Noise. Motor Cycle Noises and the Low Audiometer. Engineer, vol. 134, no. 3483, Sept. 29, 1922, pp. 335-336, 4 figs. Describes Low audiometer and gives reproductions of of audiometer records.

Manufacture. An American Motor Cycle Factory. Eng. Production, vol. 5, no. 105, Oct. 5, 1922, pp. 325-331, 19 figs. Plant and methods of the Hendee Mfg. Co., Springfield, Mass.

MOTOR TRUCKS

Weight Reductions. Notes on Motor Trucks, Cornelius T. Myers. Soc. Automotive Engrs. Jl. vol. 11, no. 4, Oct. 1922, pp. 333-341 and (discussion) 341-345, 12 figs. Author outlines reasons why weight reductions are very difficult to effect, as well as possibilities of standardizing axle details. Use of aluminum to effect weight reduction and various advantages claimed for metal wheels are commented upon. Account of series of tests conducted by large coal company to determine relative merits of wood and metal wheels on its trucks. Discusses question of unsprung weight.

N

NICKEL ALLOYS

Non-Ferrous. The Influence of Carbon in Non-Ferrous Nickel Alloys. Metal Industry (Lond.), vol. 21, no. 9, Sept. 1, 1922, p. 195, 2 figs. Points out importance of using only nickel that is as nearly carbon-free as commercial nickel can be. Nickel made by Mond process is said to comply most closely with this condition.

Properties. Nickel and Its Alloys, Paul D. Merica. Am. Mach., vol. 57, nos. 11, 12 and 13, Sept. 14, 21 and 28, 1922, pp. 397-399, 3 figs.; 450-452, 4 figs., and 484-487, 2 figs. Sept. 14: Commercial uses of malleable nickel; how various percentages of nickel affect steel; production of copper-nickel alloys. Sept. 21: Properties and uses of nickel-silver and monel metal; how monel metal should be melted, cast and forged. Sept. 28: Special tools for cutting monel metal; how it should be worked and finished; alloys for electrical and heat-resisting uses.

NON-FERROUS METALS

Superheated Steam Effect on. The Effect of Superheated Steam on Non-Ferrous Metals Used in Locomotives, Henry Fowler. Inst. Metals advance paper for meeting Sept. 20-22, 1922, 4 pp., 2 figs. Experience and practice with regard to chief parts subjected to superheated steam in case of superheated locomotives on Midland Ry. Photomicrographs. See also Engineering, vol. 114, no. 2960, Sept. 22, 1922, p. 374 2 figs.

O

OIL ENGINES

Airless-Injection. Hesselman Airless-Injection for Small and Large Oil Engines. Edvin Lundgren. Motorship, vol. 7, no. 10, Oct. 1922, pp. 766 and 769, 7 figs. Details of method devised by K. J. E. Hesselman on 65-hp. engine.

Production of Workboat Oil-Engines in the East. Motorship, vol. 7, no. 10, Oct. 1922, pp. 764-765, 7 figs. Details of new Wolverine airless-injection four-cycle marine engine.

Manufacture. An American Oil Engine Works. Eng. Production, vol. 5, no. 103, Sept. 21, 1922, pp. 277-282, 18 figs. Equipment and methods of Buffalo Gasoline Motor Co., Buffalo, N. Y.

Solid-Injection. A Swedish Solid Injection Oil Engine. Engineer, vol. 134, no. 3482, Sept. 22, 1922, pp. 290-292, 11 figs. Describes Hesselman engine, special features of which are fuel pump which receives fuel from separate feed pump connected to effective filter; governing and fuel-distributing mechanism, intimately combined with fuel pump; fuel piping; and fuel-injection valve. Translated from article in Swedish publication, by E. Hubendick.

Surface-Ignition. Oil Engines. Southern Engr., vol. 36, no. 6, Feb. 1922, pp. 50-54, 10 figs. Surface-ignition type; classification and field of service; principle, construction and operation. Presented through courtesy of Vacuum Oil Co.

OIL FUEL

Burners. A New Fuel Oil Burner, Arthur Grounds. Oil Eng. & Finance, vol. 2, no. 35, Sept. 9, 1922, pp. 284-285, 3 figs. Describes Meldrum burner for which low steam consumption is claimed. Is modification of steam slot type of burner.

Installation, Singer Building. Fuel Oil Shows Big Saving in Singer Building, Norman King. Power, vol. 56, no. 10, Sept. 5, 1922, pp. 348-352, 6 figs. Two years' operation has shown 34-per cent saving over coal and installation paid for itself in 21 months. Details of construction necessary to meet Building and Fire Departments' regulations.

OILS

Viscosity. Notes on Determination of Absolute Viscosity of Petroleum Oils, W. H. Fulweiler and C. W. Jordan. Jl. Indus. & Eng. Chem., vol. 14, no. 8, Aug. 1922, pp. 723-724. Results of examination of samples of petroleum, animal, and vegetable oils. Paper read before Am. Chem. Soc.

The Change in Viscosity of Oils with the Temperature, Winslow H. Herschel. Jl. Indus. & Eng. Chem., vol. 14, no. 8, Aug. 1922, pp. 715-723, 12 figs. Author claims there is no satisfactory theoretical equation for change of viscosity with temperature. Discusses methods of calculation in use. Paper read before Am. Chem. Soc.

OXY-ACETYLENE CUTTING

Mechanical Control of Torch. Mechanical Control of Oxy-Acetylene Torch, Fred J. Meurer. Can. Machy., vol. 27, no. 26, and vol. 28, no. 2, June 29 and July 13, 1922, pp. 27-28 and 28-29, 12 figs. Cutting metal by this process approaches very closely maximum theoretical efficiency; obtaining any desired shape by means of templates; application of radiograph.

OXY-ACETYLENE WELDING

Cast Iron. Principles of Oxy-acetylene Fusion Welding, Alfred S. Kinsey. Ry. Mech. Engr., vol. 96, no. 10, Oct. 1922, pp. 595-597, 2 figs. Welding cast iron.

Railway Repairs. Application of the Welding Torch to Railroad Repairs. Am. Mach., vol. 57, no. 12, Sept. 21, 1922, pp. 444-448, 17 figs. It is claimed that welding torch reduces cost of repairs; locomotives need not be dismounted; salvage of many small parts possible.

P

PATTERNMAKING

Methods. Firm Demands Pattern Accuracy, H. E. Diller. Foundry, vol. 50, no. 18, Sept. 15, 1922, pp. 743-747, 14 figs. partly on p. 742. Methods, from standpoint of accuracy of workmanship, of Dayton Eng. Laboratories Co., Dayton, O., which manufactures automobile starting and lighting sets.

PISTON RINGS

Iron Melting for. Melts Iron for Piston Rings, B. H. Arnold. Foundry, vol. 50, no. 18, Sept. 15, 1922, pp. 748-751, 6 figs. Oil-fired furnace equipped with pyrometers produces satisfactory metal; oxidation causes hard iron in rings as also does low carbon contents in original charge.

PISTONS

Gas-Engine. Machining Gas Engine Pistons, A. W. Freeman. Am. Mach., vol. 57, no. 15, Oct. 12, 1922, pp. 577-578, 7 figs. Rough turning in automatic machine; trouble due to expansion chuck overcome by chuck of special design; special grinding mandrel.

Light-Metal. Light Metal Piston Competition. Practical Engr., vol. 66, no. 1857, Sept. 28, 1922, p. 201. 16 aluminum and magnesium alloys in form of 32 light-metal pistons were examined in competition promoted by German Government Dept. of Aircraft and Automobiles. Compared with iron, light metals have great heat conductivity.

PLANERS

Drives. Planer Drives, Albert Clegg. Machy. (Lond.), vol. 20, no. 522, Sept. 28, 1922, pp. 777-782, 4 figs. Characteristics of various types, including, ordinary belt-driven planers, clutch and shifting belt planers, direct-coupled reversing-motor, magnetic-clutch, Newton (Derby) planer, and hydraulic drive.

PLATES

Circular, Strength of. On the Strength of a Circular Plate the Thickness of which is not Uniform, Keiichi Aichi. Soc. Mech. Engrs. Tokyo, Japan—Jl., vol. 25, no. 74, June 1922, pp. 61-71, 4 figs. Discusses strength of circular plate whose thickness is function of distance from its center.

Deflection. The Deflection of Continuous Plates and Rectangular Plates with Free Edges (Biegung durchlaufender Platten und rechteckiger Platten mit freien Rändern), A. Nadai. Zeit. des Vereines deutscher Ingeneinre, vol. 66, no. 36, Sept. 9, 1922, pp. 848-849, 3 figs. Deals with girderless ceilings supported by columns in a rectangularly arranged trellis work of points. Discusses deformation and stress of such continuous plates and state of bending in separate points on edge of unsupported rectangular plates.

PNEUMATIC TOOLS

Air-Cleaning Apparatus for. Air Compressing and Cleaning Apparatus. Machy. (Lond.), vol. 20, no. 520, Sept. 14, 1922, p. 739, 2 figs. Describes apparatus, comprising belt-driven compressor, air cooler, oil separator and air receiver for purpose of removing oil and moisture and also solid particles with which free-air supply is usually impregnated.

POWER PLANTS

Equipment. Distinctive European Power Plant Equipment, J. H. Blakey. Power Plant Eng., vol. 26, no. 19, Oct. 1, 1922, pp. 959-961, 5 figs. Describes the Gaillet continuous water purifier; use of corrugated piping; Ruths' steam accumulator; Paradox boiler-tube cleaner.

Harvard Medical School. Power Plant of the Harvard Medical School, Boston, Mass., Charles L. Hubbard. Power, vol. 56, no. 13, Sept. 26, 1922, pp. 482-486, 5 figs. Details of plant supplying light, heat and other services to group of 35 buildings having total space of 13,000,000 cu. ft. Equipment includes eight 3000-sq. ft. Stirling boilers, four of which are oil-burning, 3 d. c. units with total capacity of 725 kw. and several auxiliaries.

Industrial. Power Plant of the Duratex Company Has Many Interesting Features. Power, vol. 56, no. 10, Sept. 5, 1922, pp. 358-362, 7 figs. Plant of 625-kva. has one boiler of 3330 sq. ft. of heating surface and one turbo-generator. Boiler is operated up to 350 per cent of normal rating, is fired by automatic stoker and coal is weighed in weighing larry.

Somersworth, N. H. Power Plant of the Great Falls Manufacturing Co., D. D. Eames. Southern Engr., vol. 37, no. 6, Aug. 1922, pp. 39-42, 4 figs. Turbine units replace reciprocating engines; new boiler plant; electrical energy obtained from three sources, two steam turbines, a hydroelectric plant and water wheels at mill; boiler capacity 3,000 hp. and can be increased to 5,000; turbine capacity 4,500 kw. and can be increased to 10,000.

Sugar Refinery. The Power Plant in a Modern Sugar Refinery, Roger B. Stevens. Power, vol. 56, no. 12, Sept. 19, 1922, pp. 440-445, 4 figs. Details of plant using Corliss engines as prime movers. Advantages and disadvantages of alternating and direct current. Conditions influencing selection of prime movers.

Turbine-Driven. New Turbine Plant, Massachusetts Cotton Mills, Lindale, Ga., Robert W. Van Tassel. Southern Engr., vol. 37, no. 5, July 1922, pp. 35-41, 9 figs. Description of most modern turbine power plants in southern states which supplies power to modernly equipped cotton mill. Tabulated data of equipment giving size, capacity, use and manufacturer.

POWER TRANSMISSION

Mechanical. Mechanical Transmission of Power Forrest E. Cardullo and Franklin D. Jones. Machy. (N. Y.), vol. 29, no. 2, Oct. 1922, pp. 85-89, 4 figs. Design and installation of shafting and belt and chain transmission.

PRESSES

Hydraulic. Hydraulic Presses, Their Calculation and Construction (Prensas hidráulicas, su cálculo y construcción), Julián Pastor. Anales de la Asociación de Ingenieros del Instituto Católico de Artes e Industrias, vol. 1, no. 2, 1922, pp. 141-145, 5 figs. Construction at least cost consistent with greatest efficiency.

PULVERIZED COAL

Boiler Firing. Pulverized Coal Firing (Le Chauffage au charbon pulvérisé), Sigma. Métallurgie, vol. 54, no. 35, Aug. 31, 1922, pp. 1277-1279, 2 figs. Describes the turbo-pulverizer, its advantages, and power consumed by dry and wet coal in pulverizing.

Pneumatic Conveying. Conveying Fuel in the Form of Dust by Means of Gas (Beförderung staubförmiger Brennstoffe durch Gasleitungen), Wittfeld. Fördertechnik u. Frachtverkehr, vol. 15, no. 19, Sept. 15, 1922, pp. 247-248, 8 figs. Proposes transportation of semi-coke after grinding in gas lines and separating coal dust and gas on arrival at boiler-house.

Utilization. The Utilization of Pulverized Coal, J. Thomas Dovey and George N. Calkins. Can. Inst. Min. & Metallurgy Monthly Bul., no. 125, Sept. 1922, pp. 992-1001. Central distributing systems; oil-burning equipment convertible to burning of powdered coal; principles of use; economies effected; present status of industry.

PUMPING

Solid-Material Transportation by. Transportation of Solid Material by Pumping, Victor J. Milkowski. Cement, Mill & Quarry, vol. 21, no. 6, Sept. 20, 1922, pp. 23-26, 8 figs. Water supply in proportion to amount of solids to be moved; dewatering material at destination; cheap and ample fuel supply a requisite.

PUMPS

Calculation. A Calculation System for Pumps, Terrell Croft. Coal Industry, vol. 5, nos. 8 and 9, Aug. and Sept. 1921, pp. 350-353 and 399-402, 16 figs. Aug.: Suction lifts said to be possible under practical conditions. Study of pump heads. Formulas for determining total friction, velocity and measured heads. Sept.: Friction of water in wrought-iron, steel, and cast-iron pipe; frictional resistances in fittings and valves.

PUMPS, CENTRIFUGAL

Curves. Centrifugal Pumps, E. T. Keenan. Southern Engr., vol. 37, no. 6, Aug. 1922, pp. 55-56, 3 figs. Characteristic curves of various types.

Mechanics. Mechanics of Centrifugal Pumps, E. T. Keenan. Southern Engr., vol. 38, no. 2, Oct. 1922, pp. 52-55, 3 figs. Elementary mechanics, principally laws of motion.

Piston vs. Piston and Centrifugal Pumps (Kolbenpumpe und Kreiselpumpe als Wasserhaltungsmaschine), A. P. Mössner. Fördertechnik u. Frachtverkehr, vol. 15, nos. 18 and 19, Sept. 1 and 15, 1922, pp. 235-242 and 254-257, 8 figs. Historic development; electric drive; efficiency of quadruple-action piston and centrifugal pumps of same capacity; superiority of electrically driven centrifugal pumps; comparative tables of efficiency of plunger and centrifugal pumps.

R

RAILWAY ELECTRIFICATION

France. Electrification Work and Projects of the Midi Railway (Travaux et projets d'électrification de la Compagnie des chemins de fer du Midi), Fontaine. Annales des Ponts et Chaussees, vol. 1, no. 3, May-June 1922, pp. 277–295, 3 figs. Hydro-electric-power production in Pyrenees, equipment of power stations, program of electrification, change from single-phase to continuous current to eliminate interference with low-tension lines.

South Africa. Electrification of the Glencoe-Maritzburg Section, South African Government Railways, Charles H. Merz. Ry. Gaz., vol. 37, no. 11, Sept. 15, 1922, pp. 332–334. General system of electrification, locomotives, permanent-way equipment substations, transmission lines, power station. (Abstract.) From S. African Railways & Harbours Mag.

RAILWAY MOTOR CARS

Steam-Propelled. Steam-Propelled Unit Railway Motor Car. Ry. Age, vol. 73, no. 16, Oct. 14, 1922, pp. 711–713, 5 figs. Improved power plant with water-tube boiler and oil burner characterize Canadian national car.

Design and Operation of the Unit Railway Steam Car. Ry. Rev., vol. 71, no. 14, Sept. 30, 1922, pp. 433–437, 7 figs. Compact power plant using superheated steam at 800-lb. pressure.

Types. Self Propelled Cars on Steam Railways. Can. Ry. & Mar. World, no. 296, Oct. 1922, pp. 525–527, 6 figs. Details of four self-propelled cars of Can. Nat. Rys. on exhibit at Can. Nat. Exhibition, Toronto, viz., storage-battery car, steam car, and two types of gasoline cars. Results with self-propelled cars in United States. Diesel-electric cars.

RAILWAY OPERATION

Express-Train Service. European Express Train Services. Ry. Gaz., vol. 37, no. 13, Sept. 29, 1922, pp. 391–392 and 400. Detailed analysis of post-war restoration of express-train services is said to give proof that Great Britain occupies first position in speed, frequency and comfort.

Train Control. Automatic Train Control, Frank J. Sprague. Franklin Inst. Jl., vol. 194, no. 2, Aug. 1922, pp. 133–163, 11 figs. Notes on early failures and why greater progress has not been made; general requisites; the Sprague intermittent non-contact system.

Regan Automatic Train Control (Appareil de répétition des signaux et de contrôle automatique des trains système "Regan"), J. G. L. Piveteau. Révue Générale de l'Électricité, vol. 12, no. 6, Aug. 12, 1922, pp. 218–227, 1 fig. Detailed description of system which has been tested on line between Paris and Dieppe.

Robbing Railroading of Some of Its Hazards, Robert G. Skerrett. Compressed Air Mag., vol. 27, no. 10, Oct. 1922, pp. 273–278, 15 figs. Development of automatic train control, and description of the Sprague system.

The Electro-Magnet at the Throttle, Charles W. Burrows. Sci. Am., vol. 127, no. 24, Oct. 1922, p. 242, 2 figs. New type of automatic train control, a system using electromagnets buried in roadway.

The Train Control System of the Great Indian Peninsula Railway. Ry. Gaz., vol. 37, no. 12, Sept. 22, 1922, pp. 363–365, 3 figs. Eight control offices supervise train operation over 1153 mi. of track. Notes on principal books and forms utilized in connection with control working; traffic restrictions.

The Union System of Automatic Train Control, L. V. Lewis. Ry. Rev., vol. 71, no. 12, Sept. 16, 1922, pp. 371–374 and (discussion) 374–375, 6 figs. Describes system developed by Union Switch & Signal Co. to comply with requirements of road conditions. From paper read before Ry. Club in Pittsburgh.

RAILWAY SIGNALING

Alternating-Current, Power Lines. Overload Protection of A. C. Signal Power Lines, Harry M. Jacobs. Ry. Signal Engr., vol. 15, no. 9, Sept. 1922, pp. 345–346, 3 figs. Purpose of overload devices; transformer and substation protection; high-voltage fuses.

Automatic Block. A Scientific Method of Locating Automatic Block Signals for a Railroad of Heavy Traffic, Robert C. Johnson. Am. Ry. Assn., Signal Section, Proc., June 14–16, 1922, pp. A341–A369, 13 figs. See also Ry. Signal Eng., vol. 15, nos. 9 and 10, Sept. and Oct. 1922, pp. 350–353 and 394–398, 13 figs.

Block System. Controlled Manual Block in Hauenstein Tunnel, T. S. Lascelles. Ry. Signal Engr., vol. 15, no. 9, Sept. 1922, pp. 337–340, 8 figs. Describes installation involving wheel-counting principle, instead of track circuit, combined with Siemens-block system, in Hauenstein Base Tunnel, Switzerland, opened in 1916.

I. C. C. Statistics and Tables in Signaling. Ry. Signal Engr., vol. 15, no. 9, Sept. 1922, pp. 354–357, 2 figs. Annual report compiled by Bur. of Safety of Interstate Commerce Commission pertaining to block signals in service and percentage of all roads equipped with this system.

Electric Meters. Theory and Use of Electrical Instruments, L. F. Vieillard. Ry. Signal Engr., vol. 15, no. 10, Oct. 1922, pp. 390–393, 7 figs. Practical explanation of construction and connections of meters used in signaling.

Interlocking. New Electric Interlocking on the D. & H., W. G. Burns. Ry. Signal Engr., vol. 15, no. 8, Aug. 1922, pp. 304–306, 10 figs. Rear home signals, concrete trunking and independent power plant are unusual features.

Single-Track. Single Track Signaling in Australia, F. Raynar Wilson. Ry. Signal Engr., vol. 15, no. 10, Oct. 1922, pp. 379–382, 6 figs. Operation of trains by signal indication considered as safe as token system.

Track Circuits. Direct Current Track Circuits, W. J. Thorrowgood. Am. Ry. Assn. Signal Section, Proc., June 14–16, 1922, pp. A336–A340, 2 tables on supp. plates. Discussion of factors involved in standard of safety for track circuits.

D. C. Track Circuits with Welded Bonds, C. F. Estwick. Ry. Signal Engr., vol. 15, no. 10, Oct. 1922, pp. 383–386, 5 figs. Determination of characteristics of relay to be used on long track circuits when cut sections are eliminated.

Train Order Indications. Train Orders by Signal Indications, A. R. Fugina. Ry. Age, vol. 73, no. 13, Sept. 23, 1922, pp. 553–554, 3 figs. Shows how trains on single or double track can be operated by signals without use of written orders.

RAILWAYS

Japan. The Japanese Railways and Their Operating Problems, H. K. Smith. Ry. Rev., vol. 71, no. 12, Sept. 16, 1922, pp. 365–369, 5 figs. History, physcial characteristics, and character of service; progress toward electrification.

Mexican. Mexican Railways Prepared for Improved Business, Charles W. Foss. Ry. Age, vol. 72, nos. 18 and 19, May 6 and 13, 1922, pp. 1055–1060 and 1119–1121, 12 figs. Roadbed and motive power claimed to be in splendid condition. Shortage of rolling stock a handicap. Improvements now underway. Labor conditions. Relations with U. S. lines.

United States and England. Samuel Rea Compares English and U. S. Railroads. Ry. Rev., vol. 71, no. 15, Oct. 7, 1922, pp. 495–496. Conditions affecting railroads in United States and those of Great Britain. Finds progress abroad in regrouping and believes English carriers must make sacrifices as here. From Phila. Public Ledger.

RAPID TRANSIT

Chicago. Chicago Transportation Experience. Elec. Ry. Jl., vol. 60, no. 13, Sept. 23, 1922. Contains following articles: Carrying a Billion Passengers a Year in Chicago, pp. 419–424, 10 figs. Dealing with the Labor Problem, Britton I. Budd, pp. 425–427. How Car Design Has Progressed on Chicago's Rapid Transit Lines, H. A. Johnson, pp. 427–430, 4 figs. Maintaining Chicago "L" Structure, G. M. Anderson, pp. 430–431. Signaling Trains on Chicago Elevated Railroads, J. W. Stephenson, p. 431. How "L" Track is Built to Handle 900,000 Cars a Year, H. P. Savage, p. 432, 1 fig. Utility Insurance, Williston Fish, pp. 433–434. Heating and Ventilating Chicago Street Cars, Charles Gordon, pp. 435–439, 7 figs. Developing Chicago's Street Cars, Wray T. Thorn, pp. 440–444, 3 figs. Experience with Chicago Track, Charles S. Holcomb, pp. 445–452, 10 figs. Development of Unified Power Supply and Distribution Systems in Chicago, Ralph H. Rice, pp. 455–461, 5 figs. Requirements Imposed in Designing North Shore Passenger Cars, H. A. Otis, pp. 470–472, 6 figs. Using Direct Suspension Trolley in High-Speed Train Service, Clifford Huttleston, pp. 473–476, 9 figs. Chicago's Traffic Problem, R. F. Kelker, Jr., pp. 481–484, 10 figs.

Chicago Transportation Experience. Elec. Ry. Jl., vol. 60, no. 14, Sept. 30, 1922. Contains following articles: Developing Chicago's Street Cars, Wray T. Thorn, pp. 499–505, 14 figs. Heating and Ventilating Chicago Street Cars, Charles Gordon, pp. 505–509, 12 figs. How Stores Are Accounted for on Chicago Elevated Railroads, E. E. Kretschmer, pp. 510–514, 3 figs. Automatic Door Control on Latest Chicago Safety Cars, pp. 514–516, 3 figs.

REFRACTORIES

Compressive Strength. Volume Constancy and Compressive Strength of Refractory Lining of Boilers and Furnaces (Raumbeständigkeit und Druckfestigkeit der feuerfesten Auskleidung von Dampfkessel- und Feuerungsanlagen), W. Ritter. Feuerungstechnik, vol. 10, no. 23, Sept. 1, 1922, pp. 259–261. Methods and results of tests. See also Wärme- u. Kälte-Technik, vol. 24, no. 16, Aug. 15, 1922, pp. 185–187.

Foundry. Foundry Refractories, H. Winterton. Foundry Trade Jl., vol. 26, no. 318, Sept. 21, 1922, pp. 236–238. Notes on siliceous refractories; question of sands; coal dust; defects caused by lime in sand; grist; blackings; graphitic facings.

REFRIGERANTS

Sulphurous Anhydride. New System of Manufacturing Liquid Sulphurous Anhydride (Nuovo sistema di fabbricazione della anidride solforosa liquida nelle regioni sud-americane), H. J. Paoli. Giornale di Chimica Industriale ed Applicata, vol. 4, no. 8, Aug. 1922, pp. 349–352, 3 figs. Methods used by Sulfurica Co. in Argentina; operation of plant.

REFRIGERATING MACHINES

Air. Air as Refrigerating Agent (Sur l'emploi de l'air comme agent frigorifique), Maurice Leblanc. Révue Universelle des Mines, vol. 14, no. 3, Aug. 1, 1922, pp. 165–200, 16 figs. Describes new cold-air refrigerating machine which from tests proves to be as economical as an ammonia machine. See also Nature (Paris), no. 2529, Sept. 23, 1922, pp. 203–208, 7 figs.,

Ethyl-Chloride. Ethyl Chloride Refrigeration Charles H. Herter. Refrig. World, vol. 57, no. 9, Sept. 1922, pp. 13–16 and 32, 3 figs. Theoretical heat balance of ethyl chloride refrigerating machines; results of actual tests, horsepower per ton in small machines.

ROLLING MILLS

Electrically Driven. Electric Blooming Mill Drive, S. N. Roberts. Elec. Jl., vol. 19, no. 9, Sept. 1922, pp. 356–362, 12 figs. Deals with drive of Atlantic Steel Co.'s blooming mill.

The New Electric Rolling Mills of the Hatfield Steel Works, at Sheffield (Les nouveaux laminoirs électriques des aciéries Hadfield, à Sheffield). Génie Civil, vol. 81, no. 13, Sept. 23, 1922, pp. 269–273, 5 figs. Equipment of East Hecla Works, production of manganese steels, the blooming train, electric power equipment, etc.

Processes. The Mechanical Working of Iron and Steel, Walter Buckley. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 10, Oct. 1922, pp. 499–501, 10 figs. Outline of modern rolling mill practice, describing processes in various types of mills.

Strip and Hoop. Combined Strip and Hoop Mill of the Whitehead Iron and Steel Company, Limited. Iron & Coal Trades Rev., vol. 105, no. 2817, Sept. 22, 1922, pp. 417–418, 15 figs. on pp. 433–436. Details of continuous mill combining main features of the Acme and the Morgan continuous skelp mill. First of its type to be built in the world.

New Cold Rolled Strip Steel Plant. Iron Age, vol. 110, no. 15, Oct. 12, 1922, pp. 920–922, 5 figs. Finishing stands driven independently of roughing stands; unusual uniformity obtained in annealing ovens of special design. Details of new rolling mills of Wallingford Steel Co., Conn.

Universal Plate. Universal Mill at the Redcar Works of Messrs. Dorman, Long and Company, Limited. Iron & Coal Trades Rev., vol. 105, no. 2846, Sept. 15, pp. 377–378, 14 figs. on pp. 393–396. Describes mill of two-high reversing type with two vertical rolls on each side of horizontal rolls, which is capable of rolling universal plates 42 in. wide down to 11 in. wide.

RUBBER

Stress-Strain Tests. Electrical Records of Rubber Stress-Strain Data, C. J. Burkley. India Rubber World, vol. 67, no. 1, Oct. 1, 1922, pp. 24–25, 3 figs. How charts are made; mechanical and electrical features of apparatus; making test records.

S

SAFETY

Codes. Preparation of Safety Codes Under the Auspices of the American Engineering Standards Committee, Morton C. Lloyd. Monthly Labor Rev., vol. 15, no. 3, Sept. 1922, pp. 1–8, 1 fig. It is shown that American Engineering Standards Committee with coöperation of Safety Code Correlating Committee, furnishes machinery for formulation of safety codes in manner which will insure thorough consideration of viewpoint of various interests concerned with safety codes.

SAND, MOLDING

Grain and Bond. An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands, C. W. H. Holmes. Foundry Trade Jl., vol. 26, nos. 318 and 320, Sept. 21 and Oct. 5, 1922, pp. 245–246 and 279–282, 3 figs. Investigation undertaken with view to estimating quantitatively effect upon essential properties of sand of various processes to which molding sands are subjected.

Moulding Sands, C. W. H. Holmes. Engineering, vol. 114, no. 2962, Oct. 6, 1922, pp. 443–446, 6 figs. Investigation on factors influencing grain and bond in molding sands. (Abstract.) Paper read before Iron & Steel Inst.

Properties and Use. Some Notes on Moulding Sands, J. H. Watson. Foundry Trade Jl., vol. 26, no. 317, Sept. 14, 1922, pp. 211–216, 15 figs. Early post-war experiences; use and abuse of good sand; origin of sand and typical composition, essential properties, refractoriness, venting qualities, strength of bond, grain size.

Screen Tests. Analyzes Sand Screen Tests, H. A. Schwartz. Foundry, vol. 50, no. 18, Sept. 15, 1922, pp. 752–756, 7 figs. Mathematical investigations indicate effect of grains of different shapes and sizes on perviousness of molding sand; method of testing; conclusions. Paper read before Am. Foundrymen's Assn.

Testing. The Testing of Moulding Sands, Ernest J. Davis. Metal Industry (Lond.), vol. 21, nos. 10 and 11, Sept. 8 and 15, 1922, pp. 219–221 and 243–247, 6 figs. Describes how laboratory testing may be carried out. Notes on chemical, mechanical and mineral analysis; bonding strength, mechanical strength of sand molds and cores; thermal conductivity, permeability, porosity and microscopic examination.

SCREW THREADS

Milling. The Milling of Screws and Other Problems in the Theory of Screw-Threads, H. H. Jeffcott. Instn. Mech. Engrs. Proc., vol. 1, no. 3, 1922, pp. 515–528 and (discussion) 529–562, 19 figs. Account of problems of interest to manufacturer and metrologist.

Normal Thickness of Worm-Gear. The Normal Thickness of a Worm Thread, E. A. Limming. Machy. (Lond.), vol. 20, no. 519, Sept. 7, 1922, pp. 707–708, 1 fig. Geometrical consideration involved in finding true normal thickness.

Tolerances. Interchangeable Threaded Work. Engineering, vol. 114, nos. 2959 and 2960, Sept. 15 and 22, 1922, pp. 320–321 and 352–354, 12 figs. Brief survey of practical and theoretical requirements of

screw threads and consideration of problms of tolerances. Presents tables of effective diameter tolerances recommended by Alfred Herbert, Ltd., for all screw threads to English measurements having thread angle of 55 or 60 deg., and for all metric threads having thread angle of 53.8 to 60 deg.; and recommended for British Assn. screw threads.

SEAPLANES

German Giant. Flying Boat and Pontoon Airplane, Flugboot und Schwimmerflugzeug). Motorwagen vol. 25, no. 22, Aug. 10, 1922, pp. 421–423, 2 figs. Describes new type of giant seaplane which is a combination of flying boat and pontoon airplane with Junker wings and built-in engines. Characteristics Span, 60 m.; engines, four 700-hp.; speed, 170 km. per hr.; passengers, 60.

Types. Characteristics of the Aircraft Entered in the Curtiss Marine Flying Trophy Race. Aviation, vol. 13, no. 14, Oct. 2, 1922, pp. 413–415, 4 figs. Details of seaplanes of float and boat types.

SHAFTS

Bending Moments. Bending Moments in Pins or Shafts Determined Graphically, A. M. Winslow. Eng. News-Rec., vol. 89, no. 14, Oct. 5, 1922, pp. 568–569, 3 figs. Effect of forces in different planes expressed by composite moment diagram. Maximum movement found by inspection.

SHEARING MACHINES

Plate. Plate Shearing Machines. Eng. Progress, vol. 3, no. 9, Sept. 1922, pp. 203–205, 7 figs. Describes plate-shearing machines with and without flywheel.

SLOTTING MACHINES

Horizontal. Horizontal Slotting Machine with Electric Drive, G. Schleisinger. Eng. Progress, vol. 3, no. 9, Sept. 1922, pp. 206–208, 6 figs. Results of tests conducted during a number of years for purpose of improving horizontal shotting machine with function wheel drive.

SOLIDS

Electron Theory of. An Electron Theory of Solids, J. J. Thomson. Franklin Inst. Jl., vol. 194, no. 3, Sept. 1922, pp. 281–289, 4 figs. Points out that electronic theory of constitution of atom leads quite simply and directly to theory of solids which, as far as it has been tested, agrees remarkably well with facts.

Failure Due to Stress. Laws of Failure of Solid Bodies Due to Stress, Chidô Sunatani. Soc. Mech. Engrs., Tokyo, Japan—Jl , vol. 25, no. 74, June 1922, pp. 1–37, 50 figs. Investigation of laws by which elastic limit and ultimate failure of solid body under certain state of stress may be determined.

SPECIFIC HEAT

Low Temperatures. Investigations of Specific Heat at Low Temperatures, (Untersuchungen über die spezifische Warme bei tiefen Temperaturen), Franz Simon. Annalen der Physik, vol. 68, no. 3, Aug. 3, 1922, pp. 241–280, 6 figs. Describes certain improvements in Nernst-Schwers apparatus which greatly increases accuracy of measurements. The true specific heat of quartz glass, Lindemann glass, mercury, ammonium chloride, glycerine and other substances is measured from temperature of pumped-out liquid hydrogen to room temperature.

SPRINGS

Automobile. Automobile Springs (Automobilwagenfedern), W. Schlachter. Motorwagen, vol. 25, nos. 21 and 25, July 31 and Sept. 10, 1922, pp. 395–398 and 481–484, 10 figs. General principles underlying design; calculations.

Leaf. Leaf Springs (Ressorts spéciaux a lames superposées), C. Reynal. Arts et Métiers, vol. 75, no. 22, July 1922, pp. 210–212, 3 figs. Leaf springs for vehicles; calculation and distribution of load.

STANDARDIZATION

France. Permanent Standardization Committee (Commission permanente de Standardisation), Sigma. Métallurgie, vol. 54, no. 21, May 25, 1922, pp. 749–750. This committee has decided on public hearings. Standardization of dimensions; choice of units; etc.

Permanent Standardization Committee (Commission permanente de Standardisation), Sigma. Métallurgie, vol. 54, no. 36, Sept 7, 1922, pp. 1311–1313. Plans recently submitted to public discussion on standardization of copper and aluminum buzz bars for switchboards; aluminum wire and cables; and specifications for supplying platinum, platinum-copper, platinum-iridium and platinum-chloride.

Mechanical Construction. Standardization of Dimensions in Mechanical Construction (Sur la normalisation des dimensions des elements de la construction mécanique), F. Bayle. Révue Générale de l'Électricité, vol. 12, no. 10, Sept. 9, 1922, pp. 345–352, 4 figs. Arithmetic and geometric units; practical measures which should be given preference; importance of adoption of standard measures of length.

STANDARDS

German N. D. I. Reports. Report of the German Industry Committee on Standards (Normenausschuss der Deutschen Industrie), Maschinenbau, vol 1, no. 10, Aug. 26, 1922, pp. 665–684, 29 figs. Proposals of Board of Directors for T-head bolts; abbreviated symbols for screw threads; mathematical symbols; T-slots; test gages (unit holes and shafts); etc. Proposed standards for tangent slots, trapezoidal threads, flat keys, hollow keys, gib-headed keys, etc.

Uniform Designations for Calculating Strength in Building Construction (Einheitliche Bezeichnungen für die Festigkeitsberechnungen von Ingenieurbauwerken), Schaper. Zentralblatt der Bauverwaltung, vol. 42, no. 77, Sept. 23, 1922, pp. 464–467. Gives list of standard abbreviations and symbols for mathematics, measures, time, mechanical and statical expressions, and discusses standardization generally.

STEAM

High-Pressure. High-Pressure Steam-Heating Lines, Edgar Buckingham. Mech. Eng , vol. 44, no. 10, Oct. 1922, pp. 641–642. Effect of throttling through reducing valve or steam motor; economy of generating steam at high pressure and transmitting it through small line with large line drop.

STEAM ENGINES

Rolling-Mill Reciprocating. Rolling Mill Engine of 25,000 Horse Power. Power House, vol. 15, no. 19, Oct. 5, 1922, pp. 19–20, 2 figs. Built on marine lines for hardest kind of land service; working at full power it reverses four times per min.; three-cylinder but not compound.

25,000 Hp. Engine Built in England. Power, vol. 56, no. 13, Sept. 26, 1922, pp. 491–492, 1 fig. Describes reciprocating engine built for Carge Fleet rolling mills, one of largest in England.

Uniflow. Another Corliss Engine Firm Building Unaflow Engines. Power, vol. 56, no. 16, Oct. 17, 1922, pp. 600–601, 5 figs. Uniflow engines being built by Murray Iron Works Co. in powers ranging from 75 to 650 i.hp., of side-crank bored guide horizontal design.

Valve Gears. Engines at Baltimore Refinery Have Unusual Valve Gear. Power, vol. 56, no. 13, Sept. 26, 1922, pp. 498–499, 5 figs. Twin engines 26 by 32 in., operating at 135 r.p.m., direct connected to 1250-kw. d.c. generator.

Steam-Engine Distributing and Expansion Valves and Valve-Gear and Valve-Actuating Arrangements Therefore. Abridgments of Specifications, class 122(ii), period 1909–15, 1922, 256 pp. Patents for inventions.

STEAM POWER PLANTS

Fuel Economy. Fuel Economy in Steam Power Plants. John B. C. Kershaw. Beama, vol. 11, nos. 2, 3, and 4, Aug., Sept. and Oct. 1922, pp. 538–545, 6 figs., 617–625, 7 figs. and 671–681, 11 figs. Aug.: Present-day methods of burning fuel and their defects. Sept.: Improved methods of burning fuel. Oct.: Utilization of waste heat from steam boilers.

STEEL

Alloy. See ALLOY STEELS.

Chromium. See CHROMIUM STEEL.

Elastic Limit. Elastic Limit and Permanent Deformation of Steels by Multiple Forces (Limite élastique et deformation permanente des aciers dans le cas de forces multiples), L. Malaval. Technique Moderne, vol. 14, nos. 7 and 8, July and Aug. 1922, pp. 289–296 and 345–350, 21 figs. Elastic limit for metals subjected simultaneously to traction and compression; resistance to rupture of cylindrical tubes; effect of simple and compound loads. Bibliography.

Flow at Low Red Heat. Experiments on the Flow of Steels at a Low Red Heat with a Note on the Scaling of Heated Steels, J. H. S. Dickenson. Iron & Coal Trades Rev., vol. 105, no. 2845, Sept. 8, 1922, pp. 327–331, 15 figs. (Abstract.) Paper read before Iron & Steel Inst. See also Engineering, vol. 114, nos. 2959 and 2960, Sept. 15 and 22, 1922 pp. 326–329 and 378–379, 21 figs.

Lag. On the Dimunition of Lag at Arl through Deformation, J. H. Whiteley. Engineering, vol. 114, no. 2961, Sept. 29, 1922, p. 416, 6 figs. Evidence is given that when steel, in metastable region at Arl point is worked, lag is markedly diminished. Paper read before Iron & Steel Inst.

Manganese. See MANGANESE STEEL.

Testing. Rapid Determination of Elongation and Resistance to Impact of Steels by Doubling Over a Notched Bar (Détermination, rapide de l'allongement et de la résistance au choc des aciers, par pliage d'un barreau entaillé), L. Jannin. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 134, no. 7, July 1922, pp. 646–656, 7 figs. Results of tests.

Tool. See TOOL STEEL.

STEEL CASTINGS

Alloy, Manufacture of. Alloy Castings from Electric Furnaces, Larry J. Barton. Iron Age, vol. 110, no. 13, Sept. 28, 1922, pp. 781–786, 1 fig. Describes manufacture, properties and heat treatment of nickel, chromium and chrome-nickel steel. Practice of Los Angeles Foundry Co.

Production. Production of Steel Castings, F. Darley. Foundry Trade Jl., vol. 26, nos. 316 and 317, Sept. 7 and 14, 1922, pp. 199–202 and 225–226, 7 figs. Sept. 7: Scope of steel castings; production essentials; turbine wheels and cylinders, making large base plate; molding spur wheel. Sept. 14: Stainless steel castings, engine-wheel centers; piping, clinking, blow holes and annealing of castings.

STEEL, HEAT TREATMENT OF

Hardening. The Scientific Fundamentals of Steel Hardening (Die wissenschaftlichen Grundlagen der Stahlhärtung), Otto Kenne. Maschinenbau, vol. 1, no. 10, Aug. 26, 1922, pp. 645–649, 8 figs. Discusses relations between carbon content and strength properties; forms in which carbon is present in steel; appearance of fracture; microscopic investigation of hardened and unhardened steel; theory of steel hardening.

Lead-Pot Furnace. Heat Treating in Lead, R. B. Schenck. Am. Soc. for Steel Treating, Trans., vol 2, no. 12, Sept 1922, pp. 1203–1212. It is concluded that greatest argument for lead-pot furnace is high quality of treated product resulting from uniform and accurate temperatures.

Mass, Influence of. Influence of Mass in Heat Treatment, E. J. Janitzky. Iron Age, vol. 110, no. 13, Sept. 28, 1922, pp. 788–790, 4 figs. Role of special elements, nickel, chromium and molybdenum, in counteracting effect of size. Experimental data on sections 0.5 to 3 in. in diameter.

Nickel-Chromium. Heat Treating Changes Volume, Leslie Aitchison and G. R. Woodvine. Iron Trade Rev., vol. 71, no. 14, Oct. 5, 1922, pp. 915–918, 5 figs. Experiments conducted on nickel-chromium steels indicate expansions and contraction is related directly to temperature alterations. Summary shows results of subjecting metal to various conditions. (Abstract.) Paper presented before Iron & Steel Inst.

Tool Steel. The Heat Treatment of Tool Steel (Ueber Wärmebehandlung von Werkzeugstählen), H. Baier. Maschinenbau, vol. 1, no. 10, Aug. 26, 1922, pp. 650–653, 2 figs. Deals with treatment of ordinary tool steel and different special steels in forging, annealing, hardening and tempering practice.

STEEL, HIGH-SPEED

Lathe Breakdown Tests. Lathe Breakdown Tests of Some Modern High Speed Tool Steels, H. J. French and Jerome Strauss. Am. Soc. for Steel Treating, Trans., vol. 2, no. 12, Sept. 1922, pp. 1125–1154, 19 figs. Comparisons of performance of tool steels in so-called lathe breakdown tests, in which endurance of tools is measured under definite working conditions.

Manufacture. Practical Notes on the Manufacture and Treatment of High-Speed Steel, H. K. Ogilvie. Iron & Coal Trades Rev., vol. 105, no. 2845, Sept. 8, 1922, pp. 331–333. Deals chiefly with manufacture in basic-lined electric furnace. (Abridgment.) Paper read before Iron & Steel Inst. See also Engineer, vol. 134, no. 3481, Sept. 15, 1922, pp. 282–283.

STEEL MANUFACTURE

Electric Furnaces. Electric Steel Production of the World, Edwin F. Cone. Iron Age, vol. 110, no. 11, Sept. 14, 1922, pp. 653–654. Record of leading countries from 1913 to 1921. Post-war and present conditions. Pig iron from electric furnaces.

STEEL WORKS

England. The Devonshire Ironworks. Engineer, vol. 134, no. 3480, Sept. 8, 1922, p. 242, 3 figs., partly on p. 246. Consists in the main of up-to-date blast-furnace plant, one of largest coke-oven plants in United Kingdom, and extensive pipe foundries for manufacture of cast-iron pipe; also comprises large by-product recovery plant, and chemical plant for manufacture of sulphuric and nitric acids, and other chemicals.

Holland. Construction of the Royal Dutch Steel Works at Velsen, Holland [La construction des Aciéries royales néerlandaises à Velsea (Hollande)]. Génie Civil, vol. 81, no. 6, Aug. 5, 1922, pp. 138–139, 2 figs. Work in connection with providing access; construction of works themselves; buildings for personnel; etc.

Material Testing. Material Testing in Mass Production (Materialprüfung in der Massenfertigung), Hermann Obermüller. Werkstattstechnik, vol. 16, no. 17, Sept. 1, 1922, pp. 506–508. Points out importance of material testing in iron and steel works, and duties of material-testing department in plant for mass production.

Three-Shift vs. Two-Shift. Three Shifts vs. Two, in Steel, Bradley Stoughton. Iron Trade Rev., vol. 71, nos. 12, 13 and 14, Sept. 21, 28 and Oct. 5, 1922, pp. 791–795, 856–860 and 923–929, 1 fig. Practicability of changing work-period system in industry investigated from technical viewpoint. Report in favor of shorter hours as adopted by executive board of Am. Eng. Council. See also (abstract) in Iron Age, vol. 110, no. 11, Sept. 14, 1922, pp. 657–658 and 689.

STOKERS

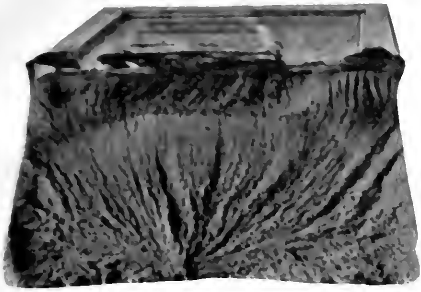
Chain-Grate. Forced-Draft Traveling Grates with Combined Chain Grate (Unterwind-Wanderroste mit kombinierter Rostkette), H. Pradel. Wärme, vol. 45, no. 30, Aug. 4, 1922, pp. 367–368, 5 figs. Describes combined sectional and nest chain grates built by Berlin-Anhalt Machine Corp., Dessau, which are said to combine advantages of both types.

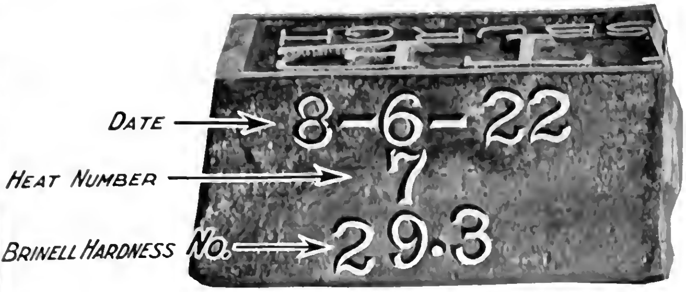
Mechanical. Mechanical Stokers and Stoking, Walter N. Polakov. Management Eng., vol. 2, no. 6, June 1922, pp. 325–330 and vol. 3, nos. 1, 2, 3 and 4, July, Aug., Sept. and Oct. 1922, pp. 29–36, 73–80, 171–179 and 233–241, 50 figs. June: Origin and development. July: Process of combustion. Aug.: Chain-grate stokers. Sept.: Overfeed stokers. Oct.: Underfeed stokers.

Underfeed. Detroit Edison Co. Has Superstoker, E. E. Dubry Power, vol. 56, no. 14, Oct. 3, 1922, pp. 536–538, 5 figs. 13-retort underfeed stoker having total grate area of 470 sq. ft. replaces double stoker setting under Stirling type-W boiler of 23,654-sq. ft. effective heating surface, and makes possible big reduction in number of overhead bunkers and coal-conveying equipment.

STRESSES

Cylinder Walls. The Stress of a Thin Cylinder Wall Taking Deformation Into Consideration (Die Beanspruchung einer dünnen Zylinderwand bei Berücksichtigung der Formänderung), Josef Krehitz. Eisenbau, vol. 13, nos. 6 and 7, June 20 and July 25, 1922, pp. 119–124 and 143–149, 6 figs. Investigation of deformation of cylinder wall which is free from bending stress.





Behind the Guarantee

Behind the Cadman Double Service Guarantee are not only sixty years of unique experience and unequalled metallurgical resources, but that infinite attention to detail which alone spells success.

No shipment of Cadman Bearing Metals, BEARITE or ACORN, can leave our plant that is not fully up to the Cadman standard. Samples from every heat are tested and filed away for future reference. No customer has yet received an "off heat" of Cadman Metals. No customer can.

The Cadman guarantee says *"double service"* and means it. Engineering Bulletin M-1 tells you why.

(Clip the coupon or simply enclose your card in an envelope)

A·W·
Cadman
Manufacturing Co
Pittsburgh
Pa.

Master Makers of Fine Bearing Metals
Since 1860

Without charge or obligation please send me Engineering Bulletins M-1 and M-2 samples and information regarding the use of Cadman Metals in:

Machinery:..

Name:.. Position:.......................

Company Name:..

Address:...

T

TANKS

Industrial. Getting the Most out of Industrial Tanks, Charles L. Hubbard. Factory, vol. 29, no. 4, Oct. 1922, pp. 398-400 and 457-458, 6 figs. Suggestions for selection of right tank.

TAPS

Production Operations. Operations in Tap Production, C. F. Henley. Machy. (Lond.), vol. 20, no. 520, Sept. 14, 1922, pp. 733-734, 3 figs. With particular reference to thread milling, thread-milling hobs, and heat treatment.

TESTING MACHINES

Railway Material. Deflection Testing of Locomotive Axles. Engineer, vol. 134, no. 3480, Sept. 8, 1922, pp. 279-280, 3 figs. Describes universal 100-ton testing machine, constructed by A. J. Amsler & Co., Schaffhausen, Switzerland, for performing acceptance tests on railway material, such as books, chains, axles, couplings, etc.

TEXTILE MILLS

Electric Drive. Electric Power in Textile Mills. Beama, vol. 11, no. 4, Oct. 1922, pp. 691-697, 4 figs. Information extracted principally from pamphlet on power in the textile mill, published by Metropolitan-Vickers Co.

The Electric Drive in the Textile Industry, William A. A. Burgess. Beama, vol. 11, no. 2, Aug. 1922, pp. 554-558, 1 fig. Notes on position of electric drive in textile industry, and type of drive.

THERMODYNAMICS

Heterogeneous Equilibria, Application to. The Application of Thermodynamics to Heterogeneous Equilibria, George W. Morey. Franklin Inst. Jl., vol. 194, no. 4, Oct. 1922, pp. 425-484, 11 figs. By detailed application of described equation (equation 97) problems of heterogeneous equilibria may be solved completely if entropy and volume changes are known in their entirety, and it is possible to predict behavior of system when subjected to changes in pressure, temperature, and composition.

Molecular. Molecular Thermodynamics, Bernard A. M. Cavanagh. Lond., Edinburgh, & Dublin Philosophical Mag. & Jl., of Sci., vol. 44, no. 261, Sept. 1922, pp. 610-640. Analysis of problem of "solvation of solutes" to which is attached discussion of results.

TIDAL POWER

Utilization. Theory of River Tides and Their Utilization (Sur la théorie des marées fluviales et ses applications), Charles Ribiere. Annales des Ponts et Chaussées, vol. 1, no. 3, May-June 1922, pp. 266-276. Mathematical investigation showing that substantial modifications are necessary in current formulas used.

Utilization of Tidal Power (Sur l'utilisation de l'énergie des marées), A. Defour. Révue Générale de l'Électricité, vol. 11, no. 9, Mar. 4, 1922, pp. 313-322, 8 figs. Discusses the Maire, Claude, État and Defour cycles and compares their efficiency.

TIME STUDY

Standards in. Establishing Standards in Time Study, Philip Bernstein. Indus. Management, vol. 64, no. 4, Oct. 1922, pp. 243-249, 4 figs. Definite procedure with specific illustrations from woodworking practice.

TIRES, RUBBER

Rolling Resistance. Rolling Resistance of Rubber Tires, E. H. Lockwood. India Rubber World, vol. 67, no. 1, Oct. 1, 1922, pp. 13-15, 4 figs. Notes on rear-wheel dynamometer; measuring tire resistance; solid-tire tests; cord and fabric-tire tests; loss of power in tires.

Truck, Pneumatic. Temperatures of Pneumatic Truck-Tires, F. O. Ellenwood. Soc. Automotive Engrs. Jl., vol. 11, no. 2, Aug. 1922, pp. 129-138, 16 figs. Investigation conducted at plant of Goodyear Tire & Rubber Co. to determine best means of measuring tire temperatures; temperature effect of inflation pressure, load, long runs, frequency of stops, and sizes of rim and tire; temperature of various designs of tire; and suitable means of reducing large-tire temperatures.

TOOL STEEL

Graphitization. Graphitization in a Carbon Tool Steel, Henry S. Rawdon and Samuel Epstein. Chem. & Met. Eng., vol. 27, no. 13, Sept. 27, 1922, pp. 650-651, 8 figs. Examination of type of black fracture occasionally occurring in annealed carbon-tool-steel bars.

Machinability. The Effect of Structure upon the Machining of Tool Steel, J. V. Emmons. Am. Soc. for Steel Treating, Trans., vol. 2, no. 12, Sept. 1922, pp. 1100-1110 and 1212, 20 figs. Discusses effect of hardness and structure of tool steel upon its machinability. Machining operations considered are turning, milling, drilling, reaming, thread cutting, swaging, wire drawing, punching and shearing. Conclusions as to most favorable structures for various machining processes.

TOOLS

Diamond, for Motor Building. Using Diamond Tools in Motor Building, G. T. Linting. Am. Mach., vol. 57, no. 12, Sept. 21, 1922, pp. 437-439, 8 figs. Information concerning accuracy, interchangeability and long life obtained with diamond tools in aluminum, bronze and cast iron. Experiences of N. Y., N. H. & H. R. R.

TRACTORS

Caterpillar. Making Tracks for Caterpillars, Howard L. McLean. West. Machy. World, vol. 13, no. 9, Sept. 1922, pp. 311-312, 5 figs. Notes on methods and machines used in Holt factory at Stockton, Cal., for machining and assembling flexible steel tracks.

Road-Building Machinery. Internal-Combustion-Engine Power for Road-Grading Machinery, C. O. Wold. Soc. Automotive Engrs. Jl., vol. 11, no. 4, Oct. 1922, pp. 323-326 and (discussion) 326-327, 4 figs. Deals with large versus small tractors and most suitable type of tractor; engine requirements; use of multiple-unit road machinery behind one power unit; combination tractor and grader units; general utilization of power units; power requirements of concrete-road construction.

Suction-Gas. The Suction Gas Tractor. Engineer, vol. 134, no. 3482, Sept. 22, 1922, p. 306. Considerations relating to use of suction gas producers on tractors and their design and working.

TUBING

Steel. Corrugated Steel Tubing for High-Pressure Liquids (Tubes ondulés en acier pour fluides à haute pression), R. Joessel. Génie Civil, vol. 81, no. 6, Aug. 5, 1922, pp. 130-133, 9 figs. Construction, application and advantages; gives greater elasticity lengthwise; has greater resistance to pressures and is easily adjustable to any profile.

U

UNEMPLOYMENT

Insurance. Unemployment Insurance in Theory and Practice. Nat. Indus. Conference Board, Research Report, no. 51, June 1922, 127 pp. Outline of theory and main questions involved in such insurance; analysis of development of and practical experience with this theory, principally in Europe; survey of theory and problems as related to situation in United States.

Insurance and Employment Exchanges. Work of the Employment and Insurance Department of the British Ministry of Labor, T. W. Phillips. U. S. Bur. of Labor Statistics Bul., no. 311, Aug. 1922, pp. 38-59. Notes on establishment of employment exchanges; employment-exchange procedure and statistics; decasualization of dock labor; unemployment insurance; effect of war; local employment committees; extension of unemployment insurance in 1920; effect of industrial depression on insurance scheme; provision of work for unemployed; etc.

Prevention. Prevention of Unemployment, U. S. Bur. of Labor Statistics Bul., no. 311, Aug. 1922, pp. 60-78. Contains following articles: Measurement of Unemployment—The Heed for Additional Information, F. S. Deibler. Contribution of Vocational Guidance to the Prevention of Unemployment, Helen T. Woolley. Reviving Private Industry through Public Works, Otto T. Mallery.

Problems of. The New Emphasis in the Problem of Reducing Unemployment, H. Feldman. Taylor Soc. Bul., vol. 7, no. 5, Oct. 1922, pp. 176-182, 1 fig. Brief review of remedies proposed in recent years. American attitude toward problem. Experiences of the Hills Bros. Co., manufacturers of dates.

V

VENTILATION

Air-Duct Calculation. How to Figure Rectangular Air Duct Sizes Quickly, W. L. Durand. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 7, Oct. 1922, pp. 719-721, 1 fig. Presents table prepared by author that will give correct-size rectangular air duct with minimum of effort which means materially simplifying calculations.

Automatic Ventilators. Comparative Tests of Automatic Ventilators, J. P. Calderwood, A. J. Mack and C. J. Bradley. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 5, July 1922, pp. 505-513, 6 figs. Tests conducted in engineering experiment station of Kansas State Agricultural College to determine efficiency of various types.

VOCATIONAL TRAINING

Foundrymen. The Training of Foundrymen, A. A. Liardet. Foundry Trade Jl., vol. 26, no. 309, July 20, 1922, pp. 54-58. Writer recommends scheme for training of foundrymen.

W

WAGES

American Manufacturing Industries. Wages and Hours in American Manufacturing Industries, July 1914-January 1922. Nat. Indus. Conference Board, Research Report, no. 52, July 1922, 235 pp., 112 figs. Sets forth reliable data portraying movement of hourly and weekly earnings, hours of operation and workers' hours as well as changes in employment, from pre-war period to date.

Incentive Systems. Effect of Labor Setting on Labor Costs, William O. Lichtner. Indus. Management, vol. 64, no. 3, Sept. 1922, pp. 169-172. It is claimed that managers have taken incentive out of wage-inventive systems by unintelligent rate cutting.

Piece-Rate Methods. The Piece-Rate Wage Method in the Workshops of the German State Railway (Das Gedingeverfahren in den Werkstätten der Deutschen Reichsbahn), Hans A. Martens. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 38, Sept. 23, 1922, pp. 916-920. Discusses principles of this system as practiced during last two years in German railway shops, and measures for improvement with special regard to time studies and details of wage system.

Putting Production Incentive into Pay Envelopes, Samuel Theaker. Indus. Management, vol. 64, no. 4, Oct. 1922, pp. 216-220, 3 figs. Explains how good points of piecework can be utilized while removing at the same time the disfavor with which it is regarded.

Systems. A Survey of Wage Systems, Paul F. Gemmill. Indus. Management, vol. 64, no. 4, Oct. 1922, pp. 207-208. Compiled from experience of 50 plants.

WASTE HEAT

Utilization. Blast Furnace Waste Heat Utilized, Hubert Hermanns. Blast Furnace & Steel Plant, vol. 10, no. 10, Oct. 1922, pp. 531-534, 9 figs. Points out that by employing waste-heat utilizers in conjunction with engines large part of waste heat may be recovered. Account of German experiences.

WASTE PREVENTION

Industrial. A Further Consideration of the Report of the Committee on Elimination of Waste in Industry, Thomas W. Mitchell. Taylor Soc. Bul., vol. 7, no. 5, Oct. 1922, pp. 198-204.

WATER

Specific Heat. The Ratio of the Calorie at 73° to That at 20°, Arnold Romberg. Am. Acad. Arts & Sci. Proc., vol. 57, no. 15, June 1922, pp. 377-378, 10 figs. Describes experiment designed as crucial test of correctness of temperature-variation curve of specific heat of water.

WATER POWER

St. Lawrence Region. Water Power Situation in the St. Lawrence Region, J. T. Johnston. Can. Engr., vol. 43, no. 12, Sept. 19, 1922, pp. 359-361, 2 figs. Relation to St. Lawrence Waterway development; 6,077,427 undeveloped horsepower within 300 miles of Long Sault exclusive of undeveloped St. Lawrence Power; probable demand for power.

Snake River. Snake River as a Source of Power, W. G. Hoyt. Elec. World, vol. 80, no. 16, Oct. 14, 1922, pp. 811-813, 3 figs. Undeveloped power sites total 1,510,000 hp., with existing flow available for 90 per cent of time.

WEIRS

Herschel Type. An Investigation of the Herschel Type of Weir, Richard H. Morris and Albert J. R. Houston. Mech. Eng., vol. 44, no. 10, Oct. 1922, pp. 651-654, 8 figs. Results of tests made to determine effect of various modifications in construction on action of improved type of weir designed by Clemens Herschel for gaging in open channels.

WELDING

Electric-Railway Practice. Welding as Practiced by Electric Railways. Elec. Ry. Jl., vol. 60, no. 15, Oct. 7, 1922, pp. 567-568. Symposium of papers forming basis of discussion at joint meeting of Am. Welding Soc. and Am. Elec. Ry. Eng. Assn. Fields of several varieties of welding were outlined.

Tube. Contraction in Tube Welding, Marcel Piette. Acetylene Jl., vol. 24, no. 3, Sept. 1922, pp. 120-121, 5 figs. Distortion can be avoided by expanding pieces in opposite sense before welding. Translated from Revue de la Soudure Autogène, with additions.

[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; OXY-ACETYLENE WELDING.]

WIND PRESSURE

Calculation. Wind Velocity and Wind Pressure (Windgeschwindigkeit und Winddruck), Karl Buchegger. Bauingenieur, vol. 3, no. 16, Aug. 31, 1922, pp. 491-495, 1 fig. Develops formulas and gives diagram based on experimental results from which main factors are readily available.

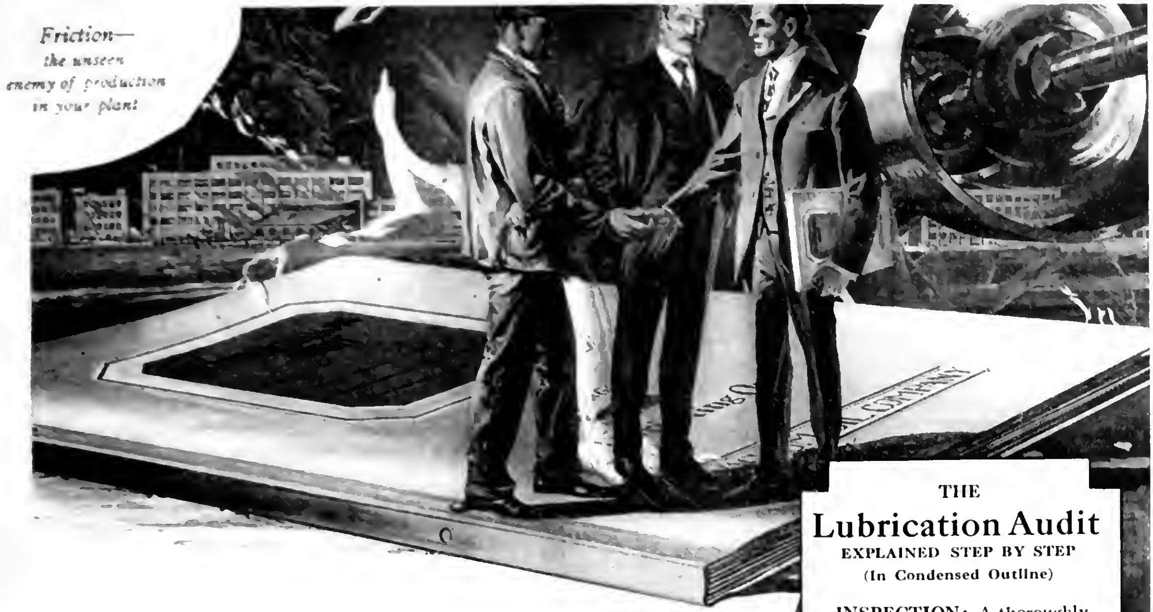
WOOD

Heating Value of American Woods. The Calorific Value of American Woods, S. W. Parr and C. N. Davidson. Jl. Indus. & Eng. Chem., vol. 14, no. 10, Oct. 1922, pp. 935-936, 3 figs. Results of experiments to determine "end point."

Testing Machine. Amsler Machine for Static and Dynamic Testing of Wood (Machine Amsler pour les éssais statiques et dynamiques des bois). Bul. Technique de la Suisse Romande, vol. 48, no. 17, Aug. 19, 1922; pp. 197-201, 9 figs. Built by A. J. Amsler & Co. at Schaffhausen, for bending, compression, impact and other tests; construction and operation.

WORKMEN'S COMPENSATION

Social Insurance and. Workmen's Compensation and Social Insurance. Monthly Labor Rev., vol. 15, nos. 1 and 3, July and Sept. 1922, pp. 142-146 and 196-201. July: Recent reports. National health and unemployment insurance in Great Britain. Sept.: Comparison of workmen's compensation insurance and administration. Recent compensation reports. Experience under Danish invalidity insurance law. Accident insurance in Norwegian fishing industry, 1920.



To Plant Executives—

When your Engineers and our Representatives put their heads together

WHEN one of our representatives comes to your plant, he comes—not as a lubrication theorist,—not as a meddler in your plant,—not as a mere oil salesman.

He comes as a practical man with a practical knowledge of machinery and a specialized knowledge of oil. He comes to co-operate.

Your man contributes his knowledge of the operating conditions and lubrication problems in your plant. Our man contributes from the Vacuum Oil Company's wide knowledge of lubrication gained through many years of study and experience all over the world.

Thus, when your man and our man get together, they meet on common ground. They discuss the common problem of Lubrication from the standpoint of such practical matters as coal waste, power losses, preventable friction, overheated bearings, oil waste, repair bills, etc.

The sale of a barrel or so of oil is the last subject brought up.

If you are not already having the benefit of the Vacuum Oil Company service, we shall be glad to make a Lubrication Audit of your plant. See details in column at right.

We are making Lubrication Audits every day in every country in every kind of plant. We make no charge for this co-operative service. Please feel free to call for it at any time.

But as "any time" is likely to be "no time"—why not today?

GARGOYLE

Lubricating Oils

A grade for each type of service

THE

Lubrication Audit

EXPLAINED STEP BY STEP

(In Condensed Outline)

INSPECTION: A thoroughly experienced Vacuum Oil Company representative in cooperation with your plant engineer or superintendent makes a careful survey and record of your mechanical equipment and operating conditions.

RECOMMENDATIONS: We later specify, in a written report, the correct oil and correct application of the oil for the efficient and economical operation of each engine and machine.

This report is based on:—

(1) The inspection of the machines in your plant.

(2) Your operating conditions.

(3) Our 56 years of lubricating experience with all types of mechanical equipment under all kinds of operating conditions throughout the world.

(4) Our outstanding experience in manufacturing oils for every lubricating need.

CHECKING: If, following our recommendations in this audit, you install our oils, periodical calls will be made to check up the continuance of the desired results.

FOR THE ABOVE FREE SERVICE address our nearest branch office.

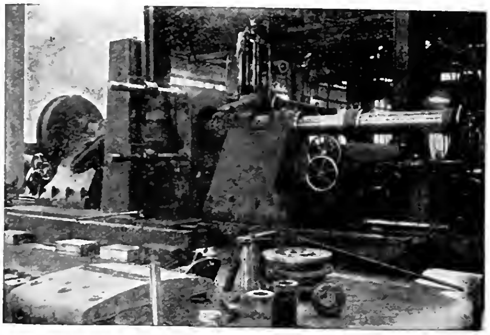
Domestic Branches:

New York
(*Main Office*)
Boston
Philadelphia
Pittsburgh
Buffalo
Rochester
Albany

Chicago
Detroit
Indianapolis
Minneapolis
Des Moines
Kansas City, Kan.
Dallas

VACUUM OIL COMPANY

HAMILTON ENGINES



A Special Cylinder Boring Machine which permits the cylinders, barrel and ports of an engine to be bored at one setting, thus insuring perfect alignment

Hamilton Engines Save Money

THE time to avoid losses, both *in* and *because* of your power plant, is when you buy your power equipment. That is why consulting and operating engineers recommend dependable HAMILTON Heavy Duty Engines and Machinery.

Costly shut-downs and expensive repairs can only be eliminated by purchasing a reliable prime mover. To get reliability, simplicity of design and sturdiness or massiveness of construction are indispensable.

HAMILTON engines have that inherent strength of construction which enables them to withstand economically all the pressure, stresses and strains that heavy duty service involves. This strength is due to:

(1)—The foundry being operated under chemical control, to assure a uniform mixture of HAMILTON quality;

(2)—All parts being properly proportioned;

(3)—The machining being done on the best tools obtainable and to gauge. The inspection is rigid and of one standard.

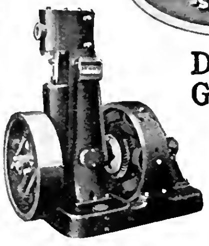
The soundness of this policy has been proven by the years of steady, economical service HAMILTON engines have rendered The Carnegie Steel Company, The Pennsylvania Hotel, The Ford Motor Company, and other corporations which are leaders in their industry. What Hamilton engineers and heavy duty engines and machinery have done for them, they can do for you.

The Hooven, Owens, Rentschler Co.

Hamilton Engines and Machinery

HAMILTON, OHIO

Engberg
THE STANDARD FOR EFFICIENCY-DURABILITY-SERVICE

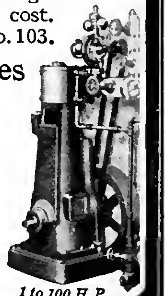


1 to 50 K. W.

Direct Connected Generating Sets

ENGBERG Customers are universal in their expression of satisfaction, and as to the big saving in operating cost. Catalog No. 103.

Vertical Steam Engines



1 to 100 H.P.

A combination of superior design, materials and workmanship—an ideal formulated on thirty years' experience in the manufacturing and testing of Vertical Steam Engines. Catalog No. 301.

HIGHEST QUALITY
ATTRACTIVE PRICES

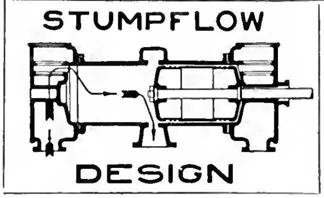
MANUFACTURED BY
ENGBERG'S
ELECTRIC & MECHANICAL WORKS
24 VINE ST., ST. JOSEPH, MICHIGAN, U.S.A.

BEFORE WE BUY POWER LET US GET THE NEW BOOK ON

THE UNA-FLOW STEAM ENGINE

SECOND ENGLISH EDITION

$5 By PROF. J. STUMPF Postage Prepaid

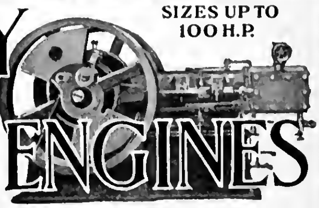


WRITE NOW

Stumpf Una-Flow Engine Co., Inc.
206 E. Genesee Street
SYRACUSE, N. Y.

TROY ENGINES

SIZES UP TO 100 H.P.



ONLY STEAM ENGINES
Good Engines only

Troy Engines are steady, dependable power producers. They deliver all the power, all the time that you must have it; and perform noiselessly and almost without vibration.

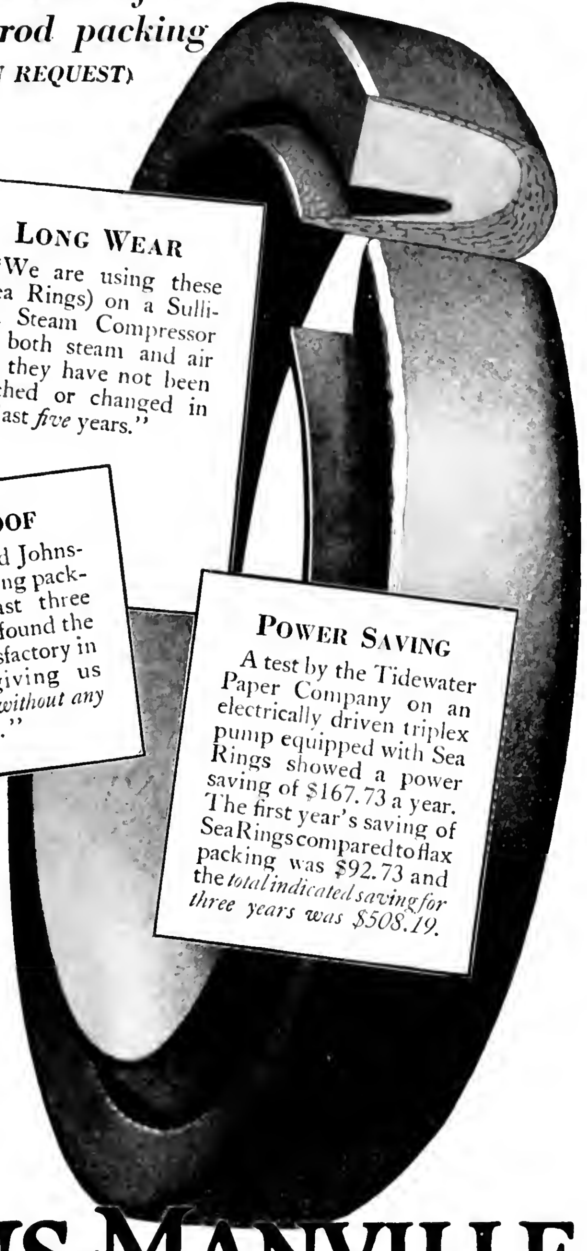
They have many good features—our latest catalog tells about them—send for it. *See our data in 1922 A.S.M.E. Condensed Catalogues*

TROY ENGINE COMPANY
TROY, PA.

4 Sea Ring Economies

—told by actual users of this remarkable rod packing

(NAMES ON REQUEST)



Long Wear

"We are using these (Sea Rings) on a Sullivan Steam Compressor for both steam and air and they have not been touched or changed in the last *five* years."

No Adjustment

"We are pleased to recommend this wonderful packing for air service as we have *never touched the stuffing boxes* since installing the packing three years ago."

Leak Proof

"We have used Johns-Manville Sea Ring packing for the last three years and have found the same to be satisfactory in every way, giving us better service *without any leaks whatever.*"

Power Saving

A test by the Tidewater Paper Company on an electrically driven triplex pump equipped with Sea Rings showed a power saving of $167.73 a year. The first year's saving of Sea Rings compared to flax packing was $92.73 and the *total indicated saving for three years was $508.19.*

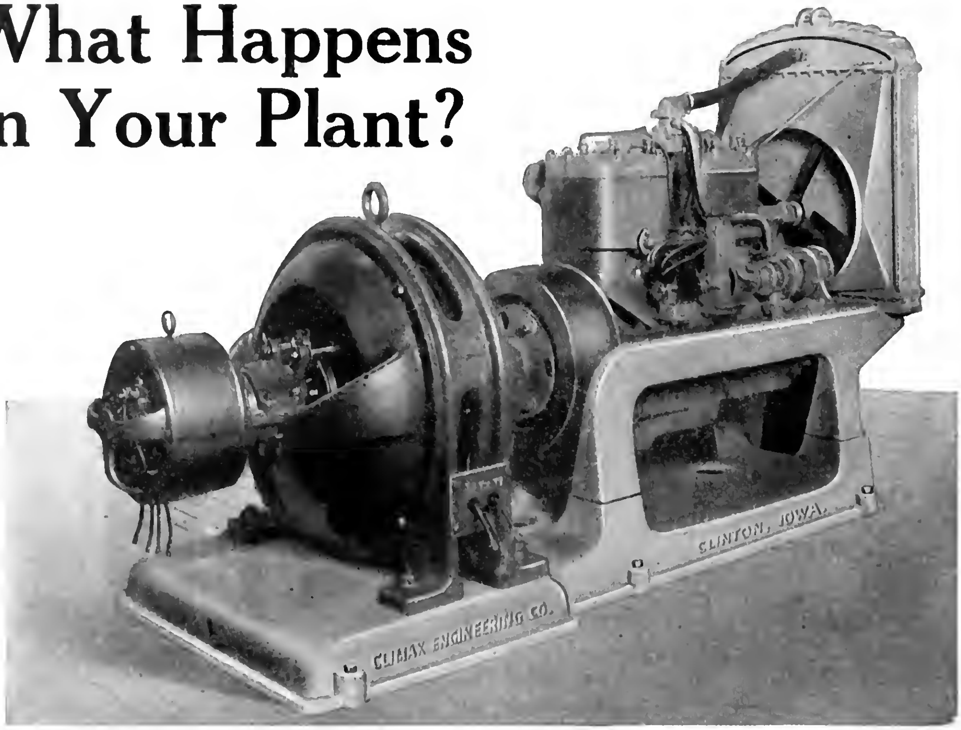
The Sea Ring is a modern, scientifically constructed rod and plunger packing. Cylinder pressure trapped in the U-shaped section expands the packing with just enough force to prevent leakage. This automatic action cuts friction and means reduced wear, power saved, and economy.

JOHNS-MANVILLE Inc.
Madison Ave. at 41st Street, New York City
Branches in 56 Large Cities
For Canada: CANADIAN JOHNS-MANVILLE CO., Ltd., Toronto

Johns Manville Service
Covers the Continent
Through—
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials

What Happens In Your Plant?



When the power is shut off in your plant what happens? A Climax power unit will bring immediate relief in any emergency by providing all the current you need for lights, motors or electric arc cutting and welding.

CLIMAX

"THE TRUSTWORTHY ENGINE"

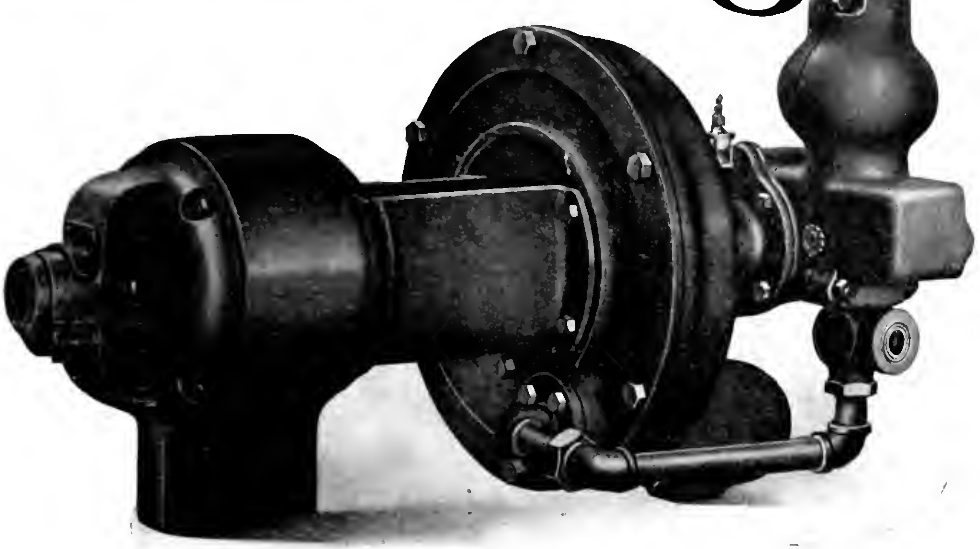
Moderate Speed—Heavy Duty
30 to 70 H. P.—Kerosene or Gasoline

Write for Catalog

CLIMAX ENGINEERING CO., 20 W. 18th Avenue,
CLINTON, IOWA

Manufacturers of Internal Combustion Engines for Automotive and Industrial Power Purposes.

Announcing!



TURBOLIGHT

KERR TURBINES GEARS
TRADE MARK

BACKED BY THE OLDEST EXCLUSIVE BUILDERS OF STEAM TURBINES AND REDUCTION GEARS

THE NEW KERR STEAM TURBINE GENERATOR SET, 500 TO 2000 WATT CAPACITY

Newest of Kerr Turbines, worthy to take its place with the thousands that have made and are making turbine history the country over.

Designed for installation and use under the many conditions where common labor and "oil can maintenance" are all that can be expected.

Provides a flexible, economical, reliable source of electric light and power wherever steam is available—and that is most everywhere. It is a real turbine for real work—ask our Engineers how it can be put to work for you.

KERR **STEAM TURBINES-REDUCTION GEARS**
KERR TURBINE COMPANY
WELLSVILLE, NEW YORK U·S·A·

2003-27

DISTRICT REPRESENTATIVES

Boston, 79 Milk St.
Charlotte
Chicago, 718 Fisher Bldg.
Cincinnati, Mercantile Library
Cleveland, 1900 Euclid Avenue
Dallas, Southwestern Life Bldg.
New York, 30 Church St.
Philadelphia, Stock Exchange Building
Pittsburgh, Oliver Building
Portland, Lewis Building
San Francisco, Sharon Bldg.
St. Louis, 1237 Syndicate Trust Building
Detroit, Kerr Mach. Bldg.
Duluth, Lyceum Building
Kansas City, 419 Reliance Bldg.
New Orleans, 211-212 Carondelet Building
Montreal, 180 St. James St.
Winnipeg, 207 Scott Block
London, 11 Carteret Street
Honolulu, Honolulu Iron Works—Shanghai, Fobes & Co.
Tokio, Imperial Export Co.—Havana, 516 National Bank Bldg.

"Ridgway" Considered the Standard

THE wide application of electrical power to industrial purposes, creates a need for transforming devices of almost endless variety. Ridgway motor-generator sets are designed to meet conditions in particular installations.

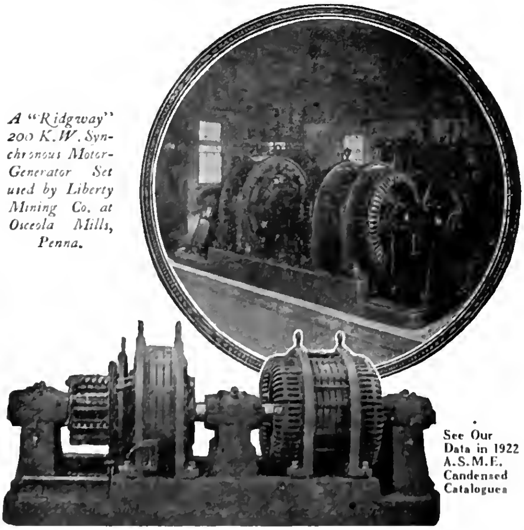
That is why "Ridgway" is considered the standard by which others are judged in many lines of industry.

When you see equipment bearing the name "Ridgway" you may be sure it was designed for that particular installation—and will deliver unfailing power economically.

Skilled engineers assemble and test Ridgway equipment before it is shipped. The purchaser need never worry about his power equipment after it is installed.

Write for Descriptive Bulletins

RIDGWAY DYNAMO
& ENGINE COMPANY
118 Electric Ave., Ridgway, Pa.
Branch Offices in all Principal Cities



A "Ridgway" 200 K.W. Synchronous Motor-Generator Set used by Liberty Mining Co. at Osceola Mills, Penna.

See Our Data in 1922 A.S.M.E. Condensed Catalogues

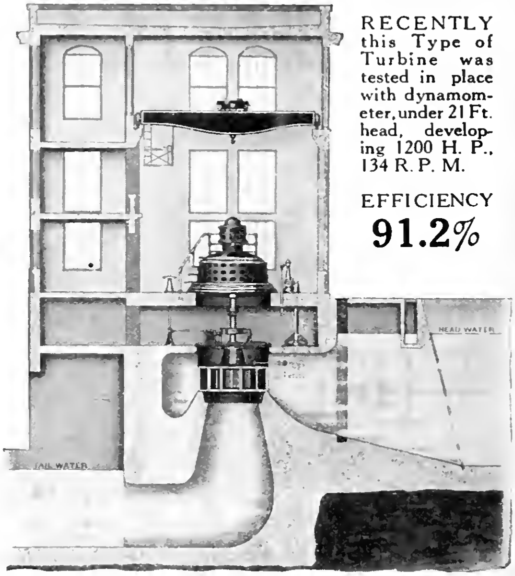
RIDGWAY

To Produce Unfailing Power Economically

POWER UNITS

LEFFEL TURBINE WATER WHEELS

HIGH SPEEDS HIGH POWERS HIGH EFFICIENCIES



RECENTLY this Type of Turbine was tested in place with dynamometer, under 21 Ft. head, developing 1200 H. P., 134 R. P. M.

EFFICIENCY
91.2%

WE WILL FORWARD BULLETINS UPON REQUEST.

The James Leffel & Co., Springfield, Ohio, U. S. A.

BRANCH OFFICES:

NEW YORK, N. Y.	39 Cortlandt St.
BOSTON, MASS.	161 Devonshire St.
ATLANTA, GA.	Fourth Nat'l Bank Building
MINNEAPOLIS, MINN.	Plymouth Building
PETERBOROUGH, ONT., CANADA	William Hamilton Co., Ltd.

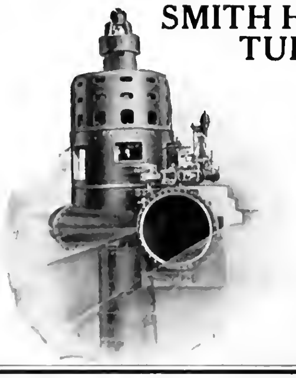
SPECIALIZED CONSULTING SERVICE

in ALL BRANCHES of the ENGINEERING FIELD

The cards of Consulting Engineers appearing on pages 108, 109, 110, 111, 112 and 113 serve as an index to professional service in the mechanical field. Specialized service may be obtained through this section on such subjects as

Accounting
Appraising
Combustion
Construction
Copyrights
Cost Systems
Designing
Foundries
Heating and Ventilating
Hydraulic Work
Industrial Plants
Inspection
Machinery Designing
Management
Manufacturing Methods
Organization
Patent Law
Plant Construction
Power Plants
Power Transmission
Production
Refrigeration
Research
Special Machinery
Taxes
Testing
Tool Designing
Trade Marks
Water Purification
Water Supply

SMITH HYDRAULIC TURBINES

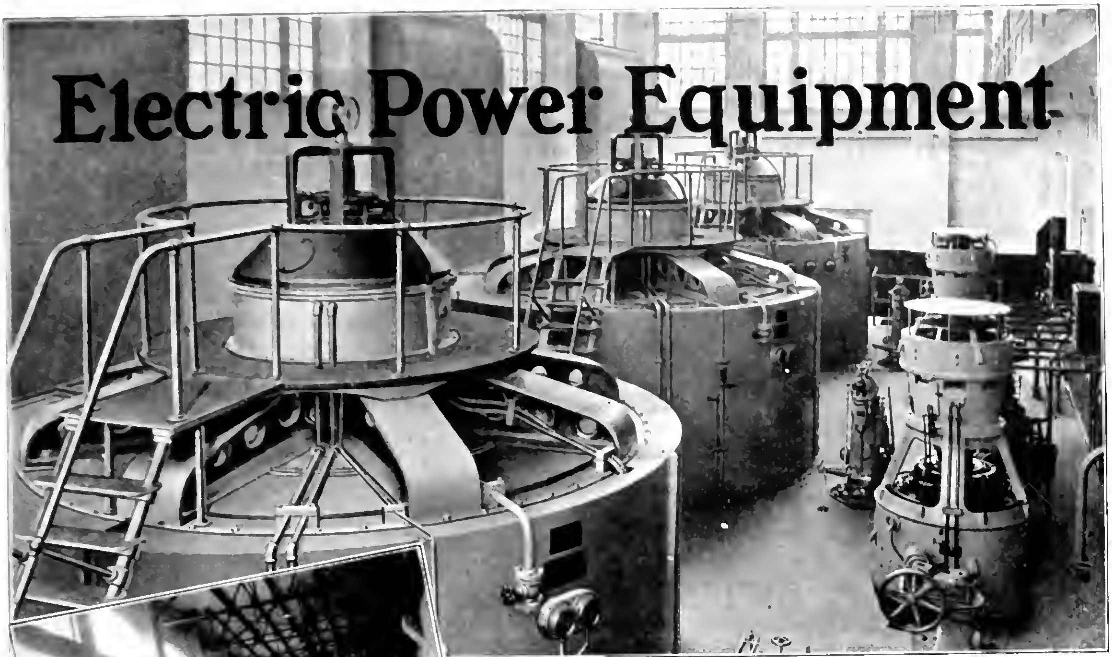


Accompanying view shows single vertical shaft turbine unit with direct connected generator and self-contained governor.

Write Dept. "R" for Bulletin of Designs.

S. MORGAN SMITH CO.
YORK, PA.

Electric Power Equipment



For the power plant, complete equipment "from prime mover to switchboard" is built by the Allis-Chalmers organization. This includes all types of prime movers—steam turbines, hydraulic turbines, steam, gas and oil engines, together with complete electrical equipment. Condensers of all types, pumps, air compressors and many other auxiliaries are also supplied. Allis-Chalmers equipment is used in plants of all sizes, and includes some of the largest power units ever built.

Allis-Chalmers Products

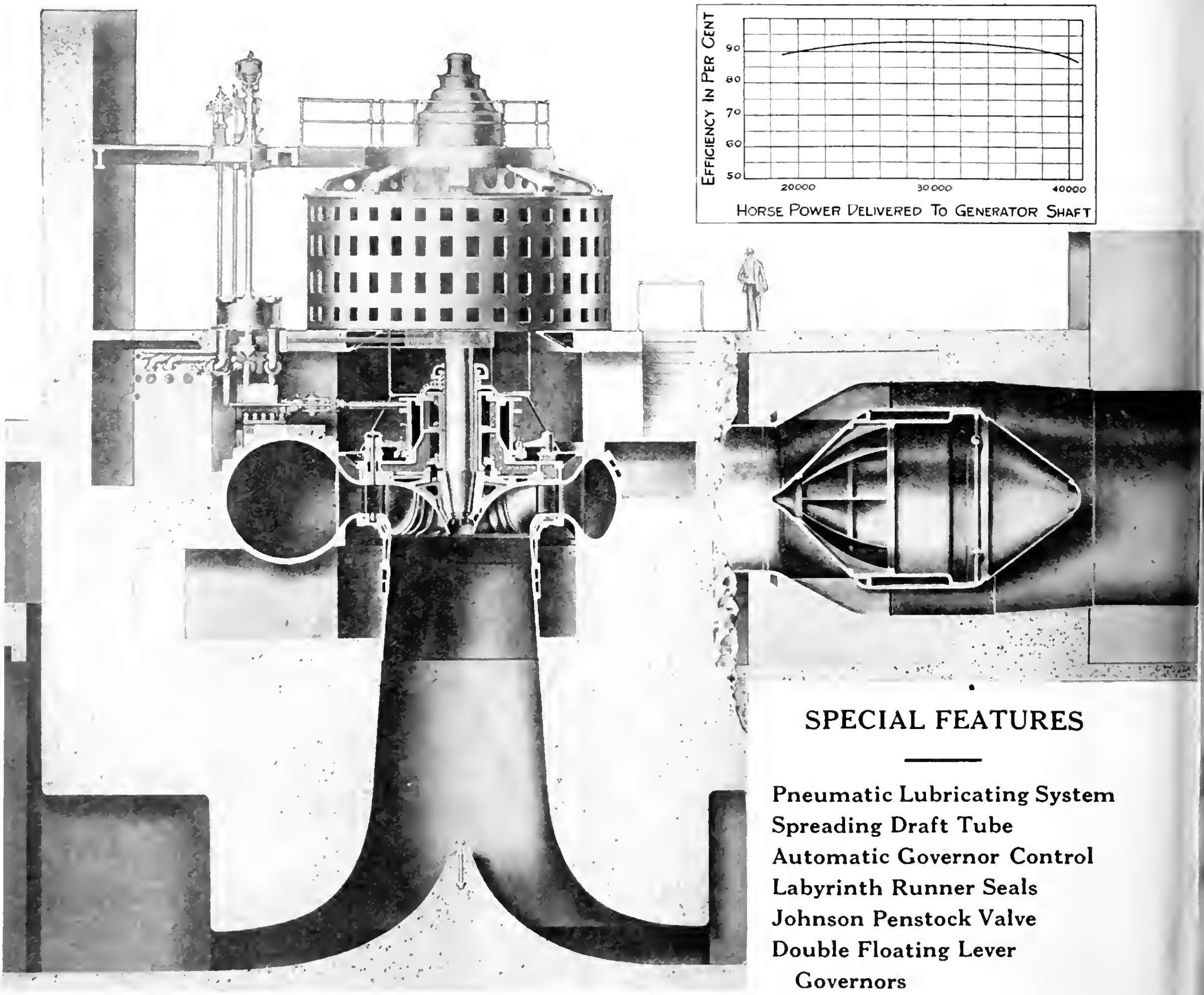
Electrical Machinery
Steam Turbines
Steam Engines
Gas and Oil Engines
Hydraulic Turbines
Crushing and Cement Machinery
Mining Machinery
Flour and Saw Mill Machinery

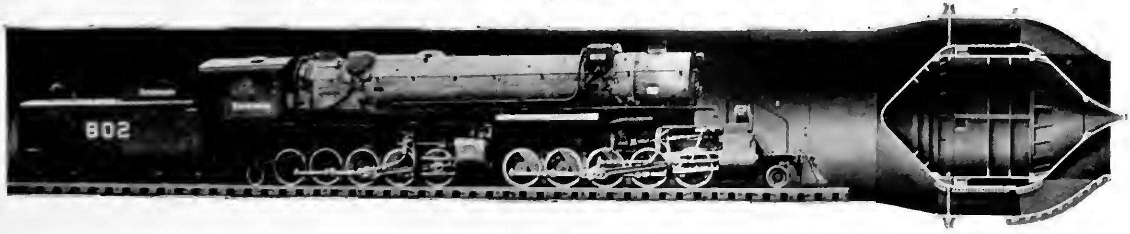
Power Transmission Machinery
Pumping Engines
Centrifugal Pumps
Steam and Electric Hoists
Air Compressors
Air Brakes
Agricultural Machinery
Condensers

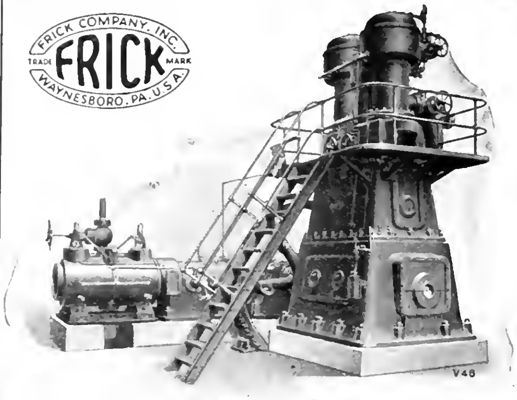
See pages 20, 21 and 398 in the 1922 A.S.M.E. Condensed Catalogues

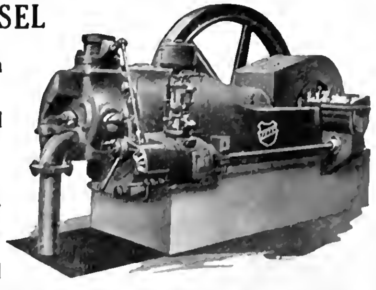
ALLIS-CHALMERS

MILWAUKEE, WIS. U. S. A.

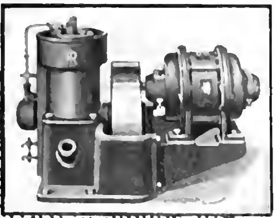

Efficiency In Per Cent
90
80
70
60
50
20000
30000
40000
Horse Power Delivered To Generator Shaft

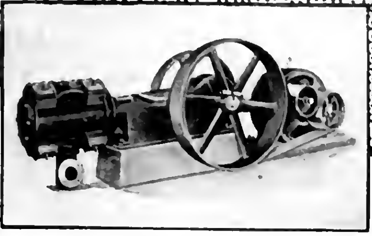

802

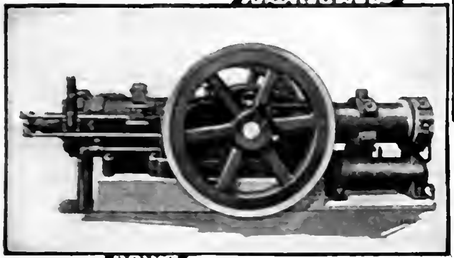

V48

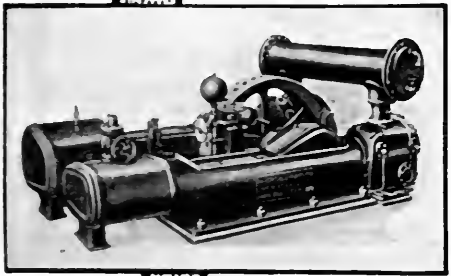


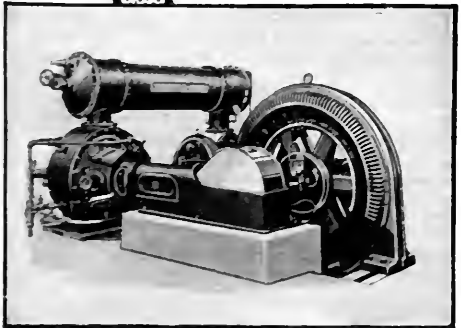
IR AIR COMPRESSORS











A Size and Type
For Every Condition

NO matter what capacity, pressure or type of drive, one of the thousand and more types and sizes of Ingersoll-Rand Air Compressors will just fit your requirements.

There are standard compressors for pressures up to 3500 pounds per square inch, and for capacities ranging from 3 to 50,000 cubic feet of free air per minute.

The question of drive has been given the most careful consideration. Whether direct-connected electric motor drive, oil or gas engine, belt or steam drive is preferred you can purchase the *complete* compressor unit from the Ingersoll-Rand Company, with the assurance that every detail of compressor and prime-mover has been given correct attention.

In addition to air compressors the Ingersoll-Rand Company manufacture a complete line of gas and ammonia compressors. Our engineers are located in all parts of the world. These men are experts on the subject of air and gas compression and will be glad to discuss your problem with you. Also, these compressors are described in illustrated booklets, copies of which will be sent you on request.

INGERSOLL-RAND COMPANY
11 Broadway, New York

*Offices in all principal domestic
and foreign cities*

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

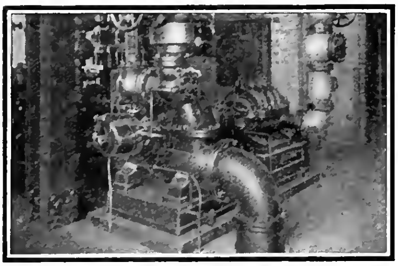
R-430 671-C

Ingersoll-Rand

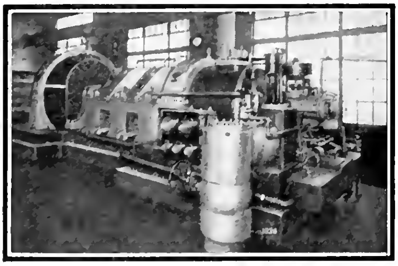
De Laval

Turbine Driven DC and AC Generators
Centrifugal Boiler Feed Pumps
Circulating and Condensate Pumps
Fire Pumps & Service Pumps
Centrifugal Blowers

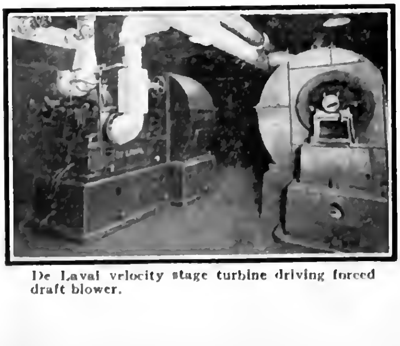
De Laval motor driven service and fire pumps.



De Laval velocity stage turbine driven 4-stage 5-in. boiler feed pump; capacity 700 gals. per min. against 693 ft. head.



De Laval geared turbine driving 1500-KW., D. C., house generator.



De Laval velocity stage turbine driving forced draft blower.

THE trend towards higher steam pressures, superheats and vacuums has presented entirely new problems to designers. Excellence of design, with workmanship and materials of the highest grade, is equally as important in auxiliary equipment as in main units, since the main units cannot remain in operation without the auxiliaries and failures of auxiliaries may result disastrously to the main units. De Laval auxiliary equipment has been designed to meet these requirements.

Low bucket speeds and liberal design insure safety. Separate speed governor and overspeed emergency trip control the steam supply by independent valves. Steam chests are made of steel and so located that heat is not conducted to the bearings. The oiling system is automatic. Governor levers and parts requiring adjustment are so located as to be easily accessible.

A standard speed generator driven by a De Laval geared turbine is a more efficient, more reliable and more durable unit than a high-speed generator driven by a steam turbine or a generator driven by a reciprocating engine.

Geared turbines should be used for driving circulating pumps, since low-speed pumps are more efficient, more reliable and longer-lived than are high-speed pumps.

De Laval turbine driven centrifugal boiler feed pumps, condensate pumps, fire pumps, and general service pumps directly connected to turbines, make exceedingly simple, reliable and compact units.

Centrifugal forced draft blowers and induced draft fans driven by De Laval geared turbines are free from the vibration and other troubles incidental to high-speed fans. The bearings are amply lubricated and cooled by a forced circulation of oil.

De Laval geared steam turbines are directly connected to medium or slow speed machinery, such as stokers, ash conveyors, coal crushers, etc., and combine high efficiency with extreme ruggedness and reliability.

The De Laval double helical speed reducing gear has been perfected in respect to both design and method of manufacture by extensive application to high-speed turbine service during the past 25 years. Its smooth and efficient operation is attested by its exceeding quietness.

CALL AT OUR EXHIBIT, BOOTH NO. 69
AT THE NATIONAL POWER SHOW.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

De Laval
Steam Turbine Company

Trenton, New Jersey

Local Offices: Boston, New York, Philadelphia, Pittsburgh, Cleveland, Indianapolis, Chicago, Duluth, Kansas City, Denver, Salt Lake City, Charlotte, Atlanta, Birmingham, New Orleans, Dallas, Seattle, San Francisco, Los Angeles, Montreal, Toronto, Vancouver. 246

"Let's stay over for the POWER SHOW"

THIS is what members of the A.S.M.E. and A.S.R.E. will be saying to each other toward the close of the annual December meeting of the Society, for the Power Show is to begin immediately after. This most complete exhibition of power plant equipment ever shown under one roof is to be held at the

Grand Central Palace

New York City
December 7-13, 1922
(except Sunday)

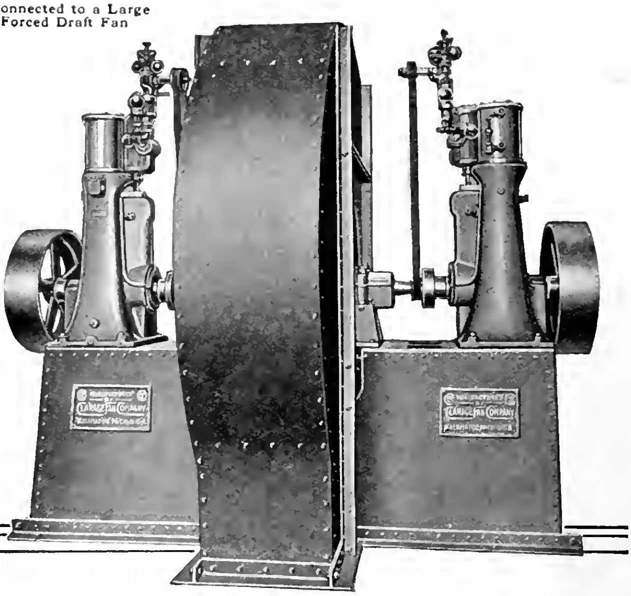
Thousands of prominent engineers from all over the country will be in attendance.

Representatives of the most progressive manufacturers of power plant appliances will be at the exhibits. No engineer can afford to miss this opportunity to personally inform himself on the latest developments in the power plant field.

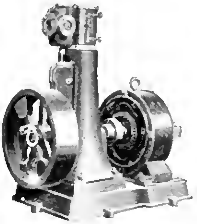
Before you leave town, See the Power Show!

**National Exposition of Power
and Mechanical Engineering**
Grand Central Palace, New York City
Room 1102

Direct Connected to a Large Clarage Forced Draft Fan



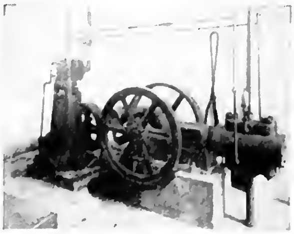
A FEW USES
FOR CLARAGE STEAM ENGINES



Clarage Engine Generator Set

Operating One Under-Feed Stoker and a Small Forced Draft Fan

Driving the Main Line-Shaft in a small factory



Driving An Air Compressor

Power at Low Cost

TESTS conducted under average operating conditions, both on the test block and in actual service, have clearly demonstrated the economy of Clarage engines. The steam consumption is unusually low, while the oil required is but a fraction of that used in the ordinary engine.

The fully enclosed features, together with the automatic pump oiling system, assure long continued service—year after year. Installation records establish the fact that Clarage Type "V" Engines demand no special attention and very rarely need any repairs, even though they have been in operation a long time.

These engines are used successfully for driving stokers, mechanical draft fans, electric generators, centrifugal pumps, air compressors and main line shafts in small factories.

If you have a job for a small steam engine—where economical, continuous operation is essential—let us give you complete information on the Clarage Type "V" unit. Send for catalog No. 6.

CLARAGE FAN COMPANY
BRANCH OFFICES IN PRINCIPAL CITIES
Main Office and Factory, KALAMAZOO, MICH.

CLARAGE TYPE V ENGINES
—KALAMAZOO SELF OILING

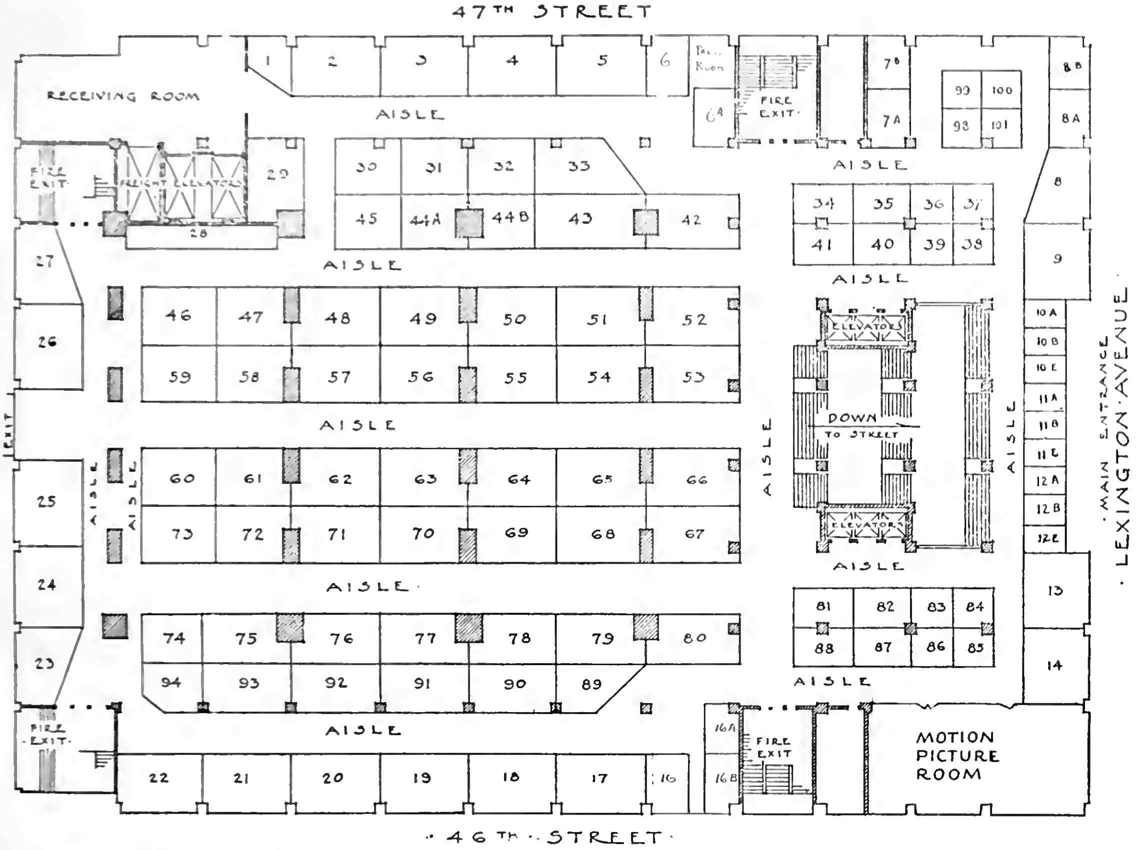
Diagram of Floor Spaces

at the

National Exposition of Power and Mechanical Engineering

To be held at

Grand Central Palace, N. Y. City, December 7–13, 1922, Excepting Sunday



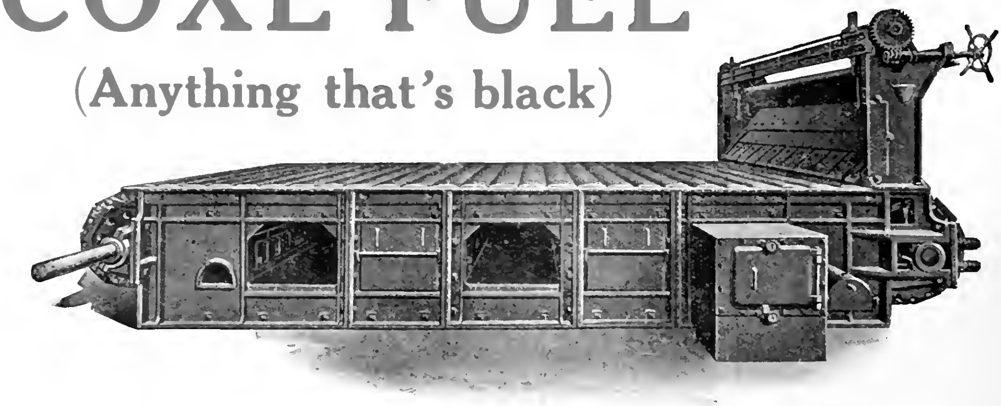
THE Following Color Pages contain information regarding the exhibits or products of firms listed below who will be represented at the exposition. Each firm's booth may be located readily by referring to the numbered diagram of floor spaces shown above

List of Advertisers in this Color Section

Name of Advertiser	Booth No.	Page No.	Name of Advertiser	Booth No.	Page No.
Bailey Meter Co.	54, 55	28	King Refractories Co.	36	33
Beaumont, R. H. Co.	50	22, 23	Leather Belting Exchange	75	31
Bernitz Furnace Appliance Co.	78	21	Lunkenheimer Co.	46	24
Combustion Engineering Corp'n	23, 24, 25	18	Martin-Morse Corp'n	8B	31
Davidson, M. T. Co.	98	26	Otis Elevator Co.	43	32
Deane, Payne Ltd.	4, 44B, 46	25	Quigley Furnace Specialties Co. (Inc.)	89	19
Furnace Engineering Co. (Inc.)	41	36	Reading Steel Casting Co. (Inc.)	44B	34, 35
H.S.B.W.-Cochrane Corp'n	67	27	Smith & Serrell	85	30
Jenkins Bros.	90	20	Tide Water Oil Sales Corp'n	31	29

COXE FUEL

(Anything that's black)



Is there any particularly cheap grade of coal, available at your plant, which at present you cannot burn efficiently?

Coxe Stokers

have established remarkable records in utilizing **efficiently**, fuels which have heretofore been considered unburnable.

Perhaps we can help you cut your coal bill. It will at least be interesting to you to find out. Write us.

See our exhibit at Booths 23-24-25
Exposition of Power
and Mechanical Engineering
Grand Central Palace—New York—Dec. 7 to 13

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

Combustion Engineering Corporation

Combustion Engineering Bldg.—43 Broad Street New York City
Offices in Principal Cities Throughout the World

Frederick Multiple Retort Stokers
Type E Stokers
Type D Stokers
Type K Stokers
Type H Stokers
Self Contained Stokers

Lopulco Pulverized Fuel Systems
Coxe Stokers
Grieve Grates
Air Heaters
CEC Tube Scraping Device
Combusco Water Seal Conveyors

Salvage Your OLD FIRE BRICK

Use them for Rebuilding and to

REPAIR FURNACE WALLS

By Crushing them and Bonding them with

HYTEMPITE

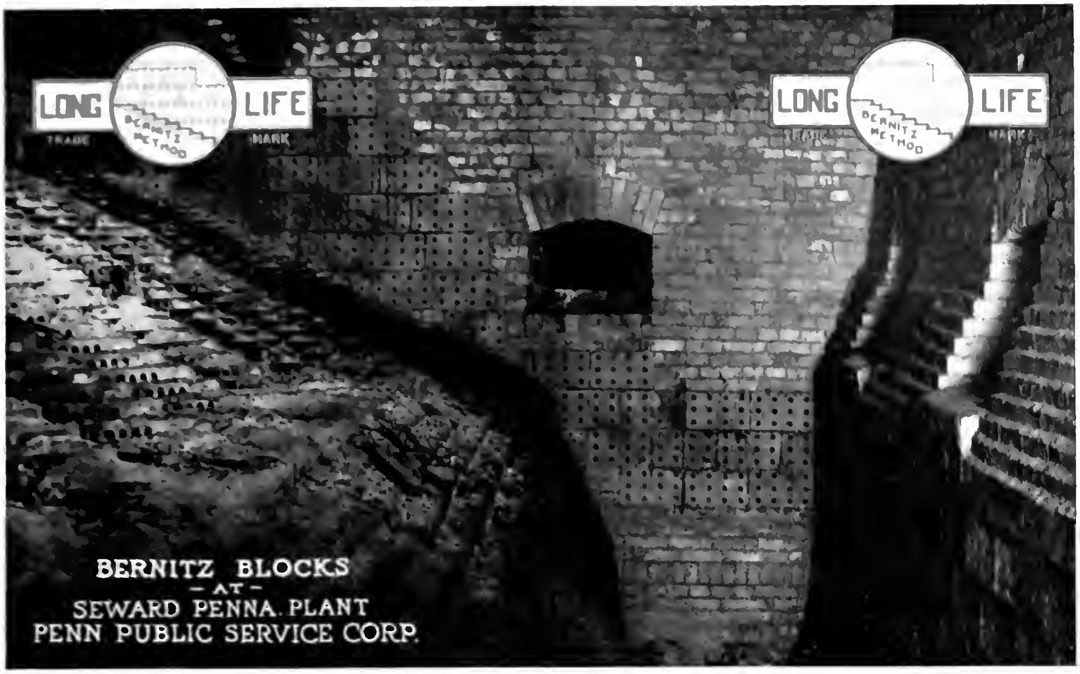
Reg. U. S. Pat. Off.

This type of monolitic fill for sidewalls is saving one Company only many thousand dollars annually in material, fuel and labor.

Bulletin 53M tells how and why.

QUIGLEY Furnace Specialties Co. Inc.
26 Cortlandt Street New York

Branch Offices
Chicago — Philadelphia
Distributors in all industrial centers.



BERNITZ CLINKER-PROOF BLOCKS

Shape "E"
shown here is
13½"x7¾"x7" deep,
replaces nine std
fire brick


FIRE FACE REAR FACE

See our
catalogue for
other shapes
and complete
information

BERNITZ BLOCKS—which are made of high grade refractory clay, and protected by the BERNITZ SYSTEM—prevent clinker adhesion on furnace linings, thereby assuring *"long-life"* to the settings, maximum furnace efficiencies, increased capacities, and elimination of the arduous task of removing troublesome clinkers.

BERNITZ BLOCKS are readily installed in existing as well as new furnaces and are in use extensively at leading central stations and industrial power plants.

At the ***New York Power Show*** (***Dec. 7-13, 1922***) will be exhibited an actual layout of these blocks as adapted to a furnace equipped with a multi-retort stoker. You may obtain at our booth descriptive catalogues and complete information, or the same will be gladly sent to you upon request.

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment

350 Madison Ave.,
New York City

BERNITZ FURNACE APPLIANCE CO.

177 State St.,
Boston, Mass.

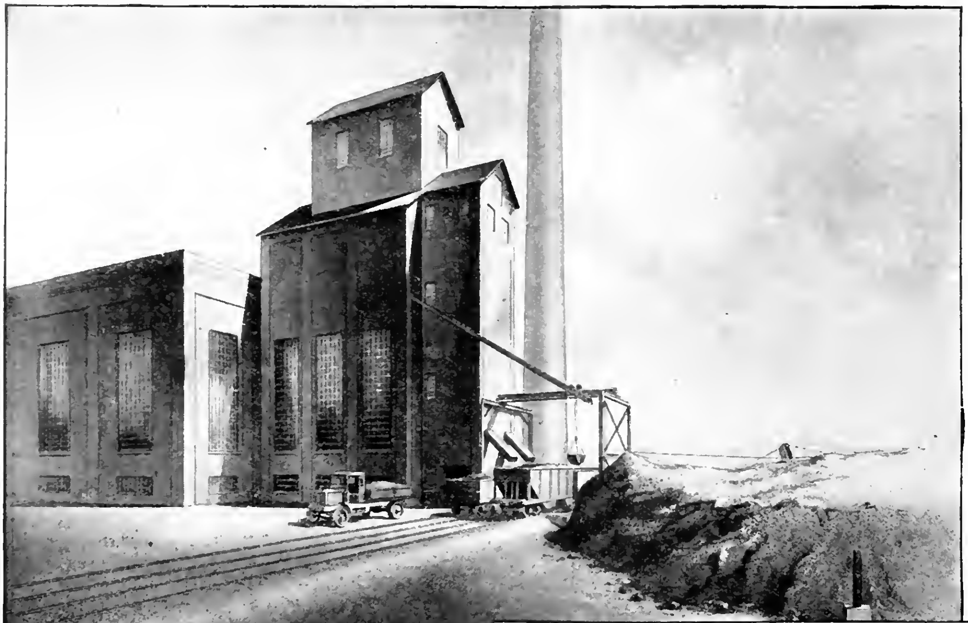
PITTSBURGH PHILADELPHIA CLEVELAND CHICAGO ATLANTA DETROIT ST. LOUIS.

NATIONAL EXPOSITION OF

-SPACE 78-

POWER & MECHANICAL ENGINEERING

Beaumont Equipment Will Concentrate



Super-Central System for coal and ash handling, designed by Beaumont for the Neosho Steam Station at the Kansas Gas & Electric Co., at Strauss Kans.—one of the properties of the Electric Bond & Share Co. Building is of inexpensive construction, yet architecturally pleasing.

Booth No. 50 at the National Exposition of Power and Mechanical Engineering will show miniature working models of the Beaumont Skip Hoist, the Beaumont Weigh Larry, and the Beaumont Cable Drag Scraper. Be sure to see them.

SKIP HOISTS
COAL WEIGH LARRIES
CABLE DRAG SCRAPERS
STEEL ASH BUNKERS
COKE SCREENING PLANTS
CONCRETE COKE BUNKERS

Beaumont
ONE CONTRACT
ONE RESPONSIBILITY

SUSPENDED Steel Coal BUNKERS
ASH HOPPERS and GATES
CRUSHERS and FEEDERS
SINTERING PLANTS
TRACK HOPPERS
CONVEYORS
ELEVATORS

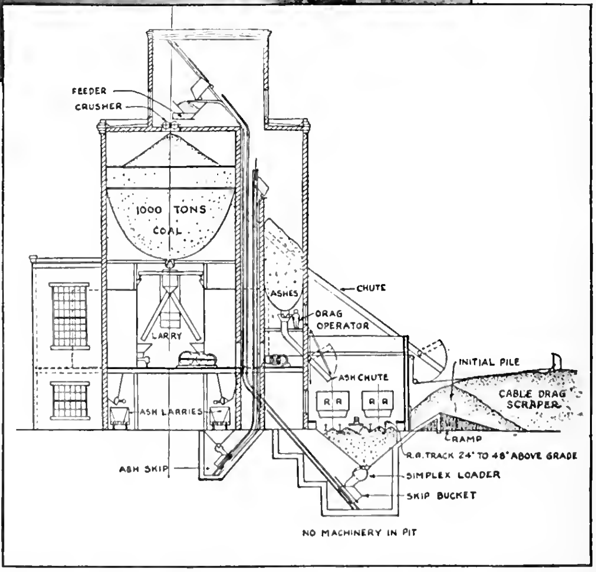


Diagram view of the Super-Central System. Building contains Beaumont Skip Hoists and bunkers for coal and ashes, driving machinery for Beaumont Cable Drag Scraper storing coal, and terminus of tracks of Beaumont Weigh Larry feeding coal to boilers.

R·H·BEAU

CHICAGO . . . . 1406 S. Michigan Ave.
BOSTON . . . . . . 261 Franklin Street
MINNEAPOLIS . . . . 501 So. 6th St.
GREENVILLE, S. C. Masonic Temple Bldg.

332 Arch Street

Your Coal and Ash Handling at One Point

CONCENTRATION of all coal and ash-handling equipment in one building of inexpensive construction is made possible by the super-central system devised by Beaumont.

Two Beaumont Skip Hoists, one for coal and one for ashes; a Beaumont Cable Drag Scraper for storing and reclaiming coal; a Beaumont Weigh Larry for feeding coal to stokers; and separate bunkers for coal and ashes comprise this complete system.

Winding machines operating skip hoists and drag scrapers are housed in same building with bunkers, which also contains terminus of larry tracks.

Because the necessary machinery is reduced to a minimum, and is of simple, rugged design, maintenance expense is very low. No chain elevators or distributing conveyors are used, and power consumption is small.

Absence of bunkers from boiler room permits maximum light and ventilation in firing aisle.

Capacities of the super-central system can be regulated to meet the requirements of any plant, large or small. Future plant extensions can be cared for without additional equipment. If desired, the system can readily be adapted to the handling of pulverized coal.

Complete details of the system and its component parts—the Beaumont Skip Hoist, the Beaumont Cable Drag Scraper, and the Beaumont Coal Weigh Larry—are given in Catalog No. 50. A free copy is here for you; write for it today.

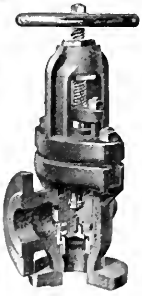
MONT CO.

Philadelphia

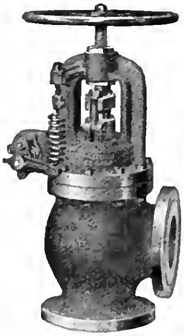
NEW YORK . . . 50 Church Street
PITTSBURGH . . 1510 Oliver Bldg.
DENVER: 538 U. S. National Bank Bld.
CLEVELAND . . . 504 Bulkley Bldg.

LUNKENHEIMER VALVES AND ENGINEERING APPLIANCES

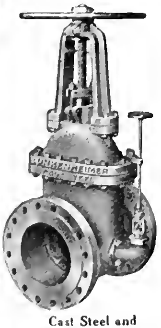
Iron, Bronze Mounted and Cast Steel Monel Mounted Globe Valves.



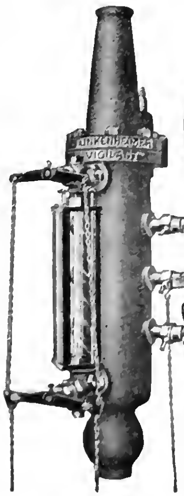
"Duro" Blow-off Valves.



Safety Non-return Boiler Stop Valves.



Cast Steel and Iron Gate Valves.



"Vigilant" Safety Water Column.

Pop Safety Valves.

Bronze Globe Valves.

Bronze Gate Valves.

"Lower cost per year of service,"—symbolized by economy both in operation and maintenance invariably results where Lunkenheimer Products are installed. Their record in service attests the supremacy of "quality,"—the factor which leads while progress lives, for QUALITY is ECONOMY.

The line being complete and providing a type and size for every requirement permits of standardization throughout the plant an accepted factor in promoting efficiency.

Lunkenheimer users are SATISFIED USERS. Specify "LUNKENHEIMER" and insist on getting the genuine.

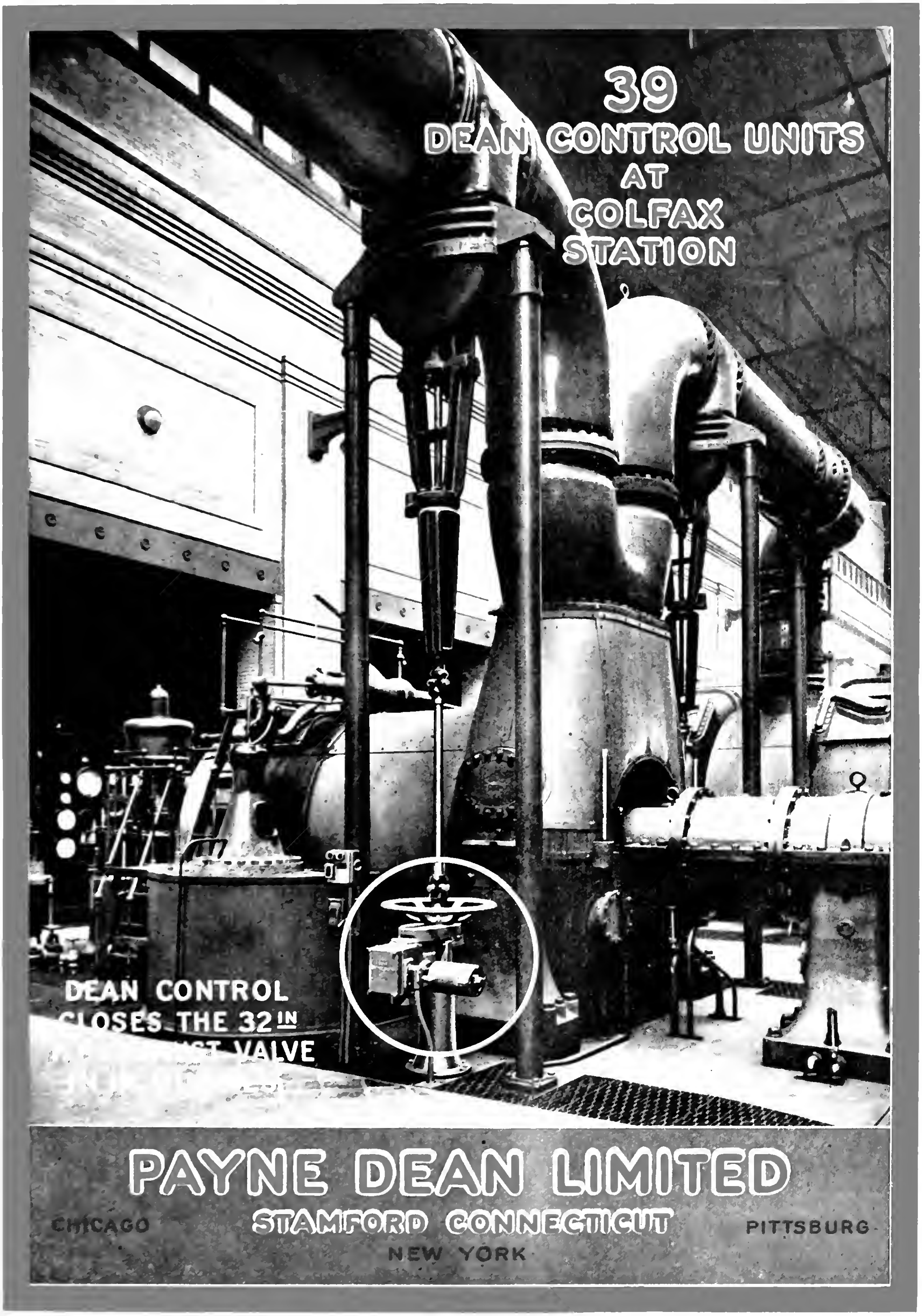
Our catalog 58-D lists the complete line and also contains technical information of value to executives, engineers, designers, purchasing agents, etc. Let us send you a copy.

See our exhibit at the
NATIONAL EXPOSITION OF
POWER AND MECHANICAL ENGINEERING
Grand Central Palace, New York
December 7th–13th

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO **CINCINNATI, U.S.A.** LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST, NEW YORK

32-33-4

America's Best since 1862



39 DEAN CONTROL UNITS AT COLFAX STATION

DEAN CONTROL
CLOSES THE 32 IN
[illegible] VALVE

PAYNE DEAN LIMITED

STAMFORD CONNECTICUT

CHICAGO
NEW YORK
PITTSBURG

Dean Controls may be seen at the Exhibits of Lunkenheimer Company, Booth No. 46—Pittsburgh Valve, Foundry & Construction Co., Booth No. 4 and Reading Steel Casting Co., Booth No. 44B.

"DAVIDSON" PUMPS

Do the Work Economically!

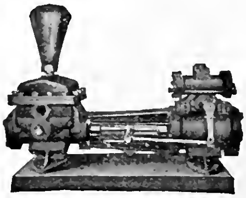
For almost half a century "DAVIDSON" Pumps have been built to a uniformly high standard of excellence.

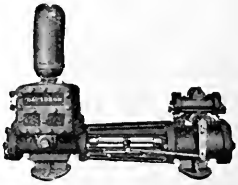
This has been our unalterable policy.

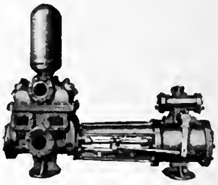
"DAVIDSON" Pumps can be depended upon always, for thoroughly satisfactory service, low operating and maintenance costs,—and to last.

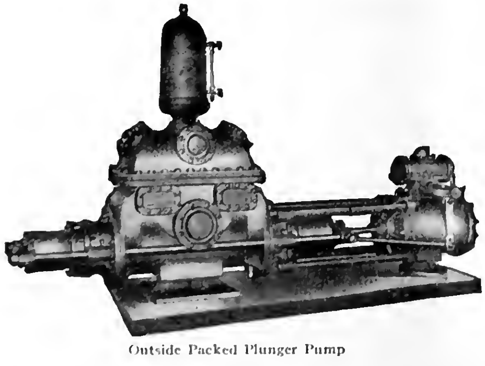
Design, materials, workmanship—all of the best, combine to produce a pump which, especially adapted for the duty required, will give the user the service he has a right to expect.

What are your present pump requirements?

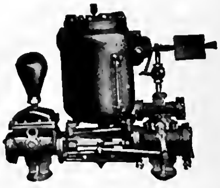

PRESSURE PUMP
Discharge Chamber Pattern

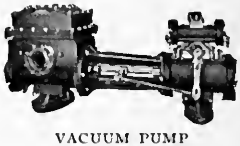

PRESSURE PUMP
Open Front Cylinder


PRESSURE PUMP
Hand Hole Cylinder


Outside Packed Plunger Pump

SPACE 98
(Main Floor)
POWER SHOW
Grand Central Palace
Dec. 7 to 13, 1922


AUTOMATIC RETURN
PUMP AND RECEIVER


VACUUM PUMP
for heating systems, etc

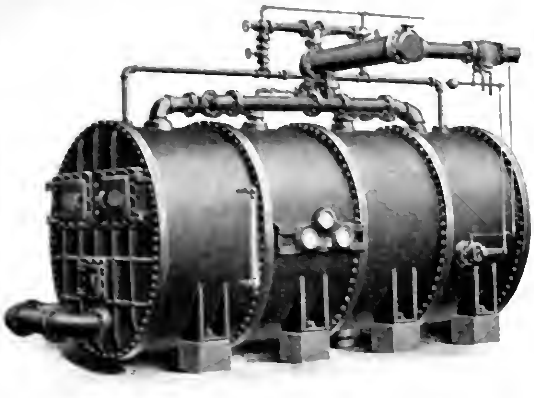
M. T. DAVIDSON COMPANY

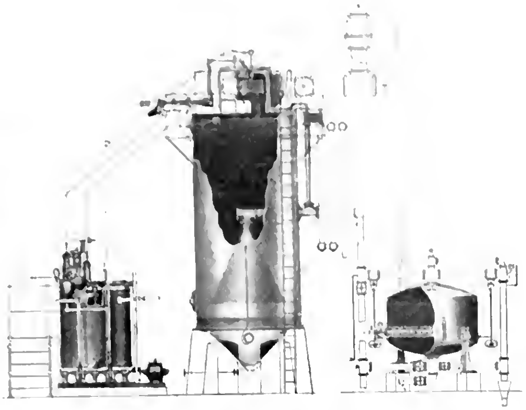
Works: 43-53 Keap Street, Brooklyn, N. Y. **Main Sales Office:** 154 Nassau Street, New York

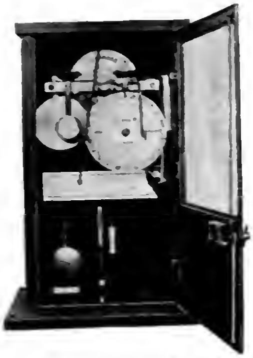
BRANCH OFFICES:

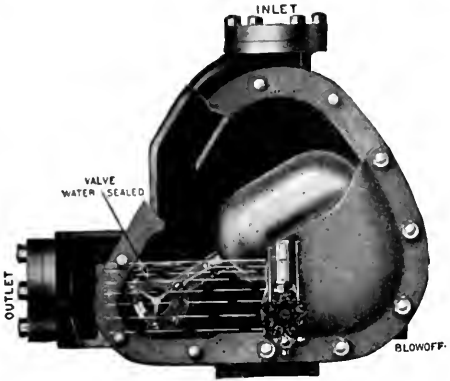
BOSTON: 135 Oliver St PHILADELPHIA: 617 Cherry St. WASHINGTON, D. C.: 817 Albee Bldg.

1224 Granite Bldg., Rochester, N. Y.; 609 Wade Bldg., Cleveland, Ohio; 324 Stimson Bldg., Los Angeles, California; 354 Colman Bldg., Seattle, Washington; Brock Sharp Machinery Co., Jacksonville, Florida; Wm. C. Churchill, 320 Jackson St., Oshkosh, Wisconsin; 604 Empire Bldg., Detroit, Michigan; 11 Church St., Albany N. Y.

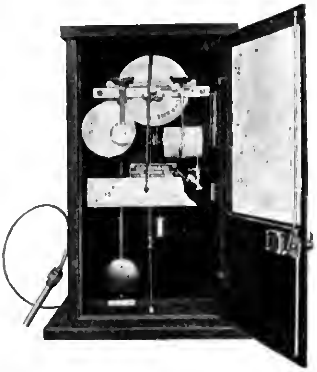

Cochrane Vacuum Deaerating Heater for supplying oxygen-free water at reduced temperatures.


Cochrane Hot Process Softener.

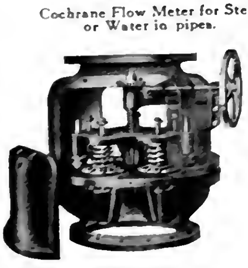

Cochrane V-Notch Recorder combined with Feed Water Thermometer and with circular chart.



The Cochrane Multiport Drainer or Trap


The Cochrane Combined V-Notch Flow Recorder and Recording Thermometer.


Cochrane Flow Meter for Steam or Water in pipes.


Cochrane Multiport Back Pressure Valve.

TO ECONOMIZE—COCHRANIZE

THE novel and improved appliances shown herewith will be exhibited at the **National Exposition of Power and Mechanical Engineering,** at Grand Central Palace, Lexington Avenue and 46th Street, New York City, December 7th to 13th, 1922. The Cochrane **Booth No. 67** is at the left as you come up the stairway from the street.

If you operate a steam plant, if you use live or exhaust steam or hot water, if you wish to meter steam, air or water or to heat, soften or deaerate water to prevent scale or corrosion in boilers, economizers or piping, you will be able to obtain highly interesting and valuable information at the Cochrane Booth.

Meet our engineers and receive copies of our latest literature. If you are unable to come to the Exposition, state which one of the several appliances interests you and we will gladly mail our publications.

H.S.B.W.-COCHRANE CORPORATION

Formerly Harrison Safety Boiler Works

3199 North 17th Street **Philadelphia, Pa.**

Also at Atlanta, Baltimore, Birmingham, Boston, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Greenville, South Carolina; Hazleton, Pa.; Houston, Indianapolis, Kansas City, Little Rock, Los Angeles, Minneapolis, New Orleans, New York, Pittsburgh, Richmond, Rochester, St. Louis, Salt Lake City, San Francisco, Seattle, Syracuse, Tucson, Toronto, Montreal, Halifax.

See This Exhibit

at the

POWER SHOW

Grand Central Palace—New York
December 7th to 13th, 1922

We invite your inspection of the following:

Miniature Boiler in Service demonstrating operation of Bailey Boiler Meter and Bailey Multi-Pointer Gage.

V-Notch Weir Meter in operation with water flowing through glass pipe demonstrating orifice principles.

Indicating and Recording Tachometers.

Gravity Recorders for Liquids (Compensated for Temperature Variations).

Meters for Granular Materials.

Totalizing Boiler Meter (for use on double outlet boilers).

Steam Meters.

Differential Gas Pressure Recorder.

Gas Meter with Pressure Compensator in operation.

Descriptive bulletins describing the various types of Bailey Meters will be sent upon request.

BAILEY METER COMPANY

2009 East 46th Street
Cleveland, Ohio

You'll find us here

POWER SHOW

Grand Central Palace
New York, Dec. 7th to 13th

Over on space 31 Tide Water will have an exhibit of unusual interest. A feature of the display this year will be the continuous daylight projection of our motion picture, "The Story of Tide Water Oil."

From the oil well to the engine room storage tank is a long and eventful journey. Our motion picture spans this gap of time and distance—come with us on a fifteen minute trip through the entire petroleum industry.

Then watch our animated comedy by Tony Sarg. The plot starts in the engine room. Trouble is brewing and the engineer knows it. He knows the reason—improper lubrication. And right here is where . . . . but it is too good to give away. Come and see it. It will test your gravity!

And there will be a warm welcome for all our friends who wish to make their headquarters at our booth.

Remember—Booth 31.

TIDE WATER OIL
SALES CORPORATION
INDUSTRIAL OIL DEPT. 11 BROADWAY, N. Y.

See Our Exhibit—Space No. 85—Main Floor

National Exposition of Power and Mechanical Engineering—Grand Central Palace, New York, Dec. 7-13

FRANCKE

FLEXIBLE COUPLINGS

FOR DIRECT-CONNECTED MACHINES

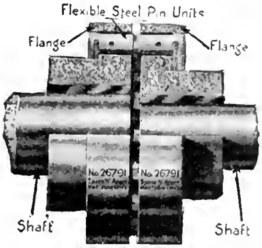
All Metal, Any Size, Any Power, Any Service
"To make good machines last longer"

New Fractional H.P. Type

Small, inexpensive sizes only for small motor driven generators, fans, pumps, sewing machines, and for magneto and pump drives, etc.

Light Duty Type (1921) and Heavy Pattern Type (Since 1912)

In capacities from ⅔ H.P. per 100 R.P.M. and shafts ½" dia. up to 3200 H.P. per 100 R.P.M. and shafts up to 13½" diameter.



For all usual direct connected drives where a flexible coupling should be used to provide for the errors in shaft alignment. Each "FRANCKE" also provides an easy means to line up the connected shafts, it cushions load shocks and vibrations, and it acts as a safety device in case excessive misalignment results from an operating accident.

Double, Floating-Ring Type (1914)

Recommended for continuous process drives and where excessive misalignment is expected.

Has been built and used successfully on drives in capacities up to 8000 H.P. per 100 R.P.M. and for shafts up to 18⅞" diameter.

Marine Type (1912)

Constructed with a center bolt to transmit the thrust and reverse pull from the propeller shaft Small sizes.

New High Speed Type

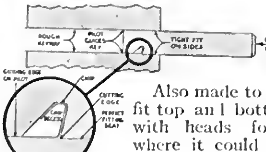
Now being developed and offered for high speed motor and turbine driven herringbone gear units, etc.

A properly sized all-metal "FRANCKE" lasts longer and provides proper flexibility. Is your name on our mailing list?

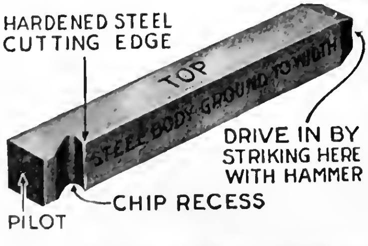
New

the self-fitting key which cuts the cost of all hand-fitting

Drive a "Keytite" into the ordinary keyseat and leave it there. The cutting edge sizes the rough keyways to make a finished fit. Does not require a skilled mechanic and always insures a correct fit.



Also made to cut and fit top and bottom, and with heads for places where it could not easily be drifted out.



KEYTITE

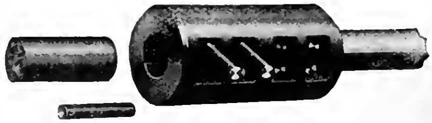
SELF-FITTING KEYS

EVERY KEY SIZES AND FITS ITS OWN SEAT

PINTITE

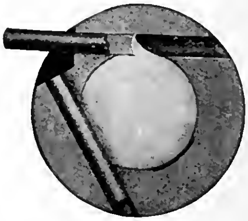
RIGID COUPLINGS

FOR LINE SHAFTING



"Pinned Tight"—These two words tell the grip of a PINTITE on the shafts which it connects—a grip that no service chain can break.

Install with the shaft ends together within the bore of the sleeve and simply drive the cup-ended pins home with a hammer.



Each cup ended, hardened steel pin cuts its own seat in the shaft—a keyway deep enough to hold inflexibly but not deep enough to weaken the shaft.

To remove—Drive pins out backwards using a round end drift. Turn coupling on shafts then drive it off shafts and use again in a new or in the same location.

Since 1917

SMITH & SERRELL

Coupling Specialists Since 1912.

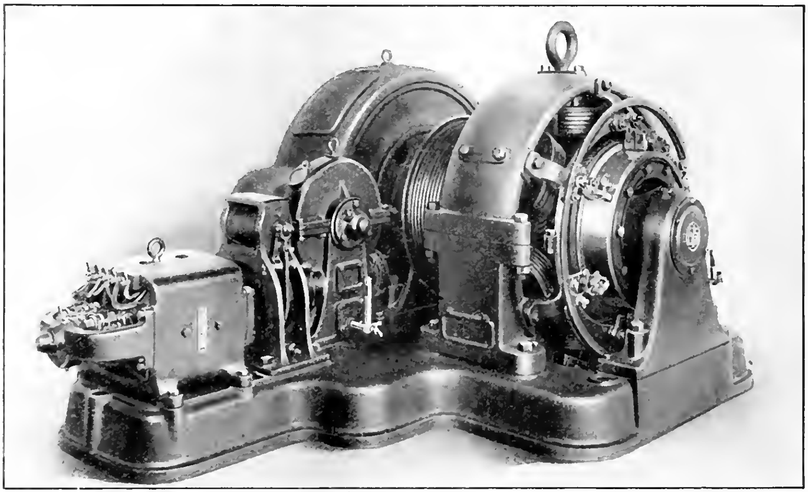
41 Central Ave., Newark, N. J.


M·M

Booth No. 43

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING

Grand Central Palace, New York
December 7th to 13th



YOU are cordially invited to visit our booth and see the latest type of Otis Gearless Traction Micro-Drive Multi-Voltage Elevator Machine in operation. This Machine automatically levels the car platform with the floor landing after the operator has brought the car to a stop within the leveling zone above or below the floor landing. The Multi-Voltage control takes current from the Balancer set in four steps of sixty volts each, and in proper sequence as the motor accelerates to full speed. This form of operation eliminates starting resistance as used with other types of elevators and provides the quickest and smoothest possible acceleration and retardation, and operates more economically than any other type.

The Exhibit consists of the complete electrical and mechanical equipment used with this type of elevator and includes the hoisting machine, motor, controller, balancer set (one set will operate a number of elevators) the car operating switch, micro-leveling switch, stopping switch, speed governor and car safety devices.

OTIS ELEVATOR COMPANY

Offices in All the Principal Cities of the World

See Our Exhibit
Booth 36
National Exposition of Power and Mechanical Engineering

See our moving Bulletin Machine displaying installations of materials we manufacture — also Model Boiler showing Mono Baffles installed.

FLAME BRAND
HIGH TEMPERATURE CEMENTS
AND
"MONO" TRADE MARK BOILER BAFFLING

RED FLAME PLASTIC CEMENT
WHITE FLAME INSULATING CEMENT
BLUE FLAME FIRE BRICK CEMENT
PLASTIKDO REPAIRING CEMENT
RAMIT FOR RAMMED-UP LININGS

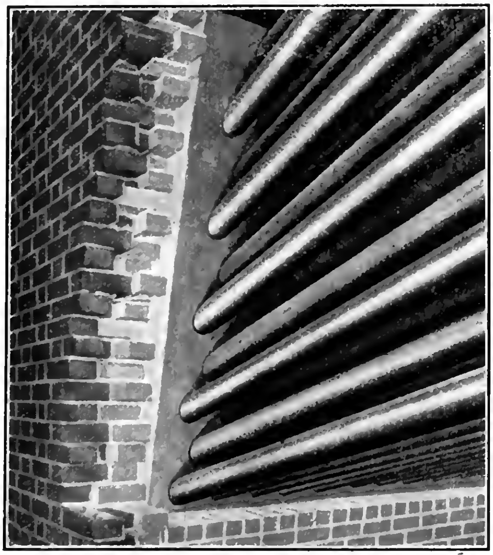
"MONO" Boiler Baffling
Reduces Fuel Waste
and Increases the Efficiency

because it is built in *one solid monolithic piece* and hugs the tubes and walls closely, regardless of the angle at which it is set. It will not spall or crack, and is not damaged by the withdrawal and replacing of tubes when ordinary care is taken.

"Mono" Boiler Baffling may be installed in any position, in any boiler; no heat is required to set the material; and it should last as long as the boiler itself.

Do *you* know at what temperature the gases are leaving *your* boilers? And what the temperature *should be* at different pressures and ratings? Undoubtedly the conditions could be improved by better baffling.

The services of our Engineering Department are at your disposal.



The illustration above shows a first pass "Mono" baffle as seen through an opening in the side wall, looking toward the rear of the boiler. Note the absolutely monolithic construction—the close fit around tubes and against the walls—and the entire freedom from any possibility of leakage.

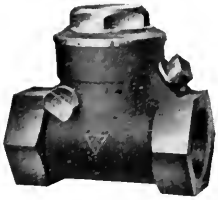
KING REFRACTORIES COMPANY, Inc.

New York Office: 707 Greenwich Street
Main Office and Works: 1709-1715 Niagara Street, Buffalo, N. Y.
Boston, Pittsburgh, Detroit *Offices in all principal cities* Philadelphia, Cleveland, Chicago

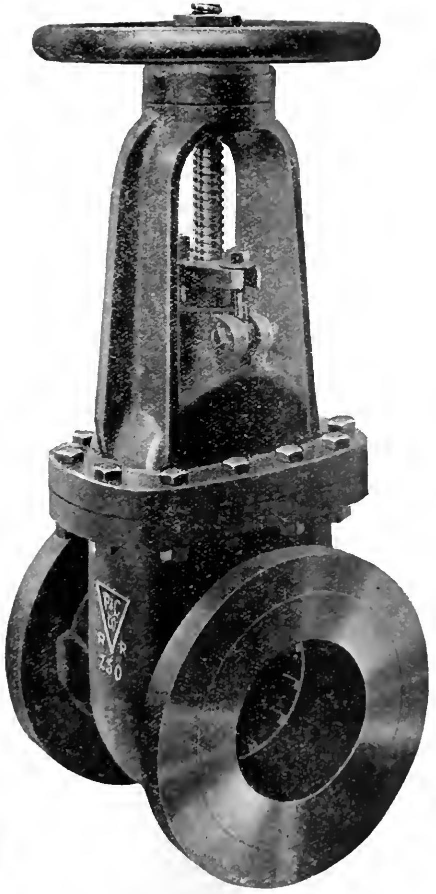
PRATT & CADY VALVES

Bronze Globe and Angle Valves

Bronze Gate Valves



Bronze and Iron Swing Check Valves



Iron Body Gate Valves

These valves will be shown at Booth 44B, National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, December 7th to 13th.

THE Pratt & Cady line of brass and iron valves and asbestos packed cocks offers a valve for your every need where the working conditions involve pressures up to 250 lbs. and temperatures up to 500° F; also hydraulic valves for pressures up to 800 lbs.

Since 1878 our policy has been to manufacture valves "as near perfect in design, material and workmanship as shall make them merchantable and of a character that will establish for this company a high reputation."

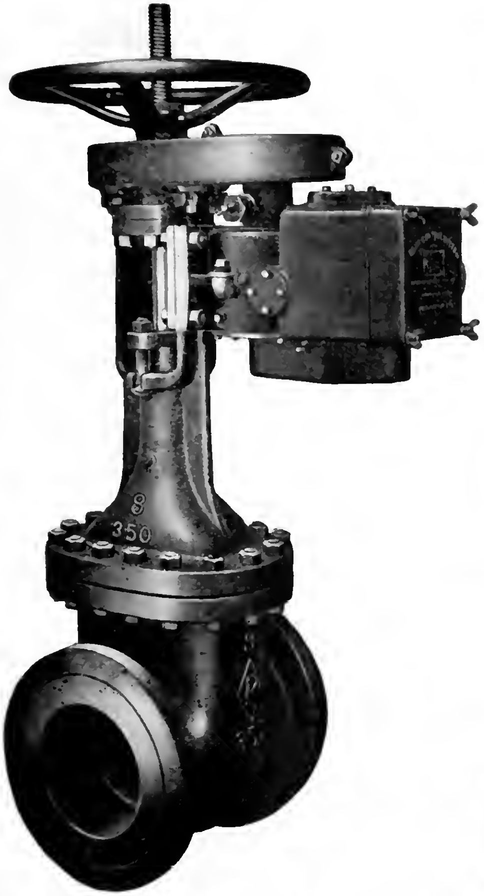
Following this policy we have built into all our valves renewable features that can actually be realized on under service conditions without removing the valve from the line.

Iron Asbestos Packed Cocks

READING STEEL

BRIDGEPORT

SAN FRANCISCO PHILADELPHIA ST. PAUL PITTSBURGH CHARLOTTE CLEVELAN



See Our Exhibit

Booth No. 41

National Exposition of Power and Mechanical Engineering

Grand Central Palace
New York, N. Y.
Dec. 7th to 13th

FURNACE ENGINEERING

that insures Maximum Efficiency

There will be a model on exhibition showing our various types of furnace equipment.

Are YOU getting *maximum* Furnace Efficiency?

Our Furnace Equipment is designed to give the greatest efficiency and to reduce to a minimum the shutting down for repairs.

All materials used in our Furnace Equipment are made from the most suitable grades for the various requirements and are carefully inspected and gauged before shipment. Thus our clients are assured of proper fitting equipment necessary for good service.

This service is backed up by an organization of experienced engineers with a record of successfully installing and operating various types of mechanical stokers and other furnace equipment.

Our Policy and Practice

is to improve the vital parts of Mechanical Stokers and to give our client unbiased common sense engineering.

Consult us on your boiler room problems.

Some of Our Installations

Monongahela Power & Railway Co.
United Electric Light & Power Co.
Consolidated Power Co.
West Penn Power Co.
New York Edison Co.
Public Service Electric Co.
American Gas & Electric Co.
Central Illinois Light, Heat & Power Co.
Richmond Light & Power Co.
Hudson Motor Co.
General Motors Co.
Firestone Tire & Rubber Co.

If you are not able to visit our exhibit write to us or our nearest branch for information about our furnace equipment.

FURNACE ENGINEERING COMPANY, INC.

5 Beekman Street New York, N. Y.

Branch Service and Sales Offices

BOSTON PHILADELPHIA PITTSBURGH MONTREAL CLEVELAND CHICAGO DETROIT

First Large Plant Using Pulverized Coal Exclusively is Equipped with Edge Moor Boilers

Installation at Lakeside Plant of Milwaukee Electric Railway and Light Co. shows highest efficiency among Central Stations

Lakeside Plant of the Milwaukee Electric Railway & Light Co.—the largest central station in the world using pulverized coal exclusively

EIGHT 1306 H. P. Edge Moor Water Tube Boilers supply steam for the Lakeside plant—the largest power plant in the world using pulverized coal exclusively.

The boilers are operated normally at 250% of their rated capacity. At this output three boilers are sufficient to operate each of the two 20,000 K. W. turbines.

In a series of fifteen tests, the average efficiency of boilers, super-heaters and economizers was 87.3%. An efficiency of 85.6% has been obtained from the boilers alone.

Boiler room at Lakeside Plant Eight 1306 H. P. Edge Moor Boilers in two rows of four each.

Flue gas analyses show average results of about 14.5% CO_2.

The success of this installation is typical of the performance of Edge Moor Water Tube Boilers. Operators of large and small plants find in Edge Moor Boilers a new means of effecting worth-while economies.

The Milwaukee Electric Railway and Light Company has installed 67 Edge Moor Boilers totaling 45,394 H. P. in its various plants, representing 23 separate orders.

The new Edge Moor catalogue contains information of value to every plant operator. Have you received your copy?

Two of the 5-drum, 4-pass Edge Moor Boilers during erection, Lakeside Plant.

EDGE MOOR IRON COMPANY
Established 1868
EDGE MOOR, DELAWARE

New York
Chicago
St. Paul

Boston
Pittsburgh
Charlotte

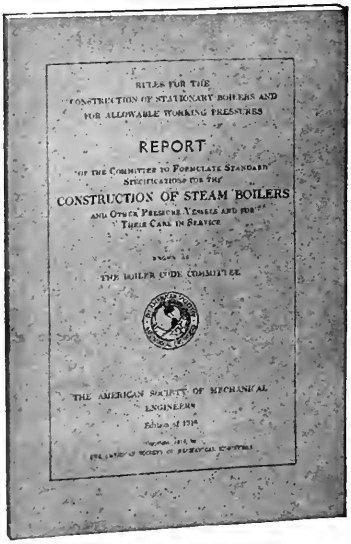
See Our
Data In 1922
A.S.M.E.
Condensed
Catalogues.

EDGE MOOR
Water Tube BOILERS

FOR INCREASED FUEL ECONOMY

A.S.M.E.

Boiler Code


RULES FOR THE
CONSTRUCTION OF STATIONARY BOILERS AND
FOR ALLOWABLE WORKING PRESSURES

REPORT

OF THE COMMITTEE TO FORMULATE STANDARD
SPECIFICATIONS FOR THE
CONSTRUCTION OF STEAM BOILERS
AND OTHER PRESSURE VESSELS AND FOR
THEIR CARE IN SERVICE

ISSUED BY
THE BOILER CODE COMMITTEE

THE AMERICAN SOCIETY OF MECHANICAL
ENGINEERS
Edition of 1918

1918 Edition

147 Pages, including appendix and index—35 Illustrations

Price $1.00 75c. to members

A REPORT containing standard specifications for the construction, equipment and use of steam boilers, and embodying the collective knowledge of the world's leading experts.

The A.S.M.E. Boiler Code is now operative as a legal construction code in the states of Arkansas, California, Delaware, Indiana, Maryland, Michigan, Minnesota, Missouri, New York, New Jersey, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Utah and Wisconsin. It is also used as a standard by fifteen of the leading boiler insurance companies, leading boiler manufacturers and by many of our foremost consulting engineers. The U. S. Government now specifies that boilers for many important Departments are to be constructed in accordance with the A.S.M.E. Boiler Code.

Interpretations of the Boiler Code

The Boiler Code Committee meets monthly for the purpose of considering inquiries and rendering interpretations relative to the Boiler Code. When approved by the Council of the Society, these interpretations are published in MECHANICAL ENGINEERING and subsequently issued in data sheet form for convenience of reference.

The interpretations which have been issued by the Committee to date—nearly 400—cover matters of setting, erection and suspension, piping connections, as well as constructural details, and thus embrace a very valuable fund of information to everyone interested in steam boiler construction.

In view of the increasing recognition of the value of these interpretations to boiler manufacturers and users alike, and the fact that they are universally accepted in the seventeen states and ten cities in which the A.S.M.E. Boiler Code is operative, it is felt that many users of the Code will be desirous of keeping in close touch with the rulings made by the Committee and The Society is now prepared to furnish these interpretations regularly as issued following the meetings of the Boiler Code Committee. **The Subscription price is $1.50 per annum.**

Complete sets of Interpretations from Case No. 200 to date are also obtainable at $1.50 a set (To members $1.25).

OFFICIAL BOILER STAMPS

Stamps for impressing the official symbols on power boilers as shown in Fig. 23 (page 87 of the Boiler Code, Edition of 1918), are obtainable only from THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (see Par. 332, Boiler Code). The stamps are obtainable in two forms, one, the regular hand stamp with ¾ in. symbol, at $3.00 each, and the other, a special hammer-type stamp, with ½ in. symbol at $3.00 each. The hammer-type stamp is particularly serviceable for stamping thin boiler plate.

It is the requirement of the Boiler Code Committee that the boiler manufacturer in purchasing the official boiler stamp shall furnish an Affidavit on a special blank form obtainable from the headquarters of the Society. It is expected that the order for each stamp purchased shall be accompanied by one of these Affidavits properly filled out and with the signature of the company officially acknowledged by a Notary Public. This requirement for the stamp is solely for the purpose of safeguarding the use of the stamp in certifying that power boilers are built to the requirements of the A.S.M.E. Boiler Code.

Manufacturer's Data Report Forms

Manufacturer's Data Report Forms are also offered for sale for the convenience of manufacturers who desire to enter power boilers in different states where the A.S.M.E. Boiler Code is operative. These blank forms are available at the following prices:

Single Copies 5c each
In lots of 6– 24....3c each
In lots of 25–100...2c each
In lots of 100 or more 1½c each

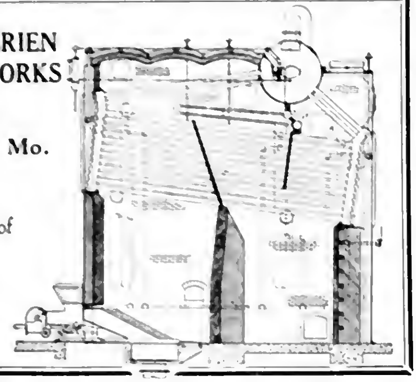
The American Society of Mechanical Engineers
29 West 39th Street, New York, N. Y.

JOHN O'BRIEN BOILER WORKS CO.

St. Louis, Mo.

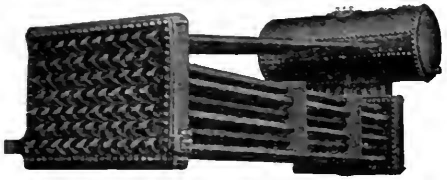
Four Types of

WATER TUBE BOILERS



J. F. DAVIS & SONS COMPANY

1122-1123-1124 Harris Trust Bldg.
111 W. Monroe St.
CHICAGO, ILL.
STEAM BOILER HEADQUARTERS



Water Tube
Cross Drum
2 Return Tubular

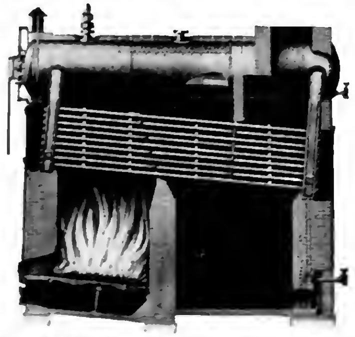
BOILERS

Plant at
West De Pere
Wisconsin

KEELER

BOILERS,

WATER TUBE AND RETURN TUBULAR



ARE RELIABLE AND SAFE

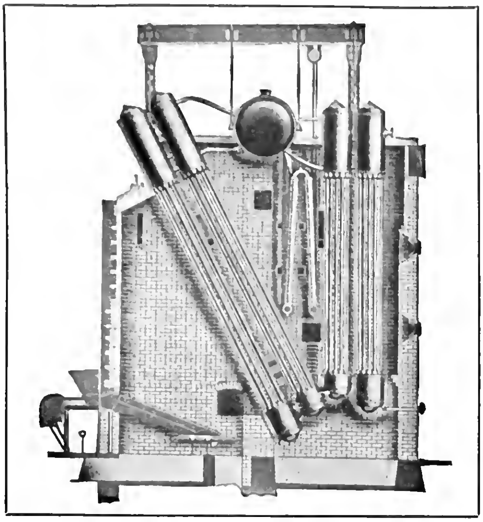
No Keeler boiler has ever exploded.
ECONOMICAL: cost of upkeep phenominally low.
EFFICIENT: numerous tests tell
Catalog of either type on request.

E. KEELER CO., Williamsport, Penna.

BRANCHES: NEW YORK PHILA. BOSTON BUFFALO PITTSBURGH CHICAGO

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

A Big Factor In Plant Economy



BIGELOW-HORNSBY
WATER-TUBE
BOILERS

will save money in steam production. Better furnace design with ample combustion space for the gases, the extra large percentage of direct heating surface exposed to the fire with assured unrestricted circulation and a 100 per cent tube area steam release establish ideal operating conditions.

Their actual economy records speak for themselves. Investigate. Send the coupon.

The Bigelow Company
20 Lloyd St., New Haven, Conn.
New York Boston

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

12-22

Date...............................

The Bigelow Company
20 Lloyd Street
New Haven, Conn.

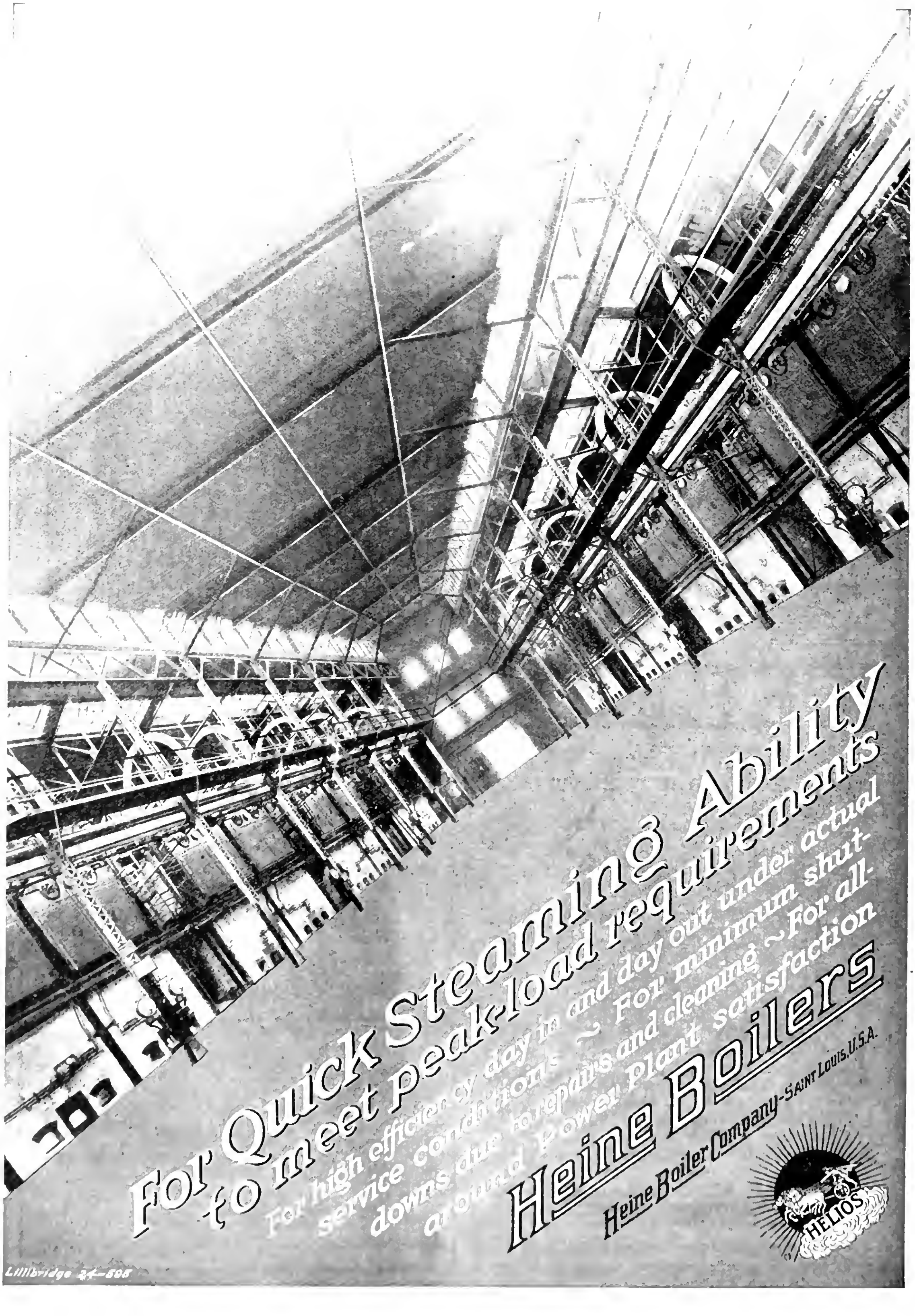
Gentlemen:

Please send me a copy of your Catalog on Bigelow-Hornsby Water Tube Boilers.

Name...............................

Address...............................

Post Office...............................


For Quick Steaming Ability
to meet peak-load requirements
For high efficiency day in and day out under actual
service conditions ~ For minimum shut-
downs due to repairs and cleaning ~ For all-
around Power Plant satisfaction
Heine Boilers
Heine Boiler Company-Saint Louis, U.S.A.
HELIOS
Lillibridge 24-808

T I T U S V I L L E

TITUSVILLE HORIZONTAL TUBULAR BOILERS FOR STEAM HEATING

Constructed in exact accordance with the A.S.M.E. Boiler Code.

Designed for a maximum working pressure of fifteen pounds to the square inch.

Subjected to a hydro static test pressure of sixty pounds before shipment.

Catalogue sent on request.

TITUSVILLE IRON WORKS COMPANY
TITUSVILLE, PA.

New York Detroit Pittsburgh
Chicago Buffalo Washington

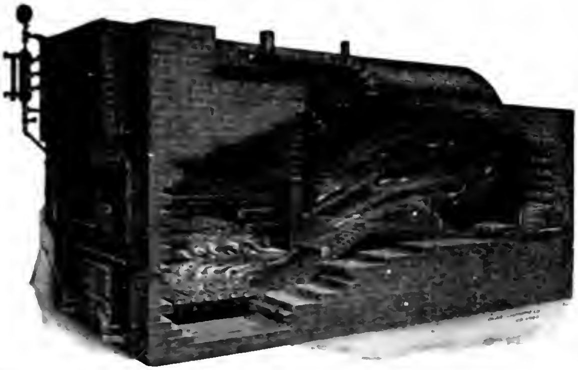
See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment

B O I L E R S

HORIZONTAL RETURN TUBULAR BOILERS

These boilers are constructed of high grade materials in full accordance with the A.S.M.E. Code. Standard settings can be provided with stationary or shaking grates, and when desired, standard steel casings can be provided for these settings. Liberal proportions of heating surface, steam space and grate area. Regularly manufactured in units up to 250 h p.; and for steam pressure of 200 lbs. per square inch. Further information regarding Cole Boilers, Tanks, Plate Work, etc., will be found on page 49 of the 1922 volume, A.S.M.E. Condensed Catalogues.

R. D. Cole Mfg. Co. **Newnan, Georgia**



Herbert Smokeless Boilers

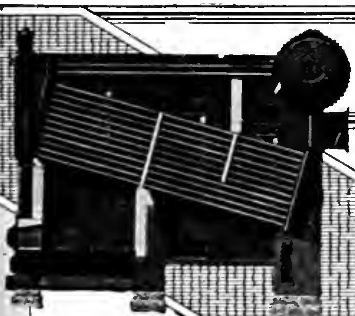
Down Draft **Detachable Firebox**

An absolutely smokeless boiler that is guaranteed to consume 95% of smoke from any grade of mine coal and to increase the boiler capacity from 5 to 25 h. p., depending on size.

HERBERT BOILER CO., Chicago

New York City St. Louis, Mo., Minneapolis, Minn., Atlanta, Ga.
Omaha, Neb., Milwaukee, Wis., Seattle, Wash., Denver, Colo.
Salt Lake City, Utah Oklahoma City, Okla. Wichita, Kan.
Spokane, Wash. Montreal, Canada Toronto, Canada

A.S.M.E. CODE BOILERS



The Casey-Hedges Boilers

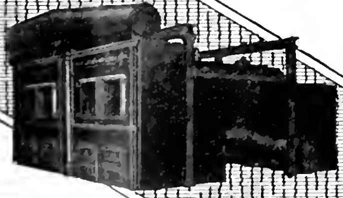
are the result of years of experience in the design and construction of all types of boilers. They are built to conform with the standards of the A. S. M. E. Boiler Code—they are safe, economical and durable.

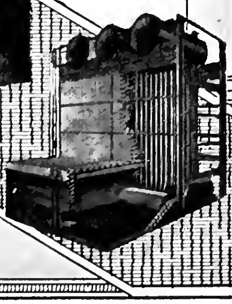
They are efficient and durable

All types of Casey-Hedges Boilers are designed to give the maximum of horse power with the minimum of fuel consumption.

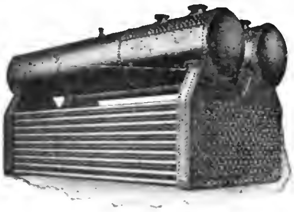
Let our engineering department assist you in selecting your next unit.

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment

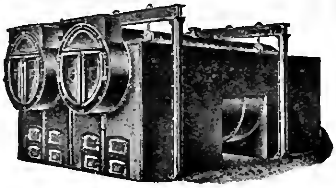


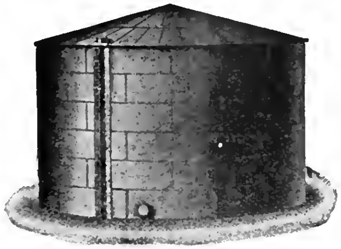


The Casey-Hedges Co.
Chattanooga, Tenn.
CHICAGO NEW YORK HABANA



A.S.M.E. CODE BOILERS





"W & W" Boilers are built—for high efficiency—for high pressure—for high rating.

"W & W Boilers conform to A.S.M.E. Code, and are economical, durable and safe.

The WALSH & WEIDNER BOILERS

All types of "W & W" Boilers are built to obtain the highest efficiency in conjunction with durability and a minimum cost of up-keep.

Before ordering your next unit—let us give you figures.

The WALSH & WEIDNER BOILER COMPANY

CHATTANOOGA, TENN.

New York New Orleans Jacksonville Memphis Havana Kansas City San Francisco

---

WICKES

VERTICAL

TRADE-MARK

REDUCE

Boiler Room Costs!

Use the Coupon

THE WICKES BOILER CO.

SAGINAW MICHIGAN, U. S. A.

SALES OFFICES

New York, 501 Fifth Ave.
Pittsburgh, 1218 Empire Bldg.
Chicago, 76 West Monroe St.
Detroit, 1116 Penobscot Bldg.
Seattle, 736 Henry Bldg.

The Wickes Boiler Co.
Saginaw, Michigan.

Gentlemen: Without obligation on my part, I would like to read your educational technical bulletins as checked:

Bulletin 2. The Steam Boiler Analyst.

Bulletin 3. Reducing Costs in the Boiler Room.

Bulletin 4. Magnitude and Prevention of Air Infiltration Losses.

Bulletin 5. Saving Coal in Steam Power Plants.

Bulletin 6. The Utilization of Waste Heat for Steam Generation.

Name ....

Business Address ....

Home Address ....

Date ....

D A.S.M.E.—22

UNION BOILERS

WATER TUBE and FIRE TUBE

Design, Workmanship and Materials of the Highest Grade

We solicit your inquiries

UNION IRON WORKS

ERIE, PA.

(*See Our Data in* 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

See our exhibit at the
NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING
Grand Central Palace, New York
December 7th to 13th

THE GEORGE T. LADD COMPANY

First National Bank Building
Pittsburgh, Penna.

Chicago Office
McCormick Bldg.

New York Office
18 Warren Street

(*See Our Data in* 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

Foster Protected Surface

While a superheater is a relatively small part of a power plant, its reliability determines its continued operation and is therefore important.

The reliability of Foster Superheaters is assured by the well known Foster protected surface, consisting of a steel tube for strength and cast iron protecting rings for ruggedness and greatest possible superheating surface.

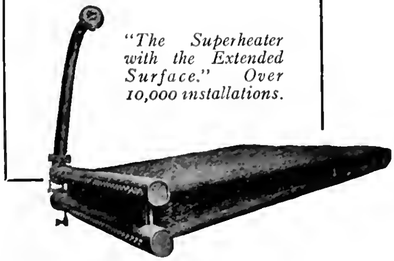
The outer cast iron surface not only steadies the degree of superheat obtained, but also prevents burning out of the superheater elements and protects the steel tubes from the corrosive effects of the furnace gases. The protection which it affords is so complete that the life of a Foster Superheater is greater than that of the boiler to which it is attached.

The reliability of Foster Superheaters is being proven daily in thousands of power plants all over the country. Send for the Foster Superheater Book. It explains in detail the benefits of superheat and describes the Foster patented construction that assures these benefits with greatest reliability and least maintenance expense.

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment.

Advantages of Foster Superheaters

1. Steel for strength, cast iron for durability.
2. Four to six times as much heat-absorption surface as obtained from bare tubes.
3. Reserve heat stored for sudden demands.
4. Steam stays close to the hot tube surface.
5. Great flexibility of design.



"The Superheater with the Extended Surface." Over 10,000 installations.

POWER SPECIALTY COMPANY
111 Broadway, New York
Boston Philadelphia Pittsburgh Chicago San Francisco
Kansas City Dallas London, England
Plant at Dansville, N. Y., and Egham, England

FOSTER SUPERHEATERS

ELESCO

SUPERHEATERS

For any size or type boiler—Close temperature regulation.
Send for Bulletin FT-7

THE SUPERHEATER COMPANY

General Offices: 17 East 42nd St., New York

Chicago: Peoples Gas Bldg. Pittsburgh: Union Arcade Bldg.
For Canada: The Superheater Company, Ltd., Montreal.

THE HEINE CHIMNEY CO.

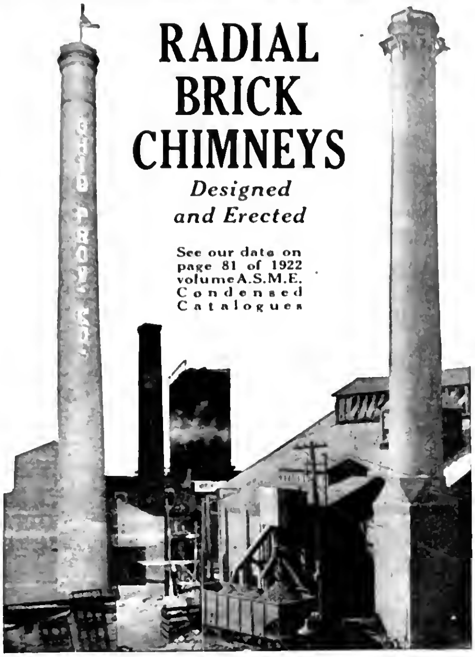
ENGINEERS and BUILDERS

RADIAL BRICK
and
CONCRETE CHIMNEYS

Chicago, Ill.
123 W. Madison St.

New York, N. Y.
30 Church St.

Branch offices in all principal cities



RADIAL
BRICK
CHIMNEYS

*Designed
and Erected*

See our data on
page 81 of 1922
volume A.S.M.E.
Condensed
Catalogues

AMERICAN CHIMNEY CORPORATION

147 Fourth Avenue, New York
BOSTON PHILADELPHIA CLEVELAND CHICAGO

Classified Advertisements

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a Classified Advertisement in Mechanical Engineering for quick results.

...RATES...

40 cents a line; 30 cents a line to members of A.S.M.E. (Minimum insertion, 5 lines; maximum, 20 lines. No display matter carried.)

Address

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street
New York City

THE BABCOCK & WILCOX COMPANY

85 Liberty Street, New York

Builders since 1868 of Water Tube Boilers of continuing reliability

BRANCH OFFICES

Boston, 49 Federal Street
Philadelphia, North American Building
Pittsburgh, Farmers Deposit Bank Building
Cleveland, Guardian Building
Chicago, Marquette Building
Cincinnati, Traction Building
Atlanta, Candler Building
Tucson, Ariz., 21 So. Stone Avenue
Dallas, Tex., 2001 Magnolia Building
Honolulu, H. T. Castle & Cooke Building

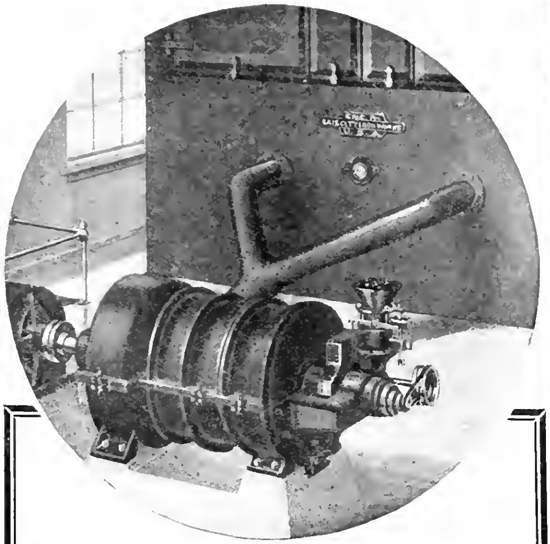
THE BABCOCK & WILCOX COMPANY
STEAM

WORKS
Bayonne, N. J.
Barberton, Ohio

Makers of Steam Superheaters since 1898 and of Chain Grate Stokers since 1893

BRANCH OFFICES

Detroit, Ford Building
New Orleans, 521-5 Baronne Street
Houston, Texas, Southern Pacific Building
Denver, 435 Seventeenth Street
Salt Lake City, 705-6 Kearns Building
San Francisco, Sheldon Building
Los Angeles, 404-6 Central Building
Seattle, L. C. Smith Building
Havana, Cuba, Calle de Aguiar 104
San Juan, Porto Rico, Royal Bank Building



The Use of Pulverized Coal Results in Large Savings

With Erie City Pulverized Coal Equipment it is possible to maintain an overall efficiency of 80% or more. This constitutes a big economy in fuel to begin with. The pulverized coal burns practically like gas or oil. Coals with low B.t.u. content, high in sulphur, and with high or low fusing ash may be utilized.

No pulverized coal is kept in storage—it is pulverized only as used. Changing load demands are taken care of by the perfect flexibility of the system. Smokeless combustion is assured. No clinker or slag troubles. No standby losses. Low draft requirements. Lowest labor cost. No cleaning of fires. Absolute control of CO_2. Low maintenance expense—entire mechanism outside of combustion space. Adaptable to any size plant—all boiler installations. One type of machine for all kinds of bituminous coal. Driven by motor, steam turbine, or provision can be made for driving by means of a belt.

Investigate Erie City Equipment

ERIE CITY IRON WORKS
ERIE, PA., U. S. A.

Manufacturers also of Erie City Water Tube, and Return Tubular Boilers, The Lentz Engine, and other products, as shown on pages 54 and 55 of the 1922 A.S.M.E. Condensed Catalogues.

Save Auxiliary Power

GREEN'S
HI EFFICIENCY HI-SPEED
RADIAL FLOW FANS

For
MECHANICAL DRAFT
GREEN'S
RADIAL FLOW
AND
STEEL PLATE FANS
MEET MODERN BOILER ROOM REQUIREMENTS

BULLETIN No. 127 - - STEEL PLATE
BULLETIN No. 152 - - RADIAL FLOW

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

THE GREEN FUEL ECONOMIZER CO.
BEACON, N.Y.

PIPE and FITTINGS

For all uses

BAROMETRIC CONDENSERS

GAS PRODUCERS

HEAVY CASTINGS
Chemical Sugar House
Miscellaneous

United States Cast Iron Pipe and Foundry Co.
General Office, Burlington, N. J.
SALES OFFICES
Philadelphia, Pittsburgh, Cleveland, Cincinnati
Chicago, St. Louis, Buffalo
New York, Birmingham, San Francisco, Kansas City
Minneapolis, Dallas

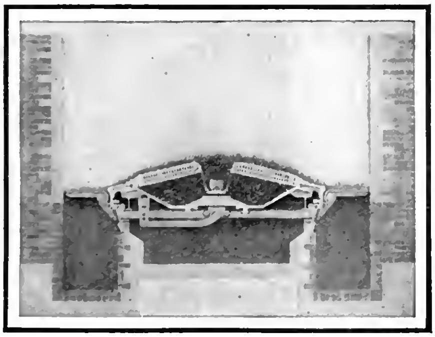
Announcing a great advance in stoker building

The Lateral Retort Stoker

TRADE MARK

Multiple retort efficiency with single retort simplicity—that is the gift of the Lateral Retort Stoker to the power plant world

THE view above shows how the multiple retort effect is obtained in an extremely simple way. Coal is fed lengthwise into the main retort by the strokes of a steam operated ram. It is then distributed sidewise into the several lateral retorts. Only two steam cylinders and moving units are used, and the few moving parts are never subjected to the heat of the furnace — yet note how this firing method attains a degree of efficiency never before equaled in a stoker of equal simplicity.



The coal is under-fed throughout. Although a side dump is employed, the fuel is not overfed onto side grate bars as in former side dump stokers. It is under-fed, not only to the main retort, but also to each lateral retort. The advantages of underfeed combustion are retained—distillation of volatiles is slow and thorough; coking is complete. This insures highest combustion efficiency, and the large reserve fuel capacity of the retorts insures heavy overload capacity and ability to handle sudden peak loads.

The coal feed to the main cylinder and to the lateral retorts is controlled separately, insuring an even fuel bed and increased flexibility.

By applying the multiple retort principle to a side dump stoker the necessity for excavation and basement ash pits is eliminated. This makes the installation cost extremely low. Also it makes the stoker adaptable to old boilers without making expensive changes.

How extreme simplicity made possible by this revolutionary basic principle, has produced a high duty multiple retort stoker that can be installed at a moderate cost is told in a new catalogue. Write for it.

SANFORD RILEY STOKER CO.

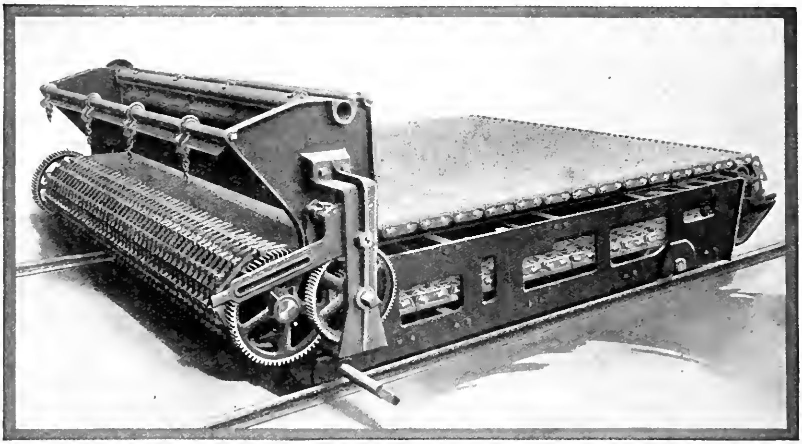
WORCESTER, MASS.

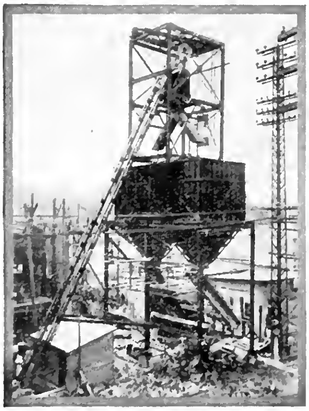
"RILEY" Underfeed Stokers "JONES" Underfeed Stokers

"MURPHY" Automatic Furnaces

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT
CHICAGO ST. PAUL THE UNDER-FEED STOKER CO OF CANADA, LTD., TORONTO DENVER CINCINNATI

A Common Sense Balance





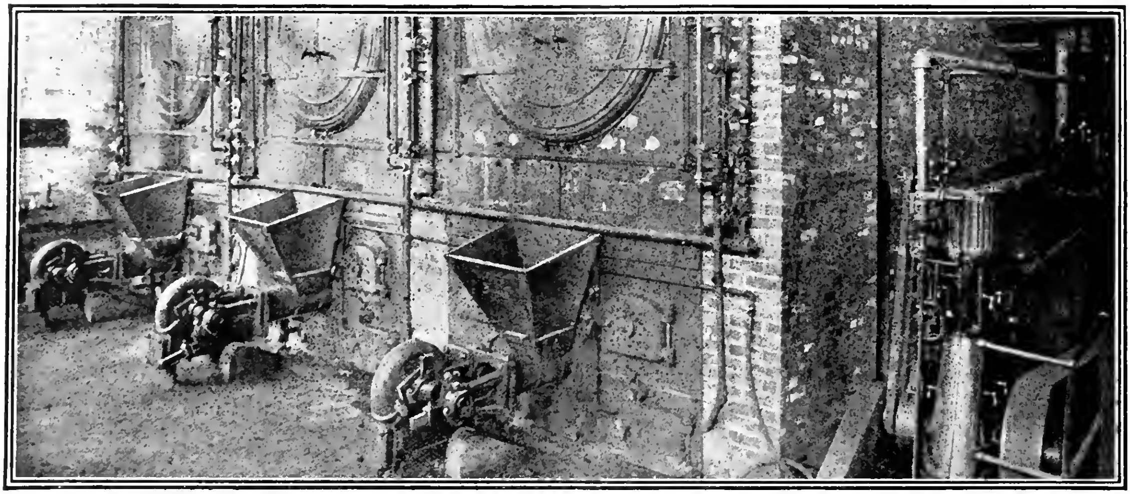
Green Cast-Iron Hoppers

solve the problem of transfer and storage of ash from the boiler room. They are adaptable to practically any plant layout. Easily and quickly erected by unskilled labor. Contents are instantly discharged into truck or railroad car thus eliminating rehandling charges.

INTERNATIONAL COMBUSTION

Green Chain

Detroit Single Retort Underfeed Stokers can be Installed Profitably Under Tubular Boilers



Tubular Boilers fired by Detroit Single Retort Underfeed Stokers

Take the case of two power plants of approximately equal size and capacity. One of them had hand-fired furnaces, under tubular boilers, and the bad conditions of this type of firing had a psychological effect on those working in the boiler room. The place was in a generally ill-kept and unsatisfactory condition. The other plant, which also had tubular boilers, was equipped with mechanical stokers, and, perhaps, because the attainment of efficiency in combustion stimulated the firemen to better work all around, the boiler room was in first class condition. The first plant was using one and one half times as much coal as the second, and because of lack of efficiency in the boiler room, the cost of steam generation was actually twice the cost of production in the second plant.

When stokers were finally installed in the inefficient plant it was found that a cheaper grade of fuel than had previously been used could be burned, and that, due to the uniformity with which the stoker fed the fuel, the proper proportioning of air for combustion, the absence of large amounts of excess air, etc., it was possible to maintain a uniform boiler efficiency of approximately 70 per cent, whereas 55 to 60 per cent had been the rule before. The same amount of steam was generated with considerably less coal.

With the installation of the stokers, a transformation took place in the boiler room. The firemen began to display a hearty interest in their work. As a net result the cost of producing steam in the plant was reduced something like 50 per cent.

Ask for your copy of "Cutting the Cost of Producing Steam." It describes Detroit Single Retort Underfeed Stokers and tells the story of the two plants mentioned in this advertisement in detail. Request Bulletin 228

DETROIT STOKER COMPANY

Underfeed Forced Draft and Overfeed Natural Draft Stokers

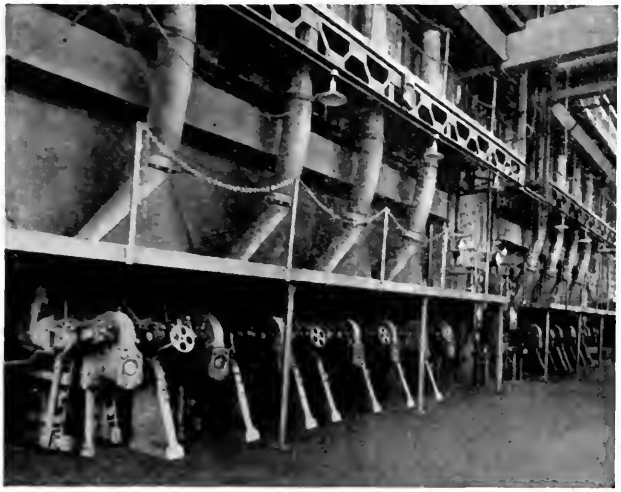
228 GENERAL MOTORS BUILDING DETROIT, MICH.

DETROIT UNDERFEED STOKERS

CLEANING THE FIRE

The Taylor Stoker was the first underfeed stoker on which the ashes were discharged at the rear. Coupled with this, it was the first underfeed stoker which automatically cleaned its own firebed.

Notice how many stokers now include this idea.



Firing aisle in the Delaware station of Philadelphia Electric Co. where Taylor Stokers now serve eight boilers of 1508 rated horse power each and four boilers rated at 1427 horse power per unit.

This is one of four large plants in the Philadelphia Electric Co. system supplying light and power to the most concentrated and diversified manufacturing center in the world. Its design is the result of the long experience of the Philadelphia Electric Co's engineers in production of power.

The Taylor Stoker

Has seen service in the various plants of the Philadelphia Electric Company system since 1908, when the first installation was made in the Schuylkill Station. The original installation and repeat orders make the records read like this:

1908—1909—1911—1912—1913—1914—1916—1917—1919—1922

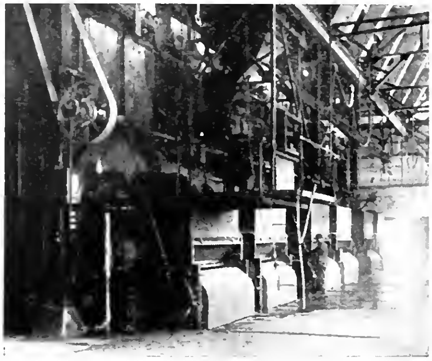
Making a total of 82 Taylors serving more than 76,000 rated boiler horse power.

Money can't buy a better stoker

Ask today for a copy of our new booklet, The Rotary Ash Discharge

American Engineering Company
Philadelphia

Manufactured in Canada by
TAYLOR STOKER COMPANY, LTD., TORONTO, ONT.
Principal Sales Office: 416 *Phillips Place, Montreal, Que.*



efficiency 79.7%

—*another triumph for dampered air control*

BEAT it if you can—that record of 79.7% efficiency—but use an Illinois Stoker if you really want to succeed!

This remarkable record is the result of a thirteen hour test of two of the six 8 x 12 ft. Type G Illinois Forced Draft Stokers installed under 421 hp. horizontal water tube vertically baffled boilers in the plant of the Imperial Oil Co., Ltd., Sarnia, Canada, as shown in the illustration above.

A heavy snow and sleet storm, accompanied by a freezing temperature, raged throughout the test; yet, when the final calculations were made, there it was in black and white fully supported by complete, accurate entries—a combined efficiency of practically 80%.

This highly significant test raises a question that you should be able to answer:

Could this high efficiency have been attained without the Illinois system of dampered air control—could it have been approached without other equally famous Illinois features?

We'll leave it to you.

The new Illinois Catalog L will help you to arrive at the correct answer. It describes Type A (natural draft) and Type G (forced draft) Illinois Stokers.

ILLINOIS STOKER CO.
102 West 7th Street, Alton, Ill.

Chicago: Ernest E. Lee Co., 115 S. Dearborn St.
Kansas City: J. F. Pritchard & Co., Reliance Bldg.
New York. H. G. Meissner, 141 Broadway.
Indianapolis R. H. Bennett, 305 Merchants Bank Bldg.
Minneapolis H. R. N. Johnson, 917A Marquette Ave.
Denver. A. B. Kennedy, Engineer's Bldg.

ILLINOIS
CHAIN GRATE
STOKERS
With Dampered AIR CONTROL

SIL-O-CEL

PREVENTS HEAT PENETRATION

TRADE MARK REGISTERED U.S. PATENT OFFICE

A CELITE PRODUCT

Concentration of heat where heat is wanted—

Control of heat where control is needed—

Utilization of heat units for the purpose intended—

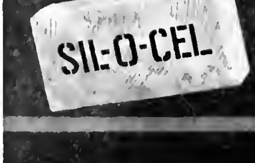
These are three of the results accomplished by Sil-O-Cel Heat Insulation.

Sil-O-Cel is a microscopically porous, siliceous material which possesses the lowest heat conductivity of any insulation suitable for high temperatures. Extremely light in weight, it possesses great structural strength and can be furnished in forms which stand without shrinkage direct heats of 2200° F.

Brick, block, powder, cement,—a form of insulation for any type of heated equipment without change in design.

Write nearest office for complete information given in Bulletin H-6 C.

CELITE PRODUCTS COMPANY
New York 11 Broadway Chicago-53 W. Jackson Blvd. San Francisco-Monadnock Bldg.
Baltimore - Boston - Buffalo - Cincinnati - Cleveland - Denver - Detroit
Los Angeles - New Orleans - Philadelphia - Pittsburgh - St Louis
CELITE PRODUCTS LIMITED, New Birks Bldg., Montreal, Canada



McClave Grates Save Fuel and Maintenance the Better to Serve Every Industry

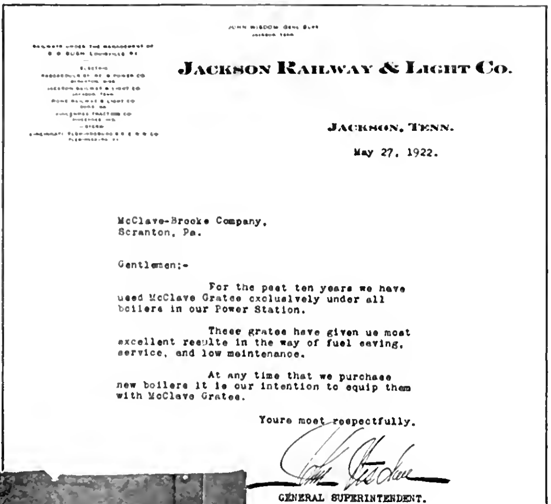
McClave
GRATES
STOKERS
STEAM
BLOWERS
McCB

Made of selected and tested materials in the McClave-Brooks Company's plant and according to the rigid McClave standards, every McClave Grate or other combustion appliance is so designed and so made that it shall render the utmost in service to the user with maximum economy in fuel and maintenance.

Write for catalog.

McCLAVE-BROOKS COMPANY
Makers of the famous McClave Grates since 1883
Scranton, Pennsylvania

BRANCH OFFICES:
New York Philadelphia Boston Detroit Chicago
Greenville, S. C. Kansas City St. Louis Jackson, Miss.
Pittsburgh Omaha Syracuse Dallas
Salt Lake City Owensboro, Ky. St. Paul



JACKSON RAILWAY & LIGHT CO.

JACKSON, TENN.

May 27, 1922.

McClave-Brooks Company,
Scranton, Pa.

Gentlemen:-

For the past ten years we have used McClave Grates exclusively under all boilers in our Power Station.

These grates have given us most excellent results in the way of fuel saving, service, and low maintenance.

At any time that we purchase new boilers it is our intention to equip them with McClave Grates.

Yours most respectfully.

GENERAL SUPERINTENDENT.

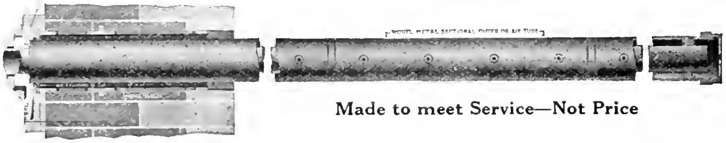
Boiler room in power station of the Jackson Railway & Light Company, Jackson, Tenn., John Wisdom, General Superintendent. Sets of McClave 2-A Grates under two 508 H. P. Sterling Boilers. Two additional sets are under two 200 H. P. Vogt Boilers in the same plant.

McClave COMBUSTION SYSTEMS *for greater economy*

The BAYER
TYPE "S"

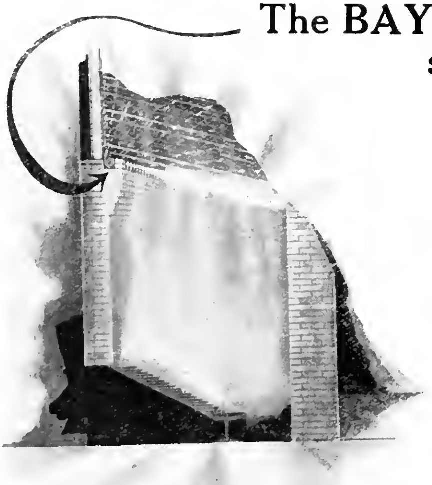
Non-Warpable, Monel metal, Sectional Air-Cooled, Soot Blower Unit

Valve-in-head-Geared-Full Floating



Made to meet Service—Not Price

The BAYER is the only unit that will stand up in this hot spot!!



Encased in its air tube housing and protected by cool circulating air, the steam element snugly awaits commands to rid the boiler of soot. It is not affected by the raging, deadly, destructive high temperatures, because of the air space between the two tubes. Further, its sectional construction allows for any expansion or contraction, thus preventing warping.

Bayer equipment is fully covered by patents allowed and pending.

To such users of the revolving type of mechanical soot blowers who are experiencing trouble with their elements located in high temperatures, we invite correspondence with a view of replacing such elements with the Bayer Non-Warpable, Indestructible, Sectional, Air-Cooled Soot Blower Unit which will eliminate much annoyance, expense and maintenance.

THE BAYER CO.

4068 Park Ave. St. Louis, Mo. U.S.A.

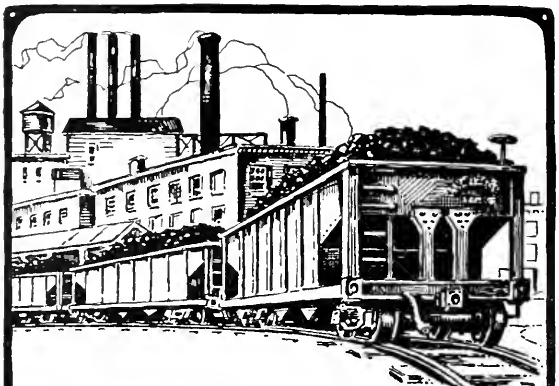
We have openings in several localities for top notch representatives

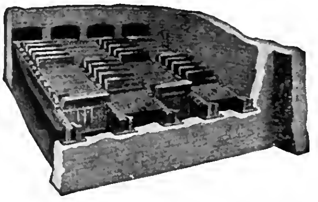
Mail coupon for booklet and complete information on our Type "S" Non-Warpable, Monel metal, Sectional, Air-Cooled Soot Blower Unit, to THE BAYER COMPANY, 4068 PARK AVE., ST. LOUIS, MO.

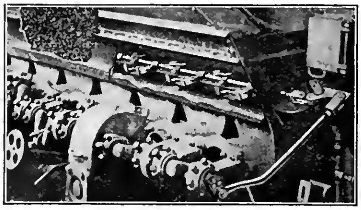
Name.. *Kind of boiler*..................................

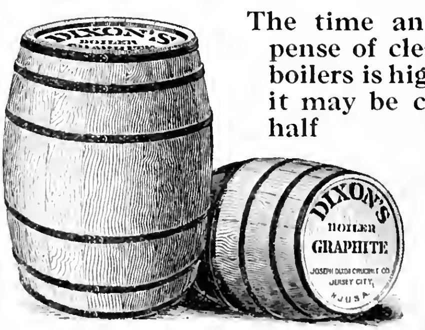
Address.. *Business*..................................

M.E.12-22

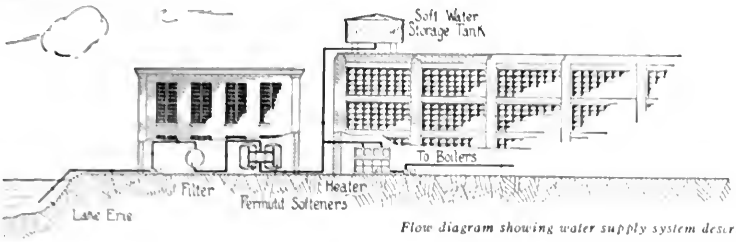








DIXON'S
BOILER
GRAPHITE
JOSEPH DIXON CRUCIBLE CO.
JERSEY CITY,
N.J. U.S.A.



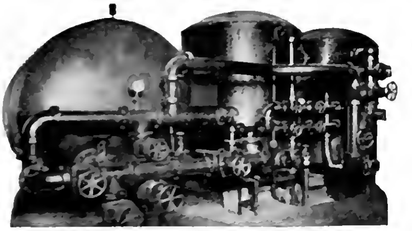
Flow diagram showing water supply system described below.

Not a Single Boiler Tube Replaced in 4800 H. P. Boiler Plant Since 1920

A large industrial corporation in Buffalo, N. Y. operates a boiler plant consisting of 6 Sterling, vertical water tube boilers that develop an average of 4800 H. P., 24 hours per day the year round.

The water supply used for boiler feed purposes is derived from Lake Erie, and besides having variable amounts of sludge and mud forming matter, contains an average of 8 grains of hardness per gallon.

Due to the steady demand for continuous service from these boilers, which are operated day and night without a letup, it is absolutely essential that they be free from scale, sludge and mud, as an interruption in service to replace or clean boiler tubes would be very costly.



Photograph of Permutit water softening plant described above. Note small size and simplicity of the installation.

With this in mind a Permutit zeolite water softening system was installed in September 1920 when the plant was built. It delivers 230,000 gallons of absolutely clean, zero soft water per day, and during the two years it has been in service it has completely prevented the formation of scale, sludge and mud in the boilers or their connections.

A letter from the vice president of the corporation states in part—

> " . . . recently we opened a boiler after nine months' continuous service and found no scale of any character on the tubes . . ."
>
> " . . . we have not as yet replaced a tube after one and one-half years of operation."

In this large boiler plant, operating at heavy loads day and night, there are no cleaning gangs employed, no boiler shut-downs, no tube replacements—and there have been none since the plant was built in 1920.

How about YOUR boiler plant? Let us solve your problems too. Write for our valuable booklet today.

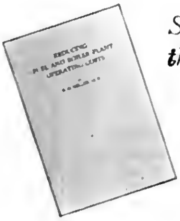
The Permutit Company
440 Fourth Ave. New York

Zeolite Water Softener Patent Sustained

The Federal Court at Buffalo (Hazel, J.) on June 15th, 1921, handed down a decision sustaining our broad patent covering Zeolite Water Softeners which has been affirmed by the Court of Appeals. According to this decision all Zeolite Water Softening Apparatus on the market not made by us is an infringement of this patent

No need to borrow trouble — buy Permutit—it is the best anyway.

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment



Send for this free booklet

The
Permutit
Company
440 Fourth Ave.
New York

Please send me your free booklet, "Reducing Fuel and Boiler Plant Operating Costs."

Name ....

Address ....

....

Company ....

The same old story over and over again—

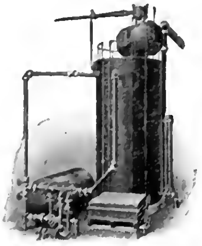
DOES it pay? Can you possibly justify the endless attack on scale? Turbining and other methods of mechanical scale removal are merely an admission that you *do* countenance scale in your boilers.

Scale increases after cleaning periods and reaches the peak of heat insulation before cleaning periods. The average insulation can be reduced only by extremely frequent cleanings, in which case labor and shutdown costs exceed the saving gained in fuel economy.

Chemical compounds are another admission that softened water is needed, and the sludge formed and frequent blow offs required, are proofs that compounds are only a makeshift remedy for scale troubles.

Are you justifying these methods on a basis of cost? Are you under the impression that these makeshift methods save money as compared with the International Hot-Flow Water Softener? If so, you should make some cost comparisons.

We have outlined the items that should be compared. You do the comparing. Would you like to have a blank to fill out that will put the dollar and cents side of the boiler scale problem clearly before you? Then pencil a request to—



The International Hot-Flow Water Softener supplies boilers with the equivalent of hot rain water. Such feed water can form no scale.

International Filter Co.
WATER SOFTENING
AND FILTRATION PLANTS
Works and General Offices:
333 W. 25th Pl., Chicago
New York Pittsburgh Buffalo San Francisco
Canadian International Filter Co., Ltd.,
Confederation Life Bldg., Toronto.

INTERNATIONAL
WATER SOFTENERS

SPRACO
Full Cone Spray Nozzles
as used in Spraco cooling pond systems produce finer drops, more uniform distribution and greater cooling results than any other device of its kind now on the market.

Send for Catalogue C-22

SPRAY ENGINEERING CO., Boston, Mass.

Manufacturing also Air Washers, Spraco Paint Guns, Spraco Nozzles and Strainers, Vaughan Flow Meters, Etc.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

UNISOL
REG. U. S. PAT. OFF.

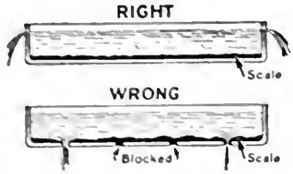
Daily blowing down, and the proper use of UNISOL, gradually removes boiler scale, prevents scale formation, stops and prevents corrosion and pitting, and removes grease from steam boilers.

Pamphlet on request. *Money back guarantee.*

UNISOL MFG. CO. Jersey City, N. J.

MECHANICAL ENGINEERING
November, 1922 CARD INDEX Vol. 44, No. 11

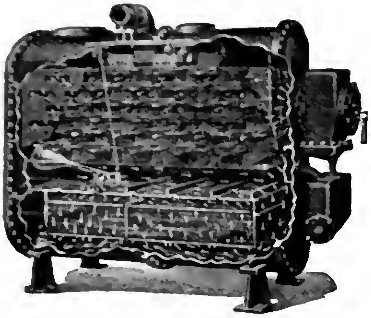
WATER
WE-FU-GO AND SCAIFE SOFTENING SYSTEMS
Scaife Standardized Softened Water For Boiler Feed and all Industrial Uses
Scaife Filters for all Purposes
NEW YORK: 26 Cortlandt St.; CHICAGO: First Nat'l Bank Bldg.
(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.



Pans Can't Clog

It is impossible for the pans of a Worthington - Stilwell Feed Water Heater to block or clog. The water flows over notches in the tray flange, and not through holes in the bottom of the pan. Scale deposit simply settles in the bottom of the pan and does no harm. The water is always broken up into the proper number of streams irrespective of lime deposits.

WORTHINGTON

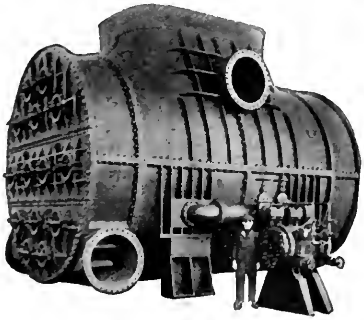


Worthington-Stilwell open feed water heater.

WORTHINGTON PUMP AND MACHINERY CORPORATION

Executive Offices: 115 Broadway, New York City. Branch Offices in 24 Large Cities W 102.4

A WHEELER CONDENSER INSTALLATION IS A TRUE ECONOMY



First cost is always a consideration in buying any apparatus but a more important consideration is the question of upkeep and operating expense.

Upkeep and operating expense rather than first cost are the reasons why "one who knows" buys Wheeler Condensers.

Send for Catalog 112-C on "Wheeler Condensers."

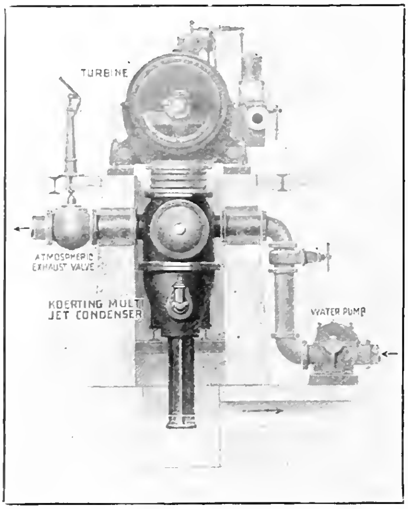
WHEELER CONDENSER & ENGINEERING CO.

CARTERET, N. J.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

See our Exhibit at Exposition of POWER & MECHANICAL ENGINEERING, GRAND CENTRAL PALACE, NEW YORK CITY, Dec. 7th to 13th

Carry a High Vacuum Without An Air Pump



KOERTING

Multi-Jet CONDENSERS

Simple to install and operate.
Positive and reliable in service.

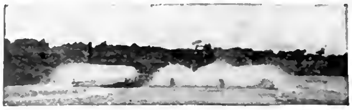
Built in 30 standard sizes from 100 to 10,000 kw. capacity.

Address Condenser Department.

SCHUTTE KOERTING
1166 THOMPSON STR
PHILADELPHIA·PA

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

SPRAY POND



VERSUS

COOLING TOWER— *which?*

Which type of water cooling device is better for your plant?

The answer depends on the nature of the duty, the climate, and the amount and value of available space.

No sweeping claim of superiority for either type can be justified in the absence of specific information covering plant conditions.

We investigate, then quote you on best type for your particular service.

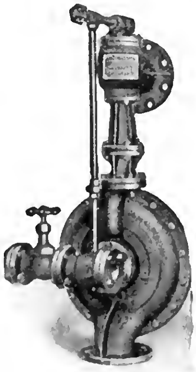
THE COOLING TOWER CO., INC.

17 John St., New York

COOLING TOWERS AIR WASHERS
SPRAY NOZZLE SYSTEMS

Write for Catalogue 9A

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)



Steam Actuated

Radojet Air Pump

(*Patented*)

Can be operated efficiently and economically with high or low pressure steam.

Over 6 million H. P. sold.

Surface and Jet Condensers for all service.

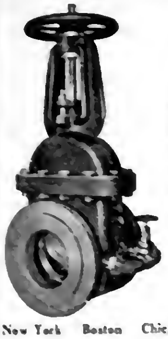
(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

C. H. Wheeler Manufacturing Co.

Main Office and Works: Philadelphia

BRANCHES:

New York Boston Chicago Pittsburgh Charlotte
San Francisco Seattle



KENNEDY VALVES

have stood the test of time. Their superior features have been proven by efficient service from year to year There is no necessity for experimenting when buying valves.

Send for the Kennedy Catalogue and keep it on your desk

KENNEDY VALVE MFG. CO.

ELMIRA, N. Y.
Export Office:
Elmira, N. Y.

New York Boston Chicago San Francisco Seattle El Paso Salt Lake City

154

ASHTON

POP VALVES and GAGES

Recognized for their absolutely dependable quality.

Used in the leading high pressure power plants.

Send for Catalog No. 18 which tells all about the full line of ASHTON Specialties.

The Ashton Valve Co.

BOSTON NEW YORK CHICAGO
SAN FRANCISCO

2 (See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

CLASSIFIED ADVERTISEMENTS

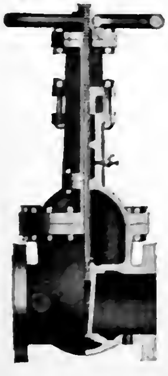
If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

RATES

40 cents a line; 30 cents a line to members of A.S.M.E. (Minimum insertion, 5 lines; maximum, 20 lines. No display matter carried.)

Address

The American Society of Mechanical Engineers
29 West 39th Street New York City



Chapman

Cast Steel Gate Valves

Guaranteed 5 years

The Chapman Valve Mfg. Co.
Indian Orchard, Mass.

BRANCH OFFICES

New York Pittsburgh Chicago Cleveland
Boston Philadelphia Detroit New York
Los Angeles Tulsa San Francisco

H-P-M HIGH PRESSURE HYDRAULIC

Whatever Your Needs

May be in the line of Hydraulic machinery or Hydraulic fittings, WE CAN FILL THEM.

Not only can we supply the style of press you desire but we can back it up with forty-five years of experience in the building of Hydraulic equipment.

In most cases we can supply presses of standard design. However our staff of engineers are at all times capable of producing presses for special requirements.

Hydraulic Presses and Pumps
Hydraulic Accumulators
Hydraulic Valves
Hydraulic Intensifiers
Hydraulic Fittings

Write us, TODAY, for catalogs, drawings and estimates of presses designed for your needs.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

■ ■

THE HYDRAULIC PRESS MFG. CO.
50-56 LINCOLN AVE., MOUNT GILEAD, OHIO
New York, 39-41 Cortlandt Street
Buffalo Cleveland
Mutual Life Building Kirby Building

Vogt DROP FORGED FITTINGS

There is a Vogt Drop Forged Steel Valve and Fitting for every need where high pressures or temperatures in oil, gas, air, water, ammonia, steam and super-heated steam are used. The drop forging method used in the production of Vogt Fittings, makes strength their dominant feature. Let us quote on your valve and fitting needs for high pressure and temperature work.

Write today for catalog, special discount sheet and sample Fitting.

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE, KY.

Vogt Drop Forged Steel Valves and Fittings Can Be Purchased From Our Agents:

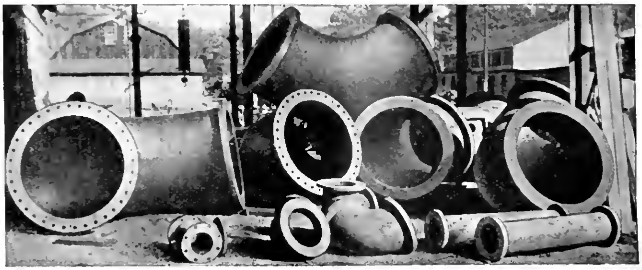
Metalwood Mfg. Co. . . Detroit, Mich.
Pittsb'gh Valve, Fdy. & Const. Co. Pittsb'gh, Pa.
John Simmons Co., New York, N. Y.
Walworth Mfg. Co., Boston, Mass.
Walworth Mfg. Co. . Chicago, Ill.
Walworth Mfg. Co., Seattle, Wash.

Branch Offices: New York, Philadelphia, Chicago, Dallas.

Vogt Products:

Oil Refinery Equipment, Horizontal Return Tubular and Water Tube Boilers, Ice and Refrigerating Machinery, Drop Forged Steel Valves and Fittings.

A COMPLETE ENGINEERING PLANT AT YOUR SERVICE



Up in the Lehigh Valley—just far enough from the Metropolitan Section to make certain definite economies possible—is a big well-equipped plant devoted entirely to the production of castings, forgings, and general machine work on a contract basis. Castings can be handled up to twenty tons in weight—forgings up to 12 inches in diameter—and we can machine anything we cast or forge.

The illustration shows a few of the pipe fittings—500,000 lbs. in all—which we furnished recently for the New Hell-Gate Power Station in New York City. The largest ones were 52" in diameter.

Correspondence is cordially invited whether your requirements are large or small.

Weatherly Foundry & Manufacturing Company, Weatherly, Pa.

N. Y. Office: 95 Liberty St.

'UNIVERSAL' STAYS TIGHT

CAST IRON PIPE THAT MAKES ITS OWN JOINTS

—no packing, no calking, nothing to deteriorate. Tight—flexible—dependable. Used the country over for water, gas and other service where freedom from leakage is essential.

THE CENTRAL FOUNDRY COMPANY

41 East 42nd Street, New York

Chicago Atlanta Dallas San Francisco

UNIVERSAL CAST IRON PIPE

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

445

H. GORDON BRINCKERHOFF CO.

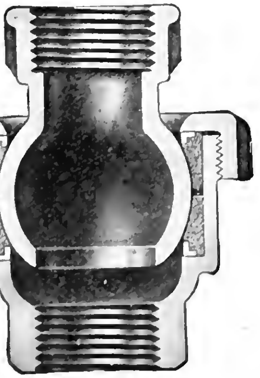
Manufacturers Representative for products having unusual features or exceptional excellence that conserve fuel, labor, or industrial costs.

10 HIGH STREET BOSTON, MASS.

Barco Flexible Joints

For

Use wherever a Flexible Connection is required for high or low Pressure, Steam, Vacuum, Water, Oils, Benzines, Naphtha, Air and Gas, in place of Rubber or Metallic Hose, Expansion Joints, Special Pipe Bends, etc. All styles, Straight, Angle, Male, Female, and Flange ends.



For

Locomotive and Car Steam and Air connections, Round house and Coach Yard Steam connections, Steam Shovels and Dredges, Oil handling plants, steel mills, mines, quarries, engine testing, and in fact nearly every industry.

Over ten years' extensive and successful experience in all branches of engineering.

Will you let us discuss our problems with you?

Patented Catalogs on request

BARCO MANUFACTURING CO.

1801-1815 Winnemac Ave., CHICAGO, ILL.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

FLANGES AND FITTINGS
for
TAYLOR'S SPIRAL RIVETED STEEL PIPE

Taylor's Spiral Riveted Steel Pipe is furnished with FORGED STEEL FLANGES attached. These flanges expand evenly with the pipe, and cannot be broken by any possible condition that may arise in the piping system.

SHEET STEEL FITTINGS are made according to your special designs to meet the most difficult or unusual conditions.

Frequently a large amount of heavy cast-iron fittings can be eliminated; and the piping system made of wrought steel throughout by the use of special fittings and outlets on our pipe—thus saving much time and expense in the installation.

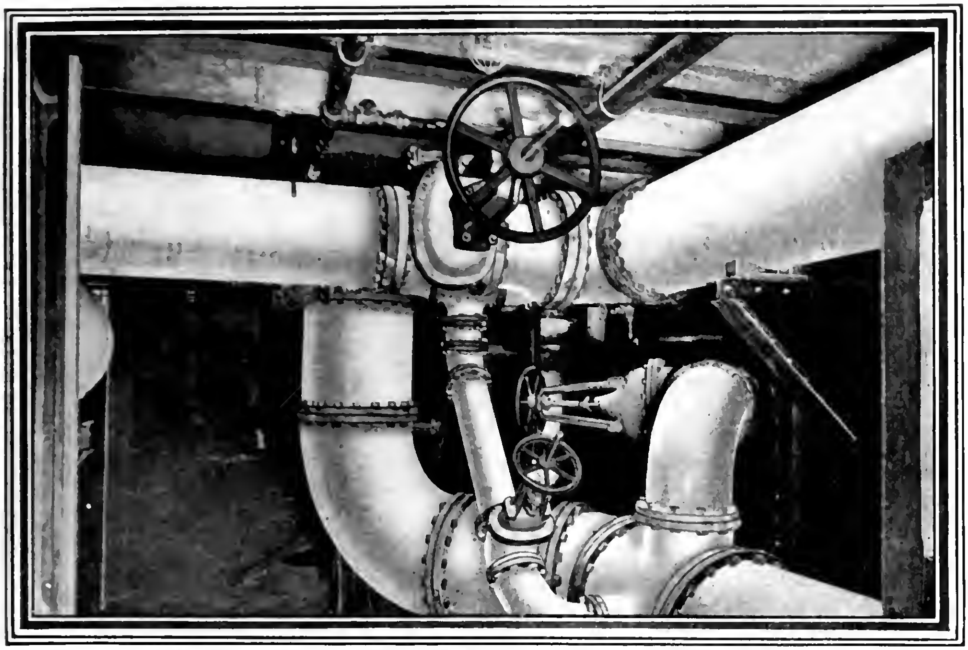
The long experience of our engineering department in designing special fittings is at your service.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

AMERICAN SPIRAL PIPE WORKS

New York Office, 50 Church St.

Main Office and Works, P. O. Box 485, Chicago.



A TYPICAL PIPING INSTALLATION — CRANE EQUIPMENT IN THE PLANT OF TRUMBULL-CLIFFS FURNACE CO.

BUILDING FOR PERMANENCE

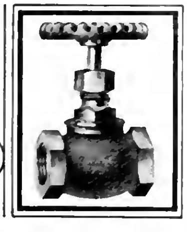
Lower upkeep expense for piping systems depends on uniform quality in all equipment used. For a pipe line is an assembly of many units and the stability of the whole demands unfailing service from each unit—valve, fitting, piping, flange or specialty.

The high quality of all Crane valves, fittings, pipe bends and specialties, guarded by rigid inspections and the most severe factory tests, insures dependable service from a pipe line constructed of Crane units. Crane branch houses maintain complete stocks of standard pipe line equipment at strategic shipping points.

CRANE

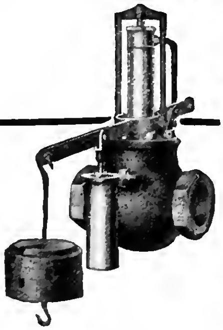
GENERAL OFFICES: CRANE BUILDING, 836 S. MICHIGAN AVE., CHICAGO

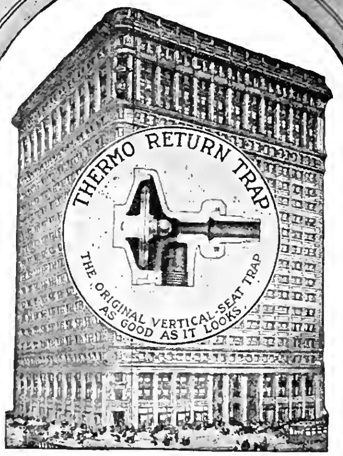
Branches and Sales Offices in One Hundred and Thirty-five Cities
National Exhibit Rooms: Chicago, New York, Atlantic City
Works: Chicago and Bridgeport

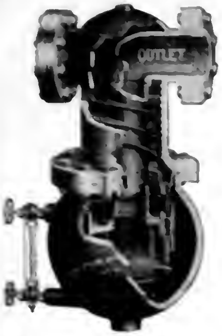


Crane 75 Low Pressure Globe Valve

See our data in 1922 A.S.M.E. Condensed Catalogues



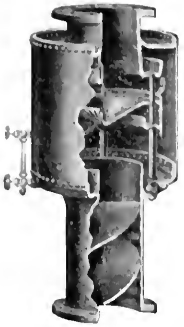

THERMO RETURN TRAP
THE ORIGINAL VERTICAL-SEAT TRAP
AS GOOD AS IT LOOKS



Steam Specialties

For thirty years we have made high grade steam specialties. Exceptional standards of materials and workmanship have always been maintained. That's why many of the leading industrial concerns of the country are numbered among our customers. Full line of standard sizes always in stock. Send for latest catalog and prices.

Representatives: We have a very interesting proposition for a few aggressive representatives. Write for details.

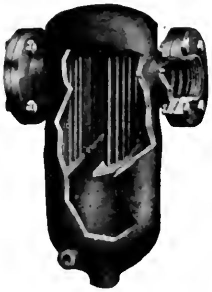


Triumph Oil Separator
(Horizontal Type)

Guaranteed to deliver water of condensation 99.995 per cent pure.

Ward Blow-Off Valve

Adaptable to stationary, locomotive and marine service. Operates by means of worm gear movement permitting gradual opening and closing with minimum energy, thus preventing all unnecessary strains on boiler and piping. Valve disc never leaves its seat—hence no dirt or scale can lodge in the valve.



Triumph Oil Separator
(Vertical Type—Ascending Current)

This separator performs the difficult work of eliminating oil from exhaust without attention or expense after installation.

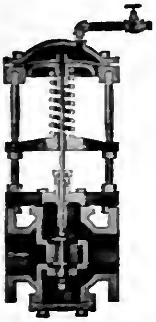
Victor Horizontal Separator
(For Steam or Oil)

This separator is guaranteed to deliver water of condensation sufficiently free from oil so that it may be used without danger for boiler feed or laundry purposes.

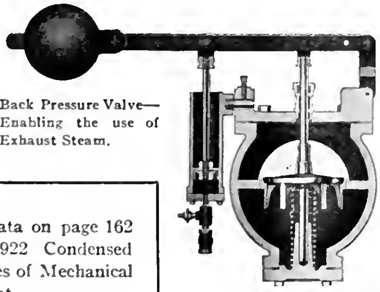
MILWAUKEE STEAM APPLIANCE CO.

WEST ALLIS - WISCONSIN

"KIELEY" ECONOMY OUTFIT

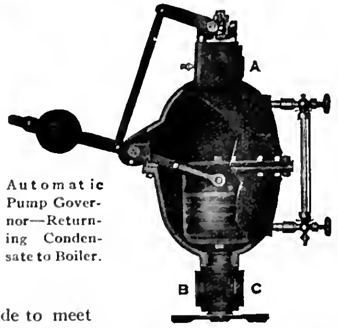


Reducing Valve—from High to Low Pressure



Back Pressure Valve—Enabling the use of Exhaust Steam.

See our data on page 162 in the 1922 Condensed Catalogues of Mechanical Equipment.



Automatic Pump Governor—Returning Condensate to Boiler.

All our equipment is made to meet the demands of modern power plant installations.

Details and prices on application

The Kieley & Mueller Co., Inc. 34-38 West 13th Street, New York City

A partial list of our automatic steam specialties

Beginning at the boiler with the **Non-return Pilot Valve** that closes in case of rupture to either power piping or boiler.

High and Low Water Alarm indicating when not enough water or two much is in the boiler.

Feed Water Controlling Device to maintain constant water level in high pressure boilers.

Damper Regulator to control draft dampers.

Pressure Reducing Valves from high to medium or above vacuum. Also for water, gas or air.

Combination for controlling engine and draft for mechanical stoker fired boilers.

Steam Separators and Traps.

Oil Separators and Grease Traps.

Back Pressure Valves, enabling the use of exhaust steam for heating purposes

Pump Governor to return condensation from high and low pressure returns direct to boilers.

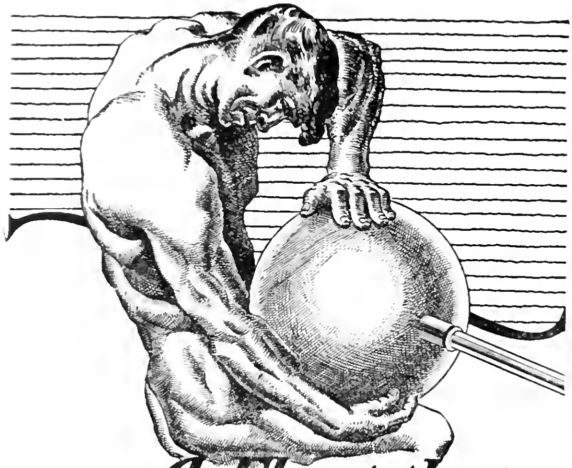
Exhaust Heads, Blow-off and Drip Tank Controllers.

Temperature Controller for hot water tank.

Combination Pump Governor and Lever Float Valve for keeping water supply tank filled.

Low Pressure Boiler Water Feeders and Damper Regulators.

Lifting and Return Traps to return condensation back to boiler where radiators or coils are set below same.



A Float that doesn't Collapse

The float in ordinary steam traps is the cause of much trouble and expense. Made of thin, flimsy metal, they will not withstand high steam pressures without caving in.

The American Ideal Trap has a heavy Hercules float made of seamless, non-corroding copper. It will resist pressures up to 600 lbs. to the square inch and is *guaranteed* for the life of the trap.

But in spite of its heavier construction, this float responds instantly to the slightest rise in the level of the condensate because of its powerful valve leverage.

AMERICAN IDEAL STEAM TRAP

keeps lines thoroughly drained at all times.

If you select your American Ideal Steam Trap on the basis of its guaranteed capacity in accordance with our tables, you will be surprised to find how completely your trap troubles will be overcome.

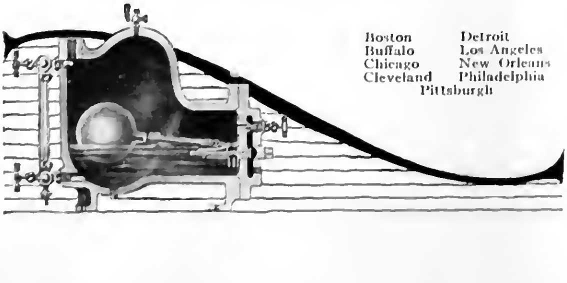
Size for size, American Ideal Steam Traps handle much more condensation than ordinary traps, and on this basis and length of service, the American Ideal is the cheapest trap on the market.

Many other features of superiority are described fully in our booklet R-24.

Write for your copy today.

See our exhibit at the National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, Dec. 7-13.

The Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO DIVISION
BROOKLYN, N. Y.



Boston
Buffalo
Chicago
Cleveland
Detroit
Los Angeles
New Orleans
Philadelphia
Pittsburgh

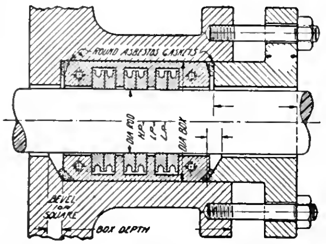
GOETZE GASKETS

TIGHT
under all
conditions

Try them on a
90 day
trial basis

Goetze Gaskets are fully described on page 193 of the 1922 volume of the Condensed Catalogues of Mechanical Equipment.

Goetze Gasket and Packing Company
11 Allen Avenue New Brunswick, N. J.



Inside Split Case Type—$12.00 per inch diameter of rod

FRANCE METALLIC PACKING

for all
conditions
of service

Send for Catalog

FRANCE PACKING COMPANY
6500 Tacony St., Philadelphia, Penna.

Engineering Societies Building

29 West 39th Street, New York, N. Y.

A Convenient Place
for
Technical Meetings, Conventions, Commencement Exercises, Lectures and Concerts

ITS HALLS ARE AVAILABLE TO YOUR ORGANIZATION

A WELL APPOINTED AUDITORIUM
Seating 875 Persons
Three Smaller Halls
Seating 90, 225 and 500 Persons
Can Be Thrown Into One Room
Accommodating 800 Persons

COMMITTEE AND CONFERENCE ROOMS TO ACCOMMODATE 25 PERSONS

Motion Picture and Stereopticon Machines available

FOR RESERVATIONS OR INFORMATION APPLY TO THE BUILDING MANAGER

CUTTING OIL—FILTRATION—STERILIZATION—CIRCULATION

We DESIGN, MANUFACTURE AND GUARANTEE Cutting Oil Purification Systems to operate under any and all conditions!

Our experience in the manufacture and installation of cutting oil systems—the fact that we have designed and installed the largest systems in the automotive industries and others—places us in position to know the proper equipment to furnish under varying conditions.

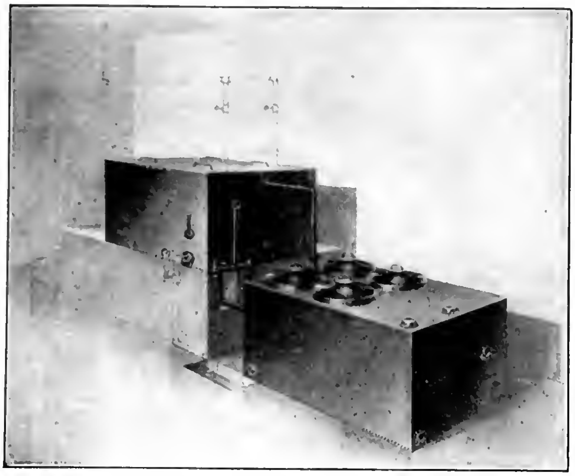


Fig. 9-F Cutting Oil Filtration and Sterilization System.

Type B Filter and Purifier.

No plant is too small—None too large. Our line of equipment is so flexible that the proper combination of standardized units may be made in most cases. Special equipment can and will be furnished when necessary.

The readers of Mechanical Engineering appreciate the advantages to be attained by the installation of cutting oil purification systems—lengthened life of machine tools, increased production, high quality work, improved working conditions.

We have manufactured the largest cutting oil systems in America.

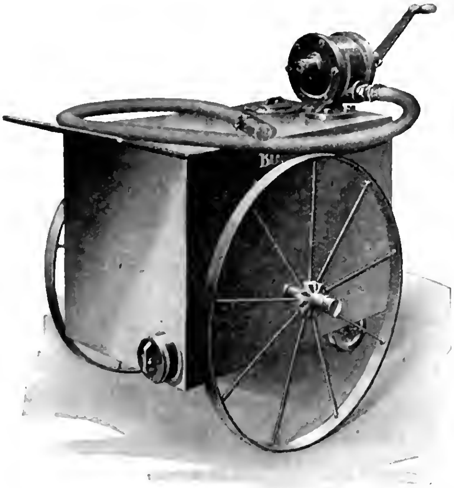
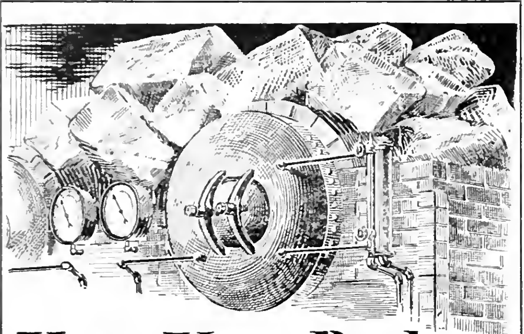


Fig. 182 Cutting Oil Wheel Tank, for use in emptying and refilling individual reservoirs on various machines.

THE RICHARDSON-PHENIX DIVISION
S. F. BOWSER & CO., INC.
LUBRICATION ENGINEERS AND MANUFACTURERS
123 BOWSER AVE., FORT WAYNE, INDIANA
Offices in all principal Cities Representatives Everywhere

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

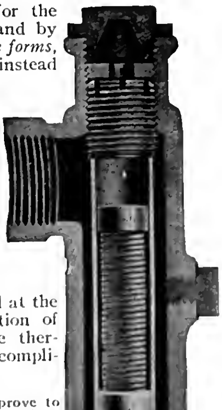


Keep Your Boiler Packed with Ice

By packing ice around your boiler you will reduce the temperature. This makes it more difficult to keep steam up. More coal will be required. Your fuel bills will be higher.

Ridiculous? Of course it is! But not any more ridiculous than the practice of trapping steam lines a hundred feet or more from the point where steam is used. Every foot of pipe that contains condensate is a foot of pipe that cools steam off and wastes coal. Get rid of the condensate *where it forms, instead of at distant points,* and cut down this waste. It requires more traps to do this, but the cost is comparatively light when your lines are fitted with the low-priced

STEAM TRAP
SARCO



You can buy three Sarcos for the price of one bucket type trap, and by placing them *where the condensate forms,* you can draw it off instantly, instead of allowing it to drain back through enormous lengths of pipe, chilling the live steam in its progress.

Despite its small size, the Sarco is a little giant for performance. It drains the condensate off as rapidly as it forms, returning it instantly to the hot well without loss of heat units.

Many engineers have marveled at the simple but scientific construction of the Sarco—the highly sensitive thermal element—the absence of complicated parts.

A 30-DAYS' FREE TRIAL will prove to you that the STEAM TRAP SARCO is a money saver. Quickly installed; does not require pit-digging or platform building. Made in sizes 3-8 in., to 3 in. for any given pressure up to 200 lbs.

Write today for Booklet No. E-26.

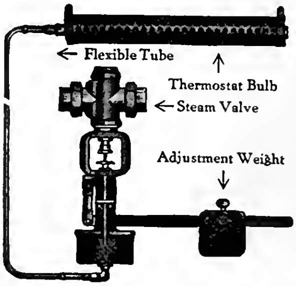
SARCO COMPANY, Inc.
7 Barclay St., New York City.

Buffalo Chicago Detroit Cleveland Philadelphio

(*See Our Data in 1922 A S M E Condensed Catalogues of Mechanical Equipment*)

You Don't Guess Time! Why Guess Temperature?

Whenever there is need for maintaining a definite even temperature—the Powers Automatic Heat Regulators give "100 per cent perfect" results. They are always on the job—accurate, sure, reliable. They prevent all the losses that creep in with manual control—by releasing men who try to control heat by hand—by preventing spoiled or substandard output—by using the necessary amount of heat *only.*



The Powers Regulator No. 15

Entirely self-contained. Thermostat bulb may be placed wherever needed, and connected with steam valve by flexible tube of any required length.

Especially adapted to the control of air or gas temperatures—in lumber kilns, textile and leather drying processes, grain and vegetable dryers, etc.

Other Powers Regulators for other specific industrial operations where heat is a factor.

We shall be glad to give you the benefit of our more than thirty years' experience in temperature regulation; and if you will tell us where you would like to try out a Powers Regulator, we will send the right one for thirty days' trial. If you don't find it satisfactory, send it back.

THE POWERS REGULATOR CO
Specialists in Automatic Heat Control

NEW YORK 2732 Greenview Ave., CHICAGO BOSTON

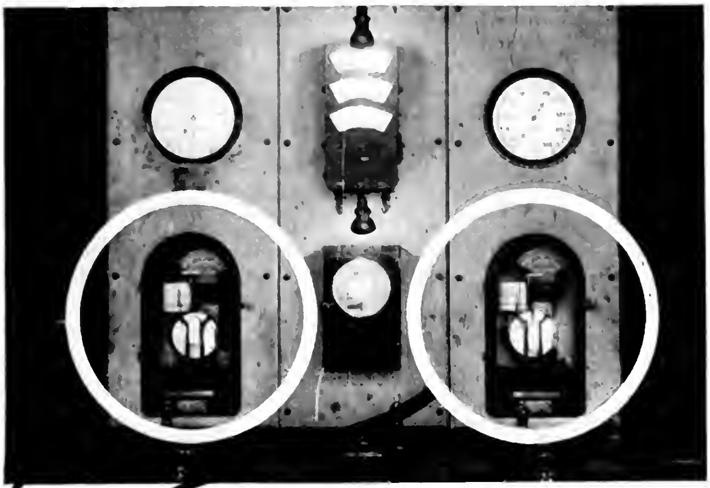
Baltimore, Md.
Charlotte, N. C.
Des Moines, Ia.
Indianapolis, Ind.
Milwaukee, Wis.
Philadelphia, Pa.
Rochester, N. Y.
San Francisco, Calif.
Buffalo, N. Y.
Cincinnati, O.
Detroit, Mich.
Kansas City, Mo.
Minneapolis, Minn.
Pittsburgh, Pa.
Seattle, Wash.
Butte, Mont.
Cleveland, O.
El Paso, Tex.
Los Angeles, Calif.
New Orleans, La.
Portland, Ore.
Salt Lake City, Utah
St. Louis, Mo.

The Canadian Powers Regulator Co., Ltd. Toronto, Ont.
Calgary, Alta Halifax, N. S. Montreal, Que.
Vancouver, B. C. Winnipeg, Man.

(1079E) (*See Our Data in 1922 A S M E Condensed Catalogues of Mechanical Equipment*)

34 Simplex Feed Water Meters

Are Recording the Flow of Boiler Feed



Typical Boiler Room Instrument Board, Colfax Station, Showing Two Simplex Boiler Feed Water Meters

Simplex Type G Boiler Feed Water Meter

The record is drawn on a rectangular chart that gives the flow in pounds per hour at 200° F. At the same time the flow is both indicated on a dial graduated in pounds per hour and in boiler horsepower, and totalized in pounds on an integrating register.

The pounds of water delivered to the boiler are continuously indicated, recorded, and totalized, *and thus the efficiency of the plant is given at all times. Every day's run becomes an evaporation test that shows the overall average rather than chance results of a single boiler test.*

A total of 34 Simplex Feed Water Meters are installed—two for each boiler. Two Simplex Condensate Meters and two Simplex Feed Make-up Meters on evaporator lines are also installed.

Simplex Meters insure accurate measurements for all rates of flow and put a particular emphasis upon high average plant performance—hence their importance cannot be over-emphasized.

Simplex Valve & Meter Company

Manufacturers of Hot and Cold Water Meters, Rate of Flow Controllers, Automatic Air Valves, Regulating Valves and Hydraulic Apparatus of Special Design.

5727 Race Street **Philadelphia, Pa.**

FUEL OIL ACCURATELY MEASURED

BY A METER THAT IS PROPERLY DESIGNED, PROPERLY BUILT, PROPERLY ADJUSTED, AND THAT *RETAINS* ITS ACCURACY

The EMPIRE

The Empire meter is a positive displacement device, operated by an easy-moving, practically frictionless oscillating piston. It has an unmatched record, covering nearly forty years, for closeness of registration and durability.

MADE IN ALL SIZES, ⅝" TO 6". SEND FOR CIRCULAR NO. 109

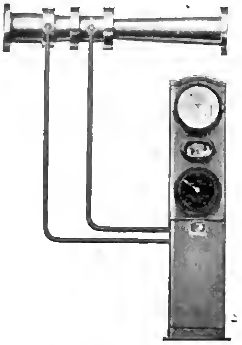
(*See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment*)

NATIONAL METER COMPANY

299 BROADWAY, NEW YORK

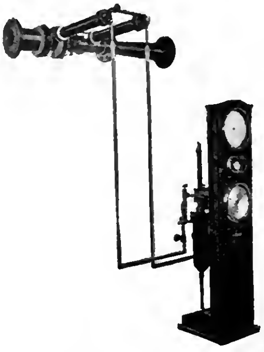
CHICAGO, ILL.: 1455 W. Congress St. LOS ANGELES, CAL.: 251 Central Ave. SAN FRANCISCO, CAL.: 141 New Montgomery St.
BOSTON, MASS.: 287 Atlantic Ave. CINCINNATI, O.: 415 Sycamore St. ATLANTA, Ga.: 251 Ivy St. WINNIPEG, MAN.: 111 Ethelbert St.

THE VENTURI METER WILL TELL YOU



Venturi Boiler Feed Water Meter

1. How many pounds of water are evaporated for each pound of fuel burned.
2. Which boilers are efficient and which need cleaning or repairs.
3. When a boiler can be cut out or another boiler should be put in service.
4. Whether or not the water tender is doing his work well.
5. Which kind and grade of fuel is most economical for your boiler plant to use.
6. How much steam is used in the engine room.
7. How much steam is used for manufacturing processes.
8. How much steam is supplied for heating.
9. How much condensation is returned to the boilers.
10. How much circulating water is used by the condensers.



Venturi Steam Meter

Is not knowledge of these things vital for efficient power plant operation? The Venturi Meter is giving this information every day in thousands of power plants throughout the United States and Canada. Our accumulated experience in this field is at your disposal.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

Shall we send you further details?

BUILDERS IRON FOUNDRY, PROVIDENCE, R. I.

NEW YORK PORTLAND, ORE. SAN FRANCISCO PHILADELPHIA LOS ANGELES
DALLAS KANSAS CITY PITTSBURGH TORONTO, CAN. CHICAGO OTTAWA, CAN.

"Emco" Meters and Regulators

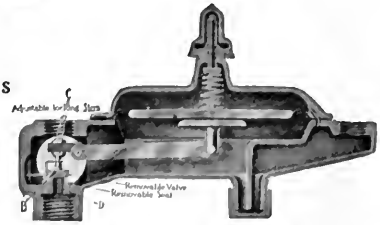
For Artificial and Natural Gas

Meters for Low and High Pressures

Proportional Meters

Provers, Gauges and Burners

Regulators of all kinds



WRITE FOR CATALOGUE AND PRICES

EQUITABLE METER CO.

Company Member of American Gas Association

432-434-436 First Avenue, Pittsburgh, Pa.

THE
UNITED STATES GOVERNMENT
offers you
Postal Savings
for the deposit of your money
and
TREASURY SAVINGS CERTIFICATES
for *investment.*

Republic Flow Meters

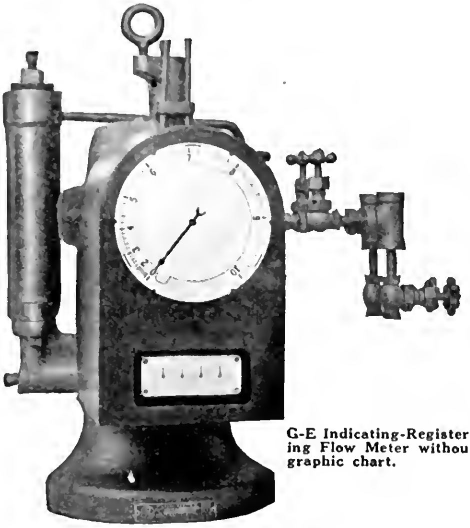
—indicating, integrating and recording steam flow. A guide to correct firing, a vital element of combustion efficiency and a record of steam consumption of units and departments. *Steam Flow—CO₂ Recorder (Model SFC)*—the only instrument giving a graphic record of per cent of CO₂ and amount of steam flow on one chart. Valuable comparisons can be made. The CO₂ Recorder is also furnished without steam flow recorder.

Republic Flow Meters Co.
2240 Diversey Parkway Chicago, Ill.

New York, Philadelphia, Boston, Pittsburgh, Detroit, Birmingham, Kansas City, Denver, Milwaukee, Seattle, Portland, Ore., San Francisco. Los Angeles, Dallas, Republic Flow Meters Co., of Canada, Ltd., Toronto, Ontario, Burton Dunglinson, 9 Oxford St., London, England.

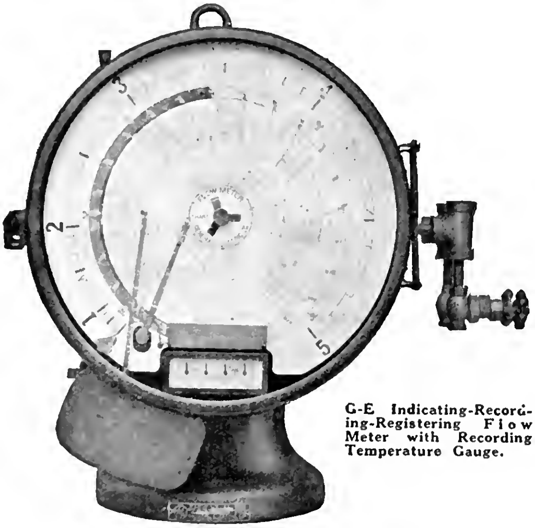
G-E REGISTERING FLOW METERS

G-E Indicating-Recording-Registering Flow Meter with recording temperature and pressure gauges.



G-E Indicating-Registering Flow Meter without graphic chart.

G-E Indicating-Recording-Registering Flow Meter with Recording Pressure Gauge.



G-E Indicating-Recording-Registering Flow Meter with Recording Temperature Gauge.

These newly designed G-E Flow Meters can be furnished for four different combinations of reading:

- —flow;
- —flow and temperature;
- —flow and pressure;
- —flow, temperature and pressure.

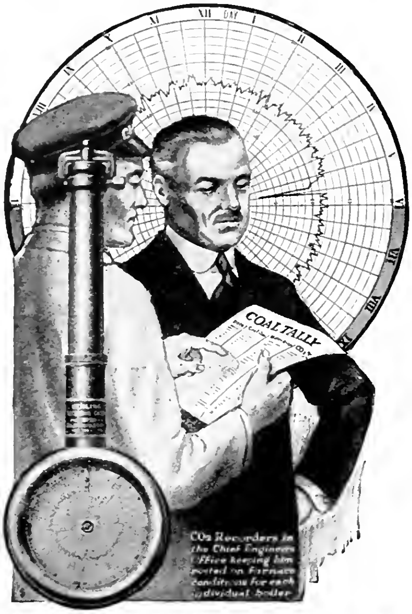
They can also be supplied without the graphic chart, for indicating the rate of flow and registering the total flow.

General Electric Company

General Office
Schenectady, N.Y.

Sales Offices in
all large cities

34C-56



UEHLING
CO_2 Recording Equipment
Measures Fuel Wasted
Up the Chimney

Uehling CO_2 Equipment is simple, accurate, easy to operate and has no moving parts. The gas is kept clean from the start by **"Pyro-porus"** filtration, an exclusive Uehling feature.

Absorption of CO_2 is by a dry cartridge, thus eliminating messy chemical solutions.

The record is continuous (not intermittent). The auxiliary Indicator for the boiler front tells the fireman when he is wasting fuel.

Above are some of the reasons why the Corn Products Refining Co. have ordered 54 Uehling CO_2 recorders, the Detroit Edison Co. have ordered 61, the Ford Motor Co. 19, the Solvay Process Co. 43, the Southern Calif. Edison Co. 60, Standard Oil Companies 104, U. S. Rubber Co. 25, S. D. Warren Paper Co. 14 and Whittaker Glessner Co. 25.

The following bulletins are yours for the asking.

Magnitude of the Power Plant's Chimney Loss

Relation Between CO_2 and Money Wasted Up the Chimney

Catalog 112 describing Uehling equipment.

CO_2 Indicator at boiler front to guide the fireman

Uehling Instrument Co.
Combustion Engineers
28 Vesper St., Paterson, N. J.

See Our Exhibit at the New York Power Show

EXECUTIVES COME TO BRISTOL BECAUSE BRISTOL MAKES THE PRECISE INSTRUMENT THEY NEED

Plain Facts Made Plain

It Pays to Know

Ignorance is never bliss in business. So whether your field is one of pressure, temperature or electricity, remember that

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE

Instruments

are standard the world over. The simplicity and careful construction of the pressure elements insure long operation and sustained accuracy.

Ask for Bulletin C-1095

See our data in 1922 A.S.M.E. Condensed Catalogues.

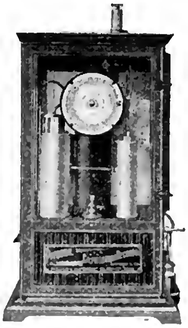
Why not ask a Bristol User?

THE BRISTOL CO., Waterbury, Conn.

Branch Offices:
Boston, New York, Philadelphia, Pittsburgh, Detroit, Chicago, St. Louis, San Francisco

---

Precision CO_2 Recorders



Precision CO_2 Recorder

A Precision CO_2 Recorder on your boiler will mean reduced coal consumption, save you money and assist the nation in the crisis that confronts us. Coal will be hard to obtain all winter. You can, however, protect yourself and keep your plant in operation.

Send for Catalogue

(See Our Data in 1922 ASME Condensed Catalogues of Mechanical Equipment)

PRECISION INSTRUMENT CO.

21 HALSEY ST., NEWARK, N. J.

Tycos

TEMPERATURE INSTRUMENTS
INDICATING-RECORDING-CONTROLLING

By means of consistent accuracy and ability to stand the unusual strains *Tycos* Temperature Instruments have become the standard in their field. Mechanical Engineers recognize this and advise their installation whenever temperature problems arise.

Reference catalogs for Engineers will be sent without obligation to all those who state their firm connection.

Taylor Instrument Companies
ROCHESTER, N. Y.
There's a Tycos or Taylor Temperature Instrument for Every Purpose

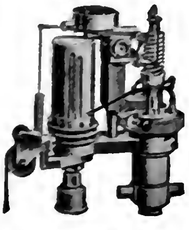
---

The Veeder Mfg. Co.

MANUFACTURERS OF
Veeder
CYCLOMETERS. ODOMETERS, TACHOMETERS
COUNTERS, SPEED COUNTERS FINE DIE CASTINGS.
Hartford, Connecticut

ENGINE INDICATOR WITH POWER COUNTER

[MAIHAK TYPE]



A TIME SAVER
Gives You Instantaneously
The M.E.P.
WITHOUT USE OF A
PLANIMETER

BACHARACH INDUSTRIAL INSTRUMENT CO.
7000 Bennett Street PITTSBURGH, PA.

Model 432 Single Phase Portable A.C. Weston, Jr., Wattmeter

Approximately
1/4 the SIZE
1/4 the WEIGHT
1/2 the PRICE

of Weston Model 310 Precision Instrument

Model 432 Wattmeter of the new Weston, Jr., group is predestined to occupy as distinctive and important a position—as a small instrument—as that always held by its larger, more expensive and world-famous brother, Weston Model 310 Wattmeter.

Model 310 has always been indispensable for both work of utmost precision and as a secondary standard for checking other instruments. Model 432 Wattmeter and Models 433 Voltmeter and Ammeter, on account of their lightness, compactness and typical Weston dependability, will be just as indispensable for making all general commercial measurements where more accurate and costly instruments are not required.

The New
WESTON, JR.,

Portable A. C. Group, including Wattmeters, Voltmeters, Ammeters and Milliammeters.

Model 432 Wattmeters are made with double voltage and single current ranges. Shielded against external magnetic fields. Negligible temperature errors. Ranges up to 50 amperes and 300 and 150 volts self contained. Model 433 Voltmeters have either single or double range, Ammeters—a single range. Accurate within 1/2%. Wattmeters or Ammeters when used with Weston Multi-Range Current Transformer Model 461 permit measurements up to 800 amperes. Bakelite cases. Strong carrying handles. Wattmeter costs $50 and up—Voltmeter, $30 and up—Ammeter, $28 and up.

This series is so unique, practical and necessary that you should know all about it at once. Bulletin 2006 describes and illustrates the instruments fully. Write for it TO-DAY.

Weston Electrical Instrument Co.,
49 Weston Ave., Newark, N. J.
Branch Offices in All Principal Cities

GROUND

ROUND STRAIGHT

TRUE TO SIZE HIGHLY POLISHED

SHAFTS

OF EXTREME PRECISION

Ground Shafts cost more than ordinary shafts on the cars but—Ground Shafts cost less than ordinary shafts when assembled in the machine—Why?

Let us tell you why—as well as about Cumberland Ground Shafts.

CUMBERLAND STEEL CO.
CUMBERLAND, MD.

MEDART

OCT. 16TH

ON October 16th we distributed our new condensed catalogue No. 43. You should find a copy in your office files. But, if not, make request for your copy today.

This catalog contains illustrations, construction details, line drawings, dimensions and price lists on Medart Line Shafting Equipment. It will be useful to superintendents, purchasing agents, owners, managers and master mechanics of power plants, as well as to designers and draftsmen who plan power transmission installations; likewise to dealers and salesmen of transmitting machinery.

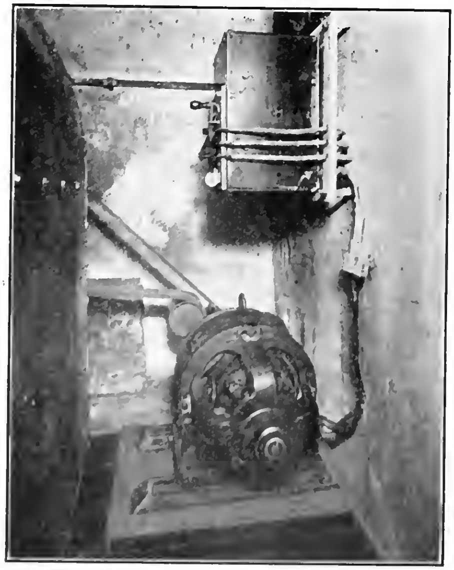
We will cheerfully give you engineering advice, as well as costs, on line shafting equipment and kindred installations.

More extended information on various Medart products is contained on page 246 of the 1922 A.S.M.E. Condensed Catalogues

THE MEDART COMPANY
(Formerly Medart Patent Pulley Co.)
General Offices and Works: St. Louis, U. S. A.
Office and Warehouse: Cincinnati Offices: Chicago and Philadelphia

MEDART *means* **EVERYTHING** *in* **LINE SHAFTING EQUIPMENT**

THE LENIX DRIVE



The ability of the LENIX Drive to transmit full load under conditions where an ordinary open belt drive could not operate efficiently is demonstrated in the installation illustrated.

This 10 H.P. Motor driving a fan is installed in a corner back of the fan casing. The floor space is extremely limited and the tight of the belt on top, but the load is transmitted without the high initial tension that would be required with an ordinary open belt drive.

Belt slippage is eliminated by the great arc of contact given by the Lenix.

Booklet

"Saving Slippage and Space"

contains interesting data on belt drives. Ask for a copy.

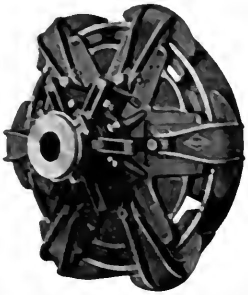
A description of the Lenix and other products of this company will be found in the 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment.

F. L. SMIDTH & CO.,
Engineers
50 Church St., New York, N. Y.

Power Transmission Machinery

Belt or Rope Distribution

Complete Engineers Catalogue on Request



Six-Arm Friction Clutch Coupling

FALLS CLUTCH & MACHINERY COMPANY

Engineers, Founders and Machinists

CUYAHOGA FALLS, Suburb of Akron, OHIO

BRANCHES

NEW YORK CITY
206 Fulton Street

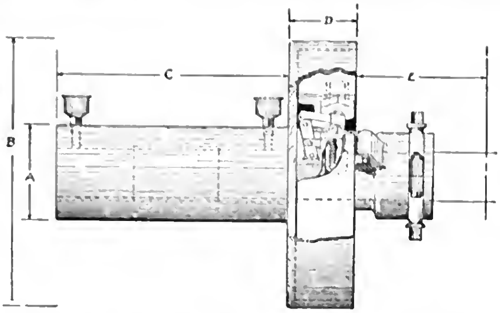
CINCINNATI, O.
208 Elm Street

BOSTON, MASS.
54 Purchase Street

DENVER, COL.
310 Mack Bldg.

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment

8



Better Clutches

Brown Inner Ring Expanding Line Shaft Clutches have demonstrated their superiority for twenty years, being unequalled for durability, ease of installation, and convenience of adjustment.

Ratings are by actual brake horse-power capacity; and over-all proportions as indicated above.

Write for catalog C.

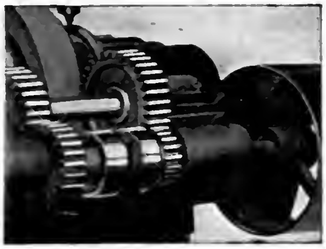
The Brown Clutch Co.

Manufacturers of
Friction Clutches and Friction Hoists

SANDUSKY, OHIO

THE JOHNSON FRICTION CLUTCH

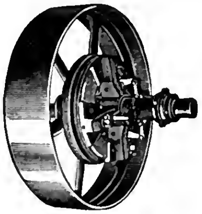
in a standard size just dropped in between these spur gears on the William's pipe threading machine.



A Johnson Clutch will solve your machine control problems.

Write for Catalog C

THE CARLYLE JOHNSON MACHINE CO. MANCHESTER CONN



CLUTCH

FRISBIE

PULLEYS

The Eastern Machinery Co.

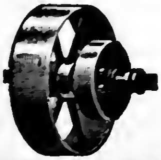
41 Gregory St., New Haven, Conn.

THE A. & F. BROWN CO.

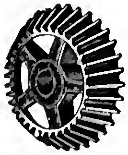
ENGINEERS, FOUNDERS, MACHINISTS AND MILLWRIGHTS

POWER TRANSMISSION MACHINERY

DESIGNED, FURNISHED AND ERECTED



Friction Clutch Pulleys and Couplings



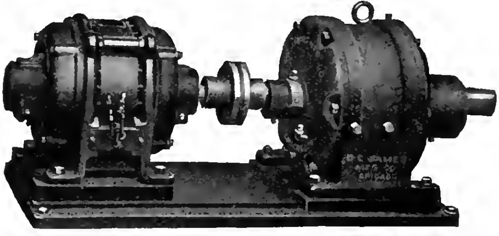
Gears of all kinds and sizes

SPECIAL MACHINERY

IRON CASTINGS

Works: ELIZABETHPORT
NEW JERSEY

Sales Room: 79 BARCLAY ST.
NEW YORK CITY



James Speed-Reducing Transmissions

Provide Operating Economy

James Transmissions eliminate complicated open Gearing, Shafting, Belts and Pulleys not to mention the great loss thru friction. Send for Bulletin descriptive of our Speed Reducing Transmissions. Manufacturers of cut Gears of every description.

D. O. James Mfg. Co.
1114 W. Monroe St., Chicago, Ill.

See our data on page 232
in 1922 A.S.M.E.
Condensed Catalogues

Some Papers on Journals and Bearings

Title	Author	Order No.	Prices To Members	Prices To Non-Members
Ball-Bearing Lineshaft Hangers	Henry Hess	1286	.25	.35
Plastic Indentation of Steel Balls under pressure	C. A. Briggs, W. C. Chaplin and H. C. Heil	1643	.25	.40
A Self-Adjusting Spring Thrust Bearing	H. G. Reist	1646	.25	.40
Slow-Speed and Other Tests of Ringsbury Thrust Bearings	H. A. S. Howarth	1715	.30	.45
Common Errors in Designing and Machining Bearings	Christopher D. Bierbaum	1720	.30	.45

No order filled for less than 50 cents

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York

FRANKLIN MACHINE COMPANY
Engineers Founders Machinists
Providence, R. I.

Transmission Machinery, Spun Silk Machinery, Ball Winding Machines, Shoe Lace Tipping Machines, Yarn Dressers, Wool Top and Yarn Baling Presses, Pneumatic Gravity Drop Hammers, Pneumatic Presses, Special Machinery, etc.

HARRIS-CORLISS STEAM ENGINES
Eastern Representative for
Cleveland Worm Gears and Worm Gear Reduction Units

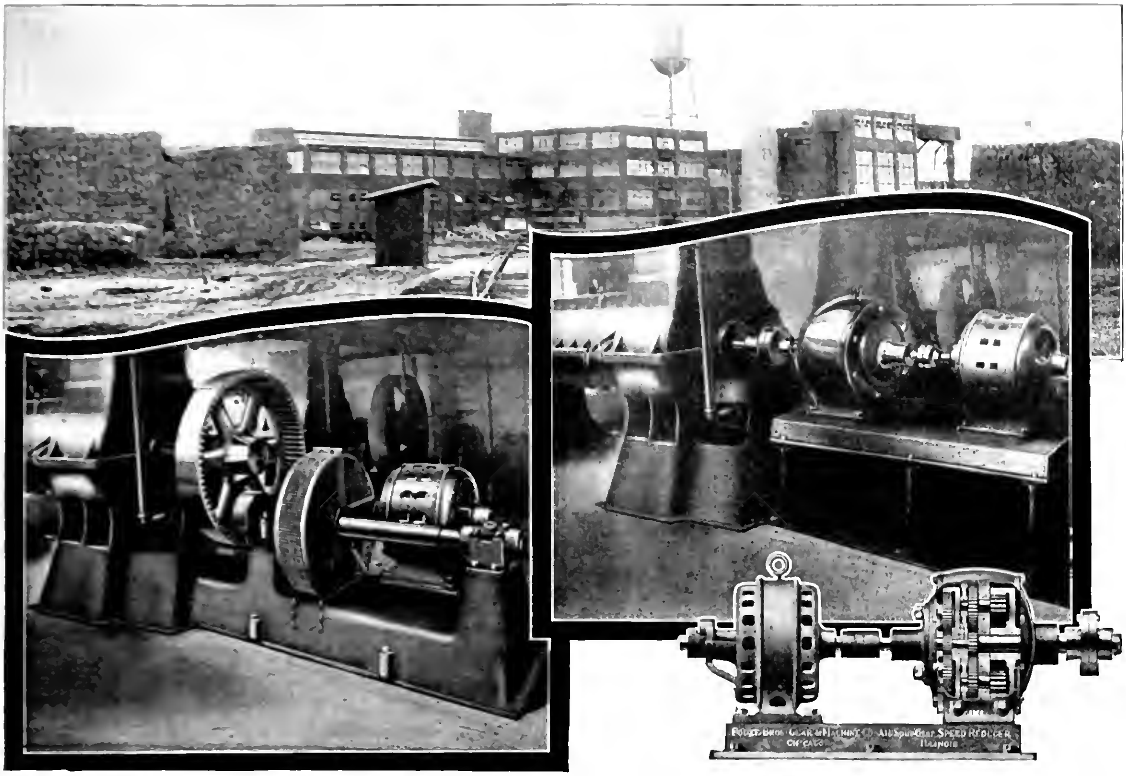
(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

Modern and Approved Appliances for the Transmission of Power

SHAFTING HANGERS
COUPLINGS PULLEYS
COLLARS BELT TIGHTENERS
FRICTION CLUTCHES
ROPE DRIVE EQUIPMENTS

T. B. WOOD'S SONS CO.
CHAMBERSBURG, PA.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)



The speed of the motor to run pulp shredder is reduced by means of a pinion gear driving a spur gear from which another pinion gear drives an internal gear. This open equipment is costly to install, causes undue maintenance cost and loss of power.

Showing the same pulp shredder driven by means of motor and Foote Speed Reducers. A high speed motor is used. This makes a compact, efficient, economical drive. This installation requires practically no maintenance.

HOW DO *YOU* DETERMINE THE BEST TYPE OF TRANSMISSION FOR REDUCING THE SPEED OF ELECTRIC MOTORS OPERATING MIXERS, CONVEYORS, AGITATORS, ETC.?

IS YOUR INSTALLATION SPACE LIMITED? *Foote Speed Reducers* are compact. They can be furnished to drive at either end or at top or bottom. They are set close to the motor.

WILL YOUR MEANS OF TRANSMISSION BE SUBJECTED TO DIRT, DUST OR GRIT? Dirt, dust and grit quickly wear out open gears, ropes, chains and belts. All working parts in *Foote Speed Reducers* are enclosed and protected. Their life is long.

ARE YOUR MEN ENDANGERED WORKING NEAR YOUR DRIVES? *Foote Speed Reducers* are fool proof. Workers cannot get their fingers or clothes into moving parts. *Foote Speed Reducers* provide positive safety. They also eliminate fire and explosion hazard.

DO YOU NEED ALL POSSIBLE POWER FROM YOUR MOTORS? *Foote Speed Reducers* are entirely enclosed and all gears run in a bath of oil. End and side thrusts are eliminated and scientific engineering insures the delivery of maximum power.

DO YOU REQUIRE A BIG REDUCTION? *Foote Speed Reducers* are made for motors of any horse power in ratios from 5 to 1 up to 500 to 1.

ARE YOU IN DOUBT AS TO THE PROPER DRIVE TO INSTALL? Our Engineering Department will assist you in solving your speed reduction problems—no obligation to you.

MEMBER OF AGMA

FOOTE BROS. GEAR & MACHINE CO.

248-258 N. Curtis St. **Chicago, U. S. A.**

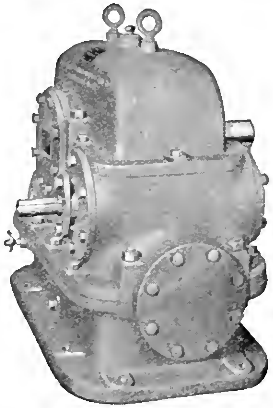
Mfgrs. of Rawhide and Bakelite Pinions and Cut Gears of All Kinds. Send for catalog. Special Machinery made to order. Submit your blueprints.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

J. R. SHAYS, JR.
145 Greenwich St.
New York City

KING & KNIGHT
Underwood Bldg.
San Francisco, Cal.

Cleveland
WORM GEAR REDUCTION UNITS



Cleveland Double Reduction Drive

Double Reduction Drives

We are in a position to furnish double reductions with ratios as high as 2000 to 1, such as are now being used in many of the leading steel plants. These are used to operate cooling tables, conveyors, etc.

We have also built a great many double reduction drives for use in other applications. Our double reductions take up considerably less space than any other form of speed reduction and are remarkable for their high efficiency in the transmission of power.

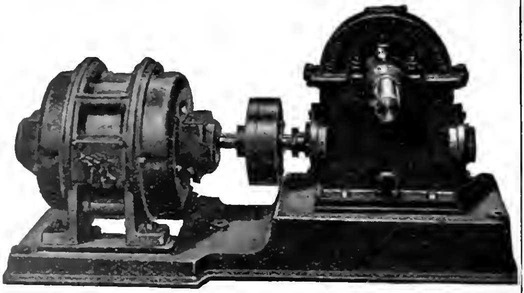
Or, we can furnish single reductions as low as 3⅝ to 1 and as high as 100 to 1.

Where high efficiency, even torque, quietness, compactness and low maintenance cost with *permanent* economy, are desirable you will find nothing to equal Cleveland Worm Gear Reduction Units.

Our latest bulletin gives ample information regarding the construction of our gearing and we will be glad to send it to you. Give us the data concerning any form of speed reduction you may have under consideration and our engineering department will gladly cooperate with yours.

The Cleveland Worm & Gear Co.
America's Worm Gear Specialists
CLEVELAND, OHIO
DRAVO-DOYLE CO., Pittsburgh
Cleveland, Indianapolis, Philadelphia
New England Representatives
FRANKLIN MACHINE CO., Providence, R. I.
Pacific Coast Representatives
ALFRED H. COATES CO., San Francisco, Cal.
Rocky Mountain States Representatives
THE VULCAN IRON WORKS CO., Denver, Colo.

(See Our Data in 1922 A S M E Condensed Catalogues of Mechanical Equipment)



HINDLEY WORM-GEAR DRIVES

For Power Transmission, the Hindley Worm-Gear Drive will meet your requirements.

Efficient, Safe, and Durable.

Hindley Gear Company
1105 Frankford Ave.
Philadelphia, Pa.

The Engineering Societies Library

ONE of the largest collections of engineering literature in the world is that found in the Engineering Societies Library, 29 West 39th Street, New York.

It comprises 150,000 volumes, including many rare and valuable reference works not readily accessible elsewhere. Over 1,300 technical journals and magazines are regularly received, including practically every important engineering journal in the civil, mechanical, electrical, and mining fields.

The library is open from 9 a.m. to 10 p.m., with trained librarians in constant attendance. Its resources are at the service of the engineering and scientific public.

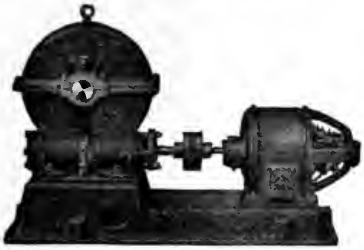
FAWCUS
HERRINGBONE GEARS

QUIET EFFICIENT
ENCLOSED GEAR DRIVES
FLEXIBLE COUPLINGS
SPECIAL MACHINERY

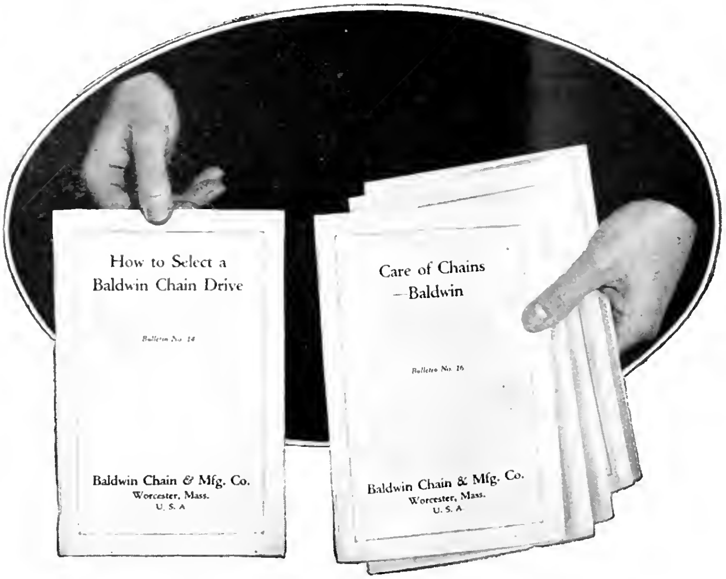
CUT SPUR = CUT BEVEL = CUT WORM = GEARING

FAWCUS MACHINE CO. Pittsburgh, Pa.

(See Our Data in 1922 A S M E Condensed Catalogues of Mechanical Equipment)



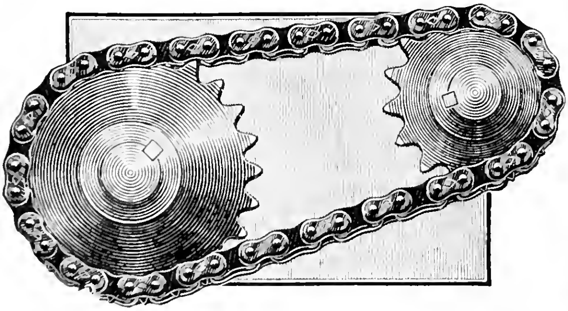
Your OPPORTUNITY to learn the advantages of BALDWIN CHAINS AND SPROCKETS



THESE bulletins have been compiled by Baldwin Engineers to give you complete engineering data on the application and design of chain drives. The Baldwin factory or your nearest Baldwin distributor will be very glad to furnish you with any or all of these bulletins without obligation:

Miscellaneous Application of Chain Drives.
How to Select a Chain Drive.
Care of Chains.
Baldwin Roller Chains.
Baldwin Roller Chain Adaptations—Special Chains.
Baldwin Block Chains.
Data on Baldwin Sprockets for Roller and Block Chains.
Malleable Detachable Chains.
Westlund Friction Clutch.

BALDWIN CHAIN & MANUFACTURING COMPANY
WORCESTER, MASS.
H. V. GREENWOOD, *Western Sales Representative* PEOPLES GAS BUILDING, CHICAGO, ILL.



Chains and Sprockets

DIAMOND Roller Chains are made in fifty models, ranging from 3/8 to 2 inches in pitch and from 1/8 to 1¼ inches in width. This large line offers you correct chain models for all the needs of machinery drives.

DIAMOND Steel Sprockets can be manufactured to meet your particular drive specifications on reasonably short notice.

For 32 years, this company has specialized on manufacturing roller chain drives and is today the world's largest exclusive maker of steel roller chains and sprockets. Our engineers will gladly assist you in planning DIAMOND Chain Drives for the machinery you manufacture or use.

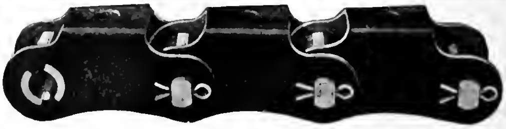
DIAMOND CHAIN & MFG. CO., Indianapolis, U.S.A.
Makers of High Grade Chains and Sprockets since 1890

DIAMOND
Chains and Sprockets

THE PHOSPHOR BRONZE SMELTING CO.

ELEPHANT BRAND
Phosphor Bronze
"PHOSPHOR BRONZE"
REG. U. S. PAT. OFF.

2200 WASHINGTON AVENUE, PHILADELPHIA, PA.
PHOSPHOR BRONZE
CASTINGS, INGOTS, RODS, SHEETS, WIRE, Etc.
DELTA METAL
IN BARS FOR FORGING AND FINISHED RODS
ORIGINAL AND SOLE MAKERS IN THE U. S.



"The Chain of Double Life"

For standard cast tooth sprockets No. 35 to 6 in. pitch
For cut tooth sprockets 1 in. to 2 in. pitch.

UNION STEEL RIVETLESS CHAINS

The Chains with the Substantial Links and Large Case-Hardened Bearings, which are reversible and renewable.

Roller Chains, Bushing Chains, Attachment Links, Cast Tooth Sprockets, Cut Tooth Sprockets, Elevating and Conveying Machinery

Special Transmission Chains up to 1,000,000 Pounds Ultimate Strength

The Union Chain & Mfg. Co., Sandusky, O.

PROMET GUARANTEE

The order to which this guarantee is attached is subject to the following conditions:

Promet must meet your bearing requirements and must give superior service to any other bearing metal or purchase price in full including freight will be refunded. Your opinion to be final.

The American Crucible Products Co.

THERE are a lot of remarkable facts we might tell you about Promet Bearing Metal.

For instance, it is uniformly giving from six to ten times the service of other bearing metals in every kind of machinery. This one fact is enough to make you interested in Promet.

But we have found that the Promet guarantee reproduced at the top of this page tells the story of Promet better than we can tell it.

We furnish a supply of these gummed stickers, exactly like that shown above, to your purchasing agent, with the request that he stick one of them on every order he sends us.

If we can afford to make this guarantee, can you afford *not* to find out what Promet Bearing Metal will do for you? Just mail the coupon.

THE AMERICAN CRUCIBLE PRODUCTS COMPANY
Elyria, Ohio

Canadian Licensees: Engineering Sales and Service Co., Ltd.
177-179 Duke Street, Montreal, Quebec, Canada

PROMET

THE HEAT-TREATED BEARING METAL

Promet Heat Treated Bronze Bearings and bushings Are Sold Under the Same Guarantee

The American Crucible Products Company, Elyria, Ohio M2

Please send me facts about Promet Bearing Metal and information regarding its use in..........................

(State kind of machinery)

Name..

Position ....

Company Name..

Address..

City..................................State..................

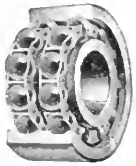
Strom BEARINGS

DURABILITY

Durability is the prime requisite of a good ball bearing. It is obtained in Strom bearings by constructing them of material of great strength which is heat-treated to obtain long-wearing quality.

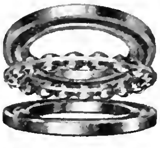
The working elements are correctly balanced in Strom bearings, making each part of equal strength to carry the heaviest loads and endure long service.

It is just such features of construction that make Strom bearings the most logical choice wherever strength, precision, power, and endurance are required.



Double-row maximum type, radial bearing

Double-acting, self-aligning thrust bearing with leveling washers 2100-U Series



Single-acting thrust bearing with flat seats (grooved races) 1100-F Series

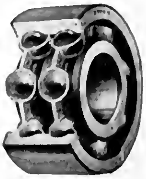
Single-acting, self-aligning thrust bearing, leveling washer 1100-U Series

Double-acting thrust bearing, flat seats 2100-F Series

Single-row, deep-groove Conrad type, radial bearing

Angular contact bearing—combination radial and thrust

Single-row, maximum type, radial bearing



Double-row, deep-groove Conrad type, radial bearing

Made in radial (single and double row), angular contact, and thrust types for any application.

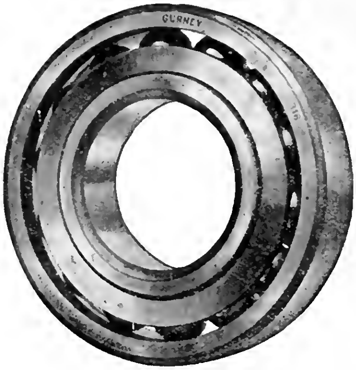
Our engineers will cheerfully assist you in a correct choice of bearings.

"Used Wherever a Shaft Turns"

U.S. Ball Bearing Mfg. Co.
(Conrad Patent Licensee)
4540 Palmer Street
CHICAGO, ILL.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

(218)



Maximum Safety Factor

COMPARATIVELY for their sizes Gurney Ball Bearings have greater capacity and thus in effect guarantee a maximum factor of safety.

This desirable result is secured by use of the maximum number and size of balls, assembled without use of a filling slot, in raceways whose curvature closely approximates that of the balls. Thus under continuous overload of shock, the theoretical point of contact becomes in fact an area of contact.

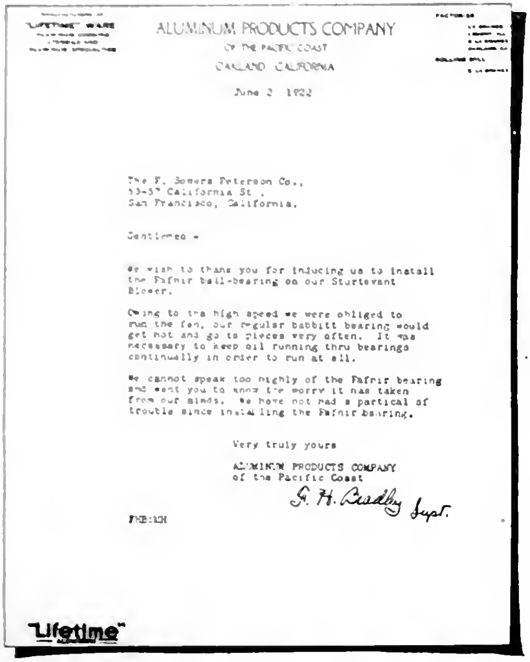
Let Gurney engineers assist in simplifying and economizing on your bearing problems.

Gurney Ball Bearing Co.
Conrad Patent Licensee
Jamestown, N. Y.

18103

GURNEY
BALL BEARINGS

FAFNIR



ALUMINUM PRODUCTS COMPANY
OF THE PACIFIC COAST
OAKLAND CALIFORNIA

June 2 1922

The F. Somers Peterson Co.,
53-57 California St.,
San Francisco, California.

Gentlemen -

We wish to thank you for inducing us to install the Fafnir ball-bearing on our Sturtevant Blower.

Owing to the high speed we were obliged to run the fan, our regular babbitt bearing would get hot and go to pieces very often. It was necessary to keep oil running thru bearings continually in order to run at all.

We cannot speak too highly of the Fafnir bearing and want you to know the worry it has taken from our minds. We have not had a partical of trouble since installing the Fafnir bearing.

Very truly yours

ALUMINUM PRODUCTS COMPANY
of the Pacific Coast
G. H. Bradley Supt.

FHB:LH

"Lifetime"

For Reliability and Efficiency Install Fafnir Double Ball Bearing Blower And Fan Boxes

Fafnir Double Ball Bearing Blower and Fan Boxes will pay for themselves many times over in power, oil and labor saved, and above all, in *reliability.*

These boxes involve unit construction and fit all standard types of blowers and fans.

Read what *Fafnir Blower and Fan Boxes* have done for the Aluminum Products Co.—They will do just as much for you.

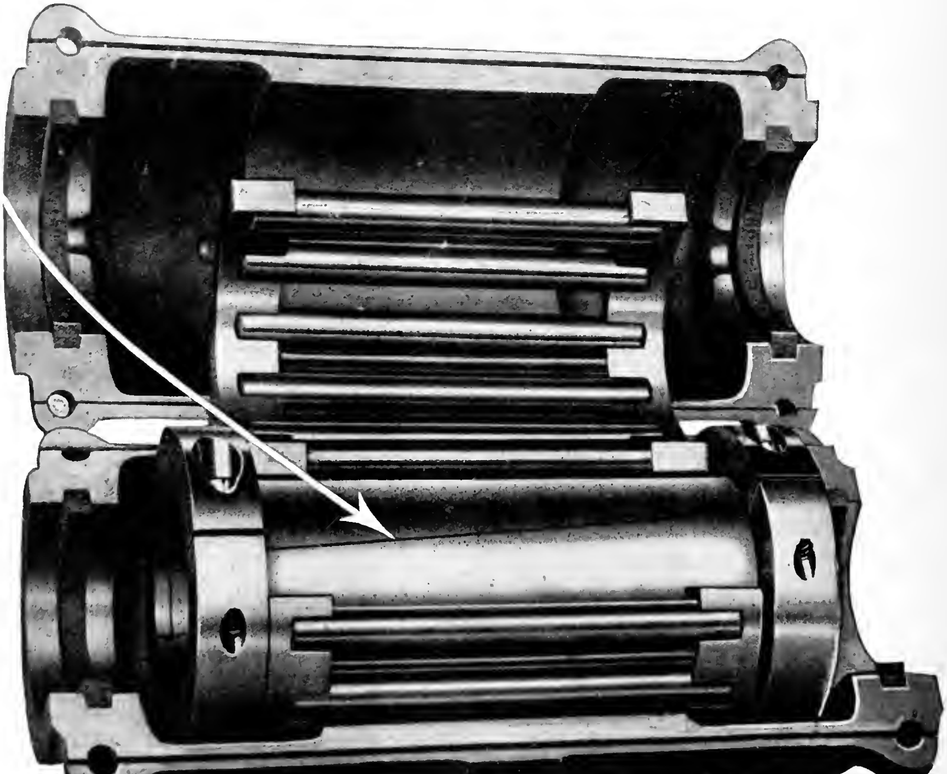
The Red Dragon Line

THE FAFNIR BEARING COMPANY

Conrad Patent Licensee
New Britain, Conn.

DETROIT Office: 752 David Whitney Bldg.
CLEVELAND Office: 1016-1017 Swetland Bldg.
NEWARK Office: 271 Central Avenue
CHICAGO Office: 1002 Ellsworth Bldg.
NEW YORK Office: 5 Columbus Circle

This split-steel sleeve which covers the places worn uneven in the shaft by the former bearings is a patented feature of the Sells Bearing.



In covering the hills and gullies, this sleeve also prevents future wear on the shaft, which, as you know, is softer steel.

This split-steel sleeve advantage alone (and there are seven others*) has influenced thousands of concerns to adopt Sells Roller Bearings.

Sells

• Put Sells Roller Bearings right in your present hanger frames, post hangers or pillow blocks. No extra cost—no loss of production. Rollers are self-contained and do not engage each other; no binding in cage rings or skewing effect.

Note the individual collars which hold the sleeve fast to the shaft.

In Sells Roller Bearings, you find the good points claimed for all other bearings with the defects of none.

A Few Installations

Millers Milling Company
Aunt Jemima Mills Co.
French, Shriner & Urner
United Shoe Machinery Co.
Gillette Safety Razor Co.
American Agricultural Chemical Co. (25 plants)
Newberry Cotton Mills
Babcock & Wilcox Mfg. Co.
Borden Condensed Milk Co.
Dodge Brothers
American Car & Foundry Co.
Smaltz-Goodwin Co.
Thornhill Wagon Co.
The American Fork & Hoe Company
Macwhyte Company

Wouldn't the fact that these nationally-known concerns have installed *Sells* Roller Bearings cause you to look into them—talk to our engineers?

At least you can ask us to send some recently written letters from those who have used Sells Roller Bearings for several years. And you will find that practically every one of these letters in praising the performance of the Sells Bearing and its lack of upkeep cost, also mentions savings in coal or power from 10 to 40 per cent.

But let's get things started now—*today,* for the longer you put it off, the greater hole is friction digging into your coal pile, or the more kilowatt consumption is being piled on your power bill.

Royersford Foundry & Machine Co.
60 N. 5th Street, Philadelphia, Pa.

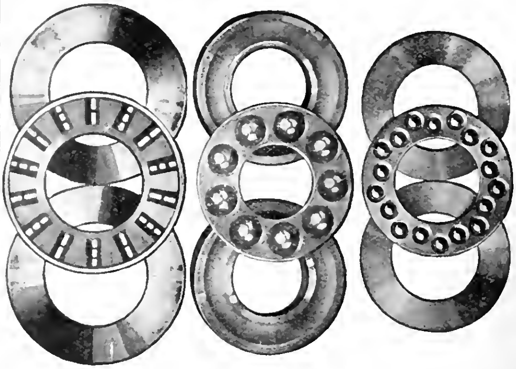
Roller BEARINGS

"NORMA"
PRECISION
BALL BEARINGS

If "repeat orders" fail to come to the builder of a "NORMA" equipped machine, he may be resonably sure that bearing troubles are not to blame. Our engineers like to help make good machines better. May one call?

THE NORMA COMPANY
OF AMERICA
Anable Avenue
Long Island City New York
BALL, ROLLER AND THRUST BEARINGS

THRUST
BEARINGS



STANDARD DIMENSIONS OR TO ORDER
One or—one thousand

See our data on page 265 in the 1922 A.S.M.E.
Condensed Catalogues of Mechanical Equipment.

THE GWILLIAM COMPANY
253 West 58th St., New York, N. Y.

2218 Chestnut St., Philadelphia, Pa.
23 Flatbush Ave., Brooklyn, N. Y.
418 Melwood Ave., Pittsburgh, Pa.

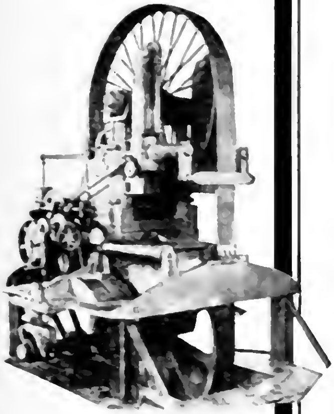
A Few Important A.S.M.E. Standards

No.	Price Mem.	Price Non-Mem.
1142—Standard Proportions for Machine Screws	.25	.40
1398—Standard Threads for Hose Couplings	.25	.35
1399—Standardization of Pipe Thread Gages	.25	.35
1733—Manual on American Standard Pipe Threads	.35	.50
1779—Screw Thread Tolerance Report	.25	.35
1654—Report of Committee on Standardization of Flanges and Pipe Fittings	.25	.35
1469—Boiler Code	.75	1.00
1778—Rules for construction of Locomotive Boilers	.25	.35
Miniature Boiler Code	.25	.35
1526—Power Test Code	1.00	2.00
1305—Identification of Power House Piping	.25	.35
1572—Code of Safety Standards for Cranes	.25	.35
1597—Code of Safety Standards for Industrial Ladders	.25	.35
1598—Code of Safety Standards for Power Transmission Machinery	.25	.35
1631—Code of Safety Standards for Woodworking Machine Guards	.25	.35
Safety Code for Elevators	.65	.65
X101—Report of Committee on Standards for Graphic Presentations	.25	.35
1510—Standardization of Safety Principles	.35	.40

No order filled for less than 50 cents

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 WEST 39th STREET, NEW YORK

Timken Tapered Roller Bearings in both the top and bottom wheels of this Wheland Band Mill are cutting down power consumption to one-half of that formerly used.



—Will Also Save
Power and Money in—

Blowers and Compressors
Clay Working Machinery
Cranes
Dairy Equipment
Electric Motors
Electrical Machinery
Elevator Drives
Farm Lighting Units
Gasoline Rail Cars
Gas Motors
Gas Producers
Grain Milling Machinery
Grinders
Hoisting and Conveying Machinery
Industrial Tractors and Trucks
Laundry Machinery
Lawn Mowers
Machine Tools
Mine Cars
Mining Machinery
Oil Well Machinery
Paper Making Machinery
Power Transmission Machinery
Printing Presses
Pumps
Railway Equipment
Refrigerating Machinery
Road Making Machinery Wheels
Separating Machinery
Shoe Machinery
Steel Mill and Foundry Equipment
Stokers
Street Railway Cars
Street Sweepers
Textile Machinery
Tire Making Machinery
Ventilating Machinery
Wood Working Machinery

—and Wherever There Is Friction

Saving 75 H P With Timkens

As a result of using Timken Tapered Roller Bearings in the new Eight Foot Wheland Band Mill, made by the Wheland Company of Chattanooga, Tennessee, the mill requires only one-half as much power as was formerly used.

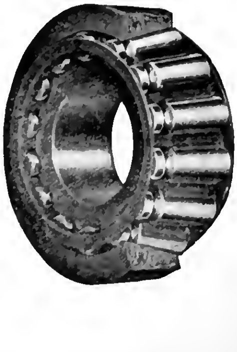
"A saving of 75 H P is made in the driving of the mill alone," says Mr. G. W. Wheland, President of the Company. "A proportionate saving is effected throughout the transmission equipment, for the mill now operates to capacity with a sixteen-inch belt, whereas a twenty-inch belt was previously necessary."

Such records of power conservation by the use of Timken Tapered Roller Bearings are not at all uncommon or phenomenal. Through their ability to carry radial loads, thrust loads, and resultant loads, they are reducing friction to an absolute minimum in nearly every type of industrial machinery.

And finally, by means of their tapered construction, their durability is indefinitely prolonged through the unassailable engineering principle of *adjustment* instead of *replacement*. When the wear which *must* follow any motion does occur (no sooner with Timkens than any other bearing), a simple, quick, easy adjustment, and Timken Tapered Roller Bearings function as when new.

The Timken Roller Bearing Co
CANTON, OHIO

TIMKEN
Tapered
ROLLER BEARINGS



BUILT STRONGER LASTS LONGER

G-W MATERIAL HANDLING EQUIPMENT

A "Safety-First" Coal Supply

Be on the safe side when a coal shortage comes. Why worry where your next load of coal is coming from when a G-W Ground Storage Plant can be installed at such a conservative cost?

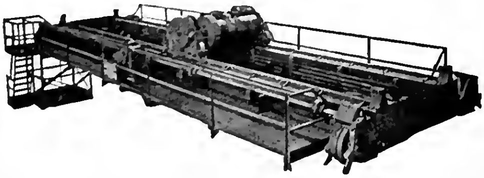
The ample storage facilities of a G-W Ground Storage Plant enable you to buy coal when the market is most favorable and to have it on hand when your competitors are paying a fancy price and still not getting deliveries.

Send for a G-W representative to show you how a "Safety-First" coal supply can be assured in your plant.

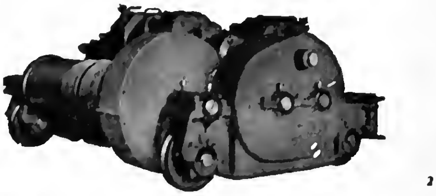
(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment), 2120-R

WORKS HUDSON N.Y.
Gifford-Wood Co.
NEW YORK-CHICAGO BOSTON-BUFFALO

NORTHERN CRANES



Our type E Cranes for either standard or mill service will interest those who buy and use cranes. Enclosed non-overhung gearing—simple substantial design—Good workmanship—The "Repeat Order" Crane.



(Also Electric Hoists)

NORTHERN ENGINEERING WORKS
DETROIT MICHIGAN — U.S.A.

BLOW 4,000 Ft.

SHAVINGS SAWDUST OR PULP CHIPS

With a positive pneumatic conveyor.

We Install and Guarantee Operation.

THE ALLINGTON & CURTIS MFG. CO.
Incorporated 1888
Factories & Offices: Saginaw, Mich.
321 Rutherford Avenue, Boston, Mass.
Offices: 565 Washington Blvd., Chicago, Ill.
333 St. Paul Pl., Baltimore, Md.; 45 West 18th St., New York, N. Y.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

ROEBLING

WIRE ROPE SLINGS
for
Industrial Plants

Strong, Durable Equalizing Thimbles.

High Safety Factor
Our Blue Center Steel Used

John A. Roebling's Sons Co., Trenton, N. J.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

SPECIALIZED CONSULTING SERVICE

in ALL BRANCHES of the ENGINEERING FIELD

The cards of Consulting Engineers appearing on pages 108, 109 110, 111, 112 and 113 serve as an index to professional service in the mechanical field. Specialized service may be obtained through this section on such subjects as

Accounting
Appraising
Combustion
Construction
Copyrights
Cost Systems
Designing
Foundries
Heating and Ventilating
Hydraulic Work
Industrial Plants
Inspection
Machinery Designing
Management
Manufacturing Methods
Organization
Patent Law
Plant Constructio
Power Plants
Power Transmission
Production
Refrigeration
Research
Special Machinery
Taxes
Testing
Tool Designing
Trade Marks
Water Purification
Water Supply

Clyde's Greatest Asset—

Hundreds of satisfied customers who always specify Clyde Equipment on repeat orders.

You'll take pride in your Clyde!

CLYDE

Clyde Iron Works Sales Company
DULUTH, MINN., U. S. A.
Sole Distributors for Clyde Iron Works
NEW YORK NEW ORLEANS SEATTLE CINCINNATI
CHICAGO JACKSONVILLE PORTLAND

LIDGERWOOD HOISTS

STEAM - ELECTRIC - GASOLENE

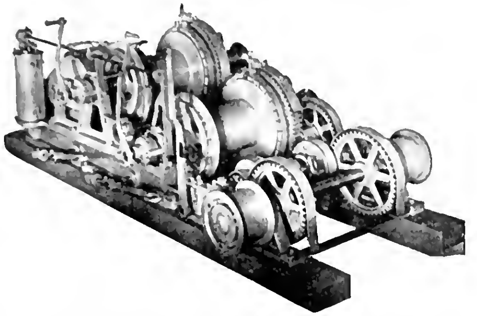


Illustration shows Double Drum Electric Hoist, with boom swinging clear for derrick work

We have types to meet every kind of hoisting service

STRENGTH - SPEED - ECONOMY

are features of all Lidgerwood

HOISTS - DERRICKS - CABLEWAYS

REQUESTS FOR CATALOGS INVITED

LIDGERWOOD MFG. CO.
96 LIBERTY STREET NEW YORK
Chicago Cleveland Detroit Los Angeles Pittsburgh
Philadelphia Seattle

Perforated Metal Screens

in

STEEL, COPPER, BRONZE, BRASS, LEAD, etc.

for all purposes

ELEVATOR BUCKETS

PLAIN AND PERFORATED

General Sheet and Light Structural Work

Light and Heavy Steel Plate Construction

HENDRICK MFG. CO., Carbondale, Pa.
New York Office, 30 Church Street
Pittsburgh Office, 544 Union Arcade
Hazleton, Pa. Office, 705 Markle Bank Bldg.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

MSFCo
TRADE MARK

HOISTS

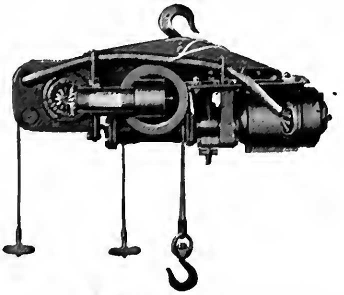
CABLEWAYS
WINCHES
WINDLASSES
CAPSTANS
DREDGING MACHINERY

Catalog on Request
Wire, write or phone our nearest office

S. FLORY MFG. CO.
Works: BANGOR, PA.
New York, 95 Liberty St.
Chicago, Monadnock Bldg.
Pittsburgh, House Bldg.
Hartford, Conn., K. B. Noble Co.
Birmingham, Ala., Chas. T. Lehman Co.
Huntington, W. Va., Banks Supply Co.

The New EVEREDY Electric Hoist

LIGHT WEIGHT



QUICK SPEED

READING CHAIN & BLOCK CORP., READING, PA.

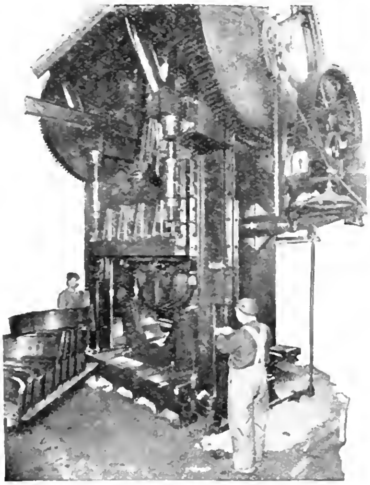


Photo by courtesy of our customer PATENTED

Forming Fenders

BLISS

THE ILLUSTRATION shows a BLISS No. 409-C Patented Double Crank Toggle Drawing Press forming pressed steel fenders.

The further we go in the work of illustrating what BLISS Presses are doing, the wider becomes the range of industries they are serving at a saving over other methods. One of our customers recently said something like this: "We used to buy the BLISS Presses we thought we needed and use them as we thought best. Now we have asked Bliss Engineers to come in and show us, not only how to get more production out of what we have, but how to use more presses in the interests of economy."

There is a BLISS Press for every requirement.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

Bliss for Machinery

E. W. BLISS CO. MAIN OFFICE AND WORKS **BROOKLYN, N. Y., U. S. A.**

SALES OFFICES DETROIT Dime Bank Bldg. CLEVELAND Cleveland Discount Bldg. CHICAGO Peoples Gas Bldg. PITTSBURGH Oliver Bldg. ST. LOUIS Boatmen's Bank Bldg. BUFFALO Marine Bank Bldg. CINCINNATI Union Trust Bldg. NEW HAVEN Second Nat'l Bank Bldg.

American Factories: BROOKLYN, N.Y. HASTINGS, MICH. CLEVELAND, OHIO. SALEM, OHIO.

FOREIGN SALES OFFICES AND FACTORIES:

ENGLAND, Pocock St., Blackfriars Rd., S. E., London ITALY, 345 Via Nizza, Turin FRANCE, 54 Blvd. Victor-Hugo, St. Ouen, Paris

No. 321

MACKINTOSH-HEMPHILL CO.

Offers You a Complete Service—IN ROLLING MILL AND STEEL WORKS EQUIPMENT—thru its following departments:

FORT PITT FOUNDRY . . . PITTSBURGH, PA.
A. GARRISON FOUNDRY . . PITTSBURGH, PA.
WOODARD MACHINE CO. . . WOOSTER, OHIO
PITTSBURG IRON & STEEL FDRY., MIDLAND, PA.

"The Best In Rolling Mill Machinery"

ROLLS FOR ALL PURPOSES

"MANGANITE"—CHILLED, SAND AND STEEL—"ADAMITE"

ROLLING MILLS OF ALL KINDS AND TYPES

STEEL AND IRON CASTINGS UP TO 75 TONS
BRASS CASTINGS
"ADAMITE" AND SPECIAL STEEL CASTINGS

SHEARS, SAWS, PRESSES, ROLL LATHES, HYDRAULIC MACHINERY AND OTHER MILL EQUIPMENT

CAST AND CUT TEETH GEARS AND PINIONS (SPUR—BEVEL—HELICAL)

ANNEALING BOXES AND BOTTOMS

Mackintosh-Hemphill Co.
Pittsburgh, Pa.

CLASSIFIED ADVERTISEMENTS

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

RATES

40 cents a line; 30 cents a line to members of A.S.M.E. (Minimum insertion, 5 lines: Maximum, 20 lines. No display matter carried.)

Address

The American Society of Mechanical Engineers
29 West 39th Street New York City

"THE QUALITY LINE"

POWER PUNCHING AND SHEARING MACHINERY

Your Inquiries Solicited

THE LONG & ALLSTATTER CO.
American Punch & Shear Works
HAMILTON, OHIO, U.S.A.

"You pay for what you need Whether you buy it or not"

Each machine shop needs the equipment which will do at the lowest cost the work required of it—and pays more in time and materials wasted in makeshifts when it doesn't buy what it needs.

There's a way to prove whether or not you are getting your work at the lowest cost.

There's a way to prove whether or not your shop is making or losing money on its equipment.

A staff of machine shop engineers is maintained by The Warner & Swasey Company to keep up to date on just such problems. It doesn't cost you a cent to consult them and may save your shop thousands of dollars.

Send us blue prints of your work and see if you don't gain something.

The Warner & Swasey Company

Cleveland, U. S. A.

NEW YORK: Singer Building
CHICAGO: 618-622 Washington Boulevard
MILWAUKEE: 209 Sycamore Building

BOSTON: Oliver Building
INDIANAPOLIS: 940 Lemcke Annex

BUFFALO: Iroquois Building
DETROIT: 5928 Second Boulevard
DAYTON: 518 Mutual Home Building

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

In the HEALD Line

There is a Machine for Every Internal and Surface Grinding Requirement

Style No. 80. Automatic Internal Grinding Machine for small, long work.

Style No. 85. Hand Feed Internal Grinding Machine for small, short work.

Style No. 70. Automatic Internal Grinding Machine for medium work, both length and size.

Style No. 75. Hand Feed Internal Grinding Machine for medium sized short work.

Style No. 50. Cylinder Grinding Machine for a great variety of large awkward-shaped work.

Style No. 20. Surface Grinding Machine for single work. Has 8 in. capacity.

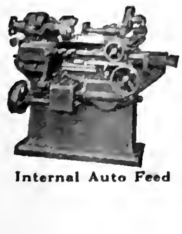
Style No. 22. Surface Grinding Machine for large single or multiple work. Has 12 in. diameter capacity.

Style No. 25. Surface Grinding Machine. Has automatic feed for chucking work. Ideal for piston rings, collars, ball races, etc.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

The Heald Machine Co., Worcester, Mass.

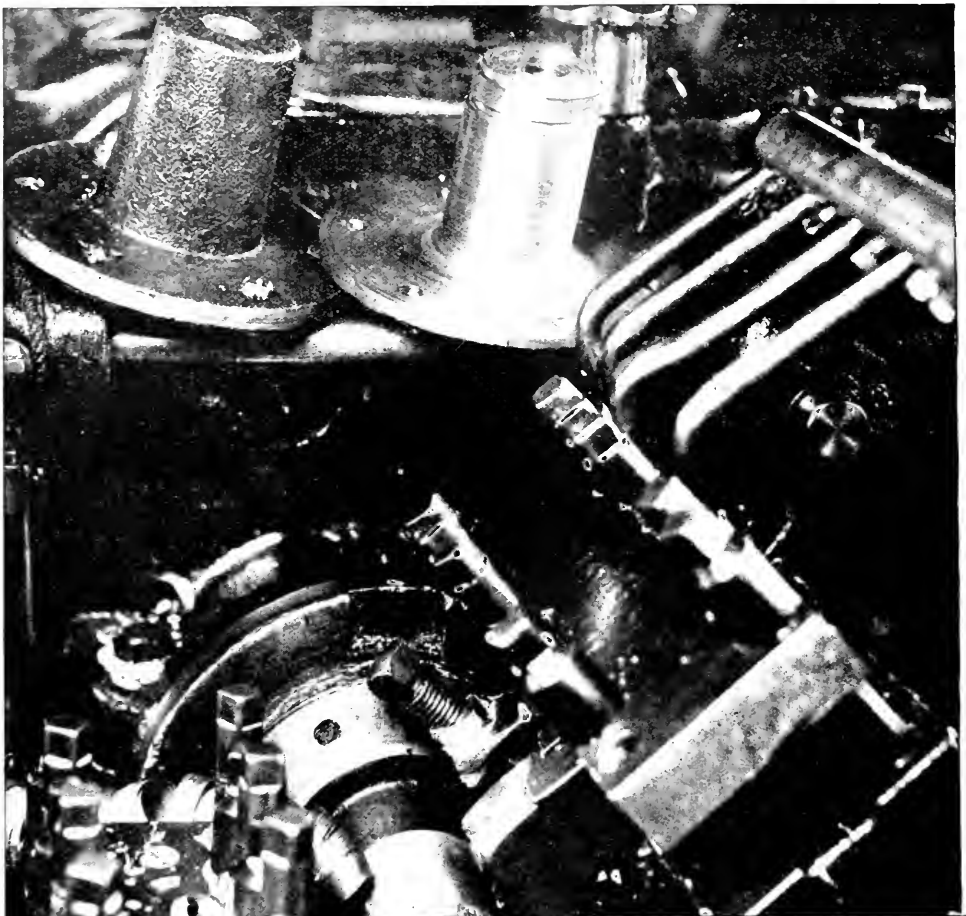
Cylinder Grinder

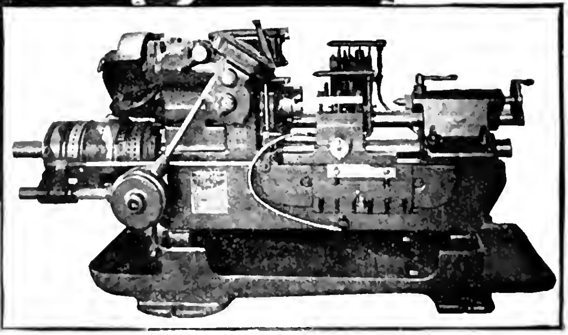


Internal Auto Feed

Surface Grinder

230 Ford Truck Rear Hubs





The above photograph was taken at the plant of a prominent automobile parts manufacturing corporation and shows a close-up of one of a battery of Fay Automatic Lathes finish turning Ford Truck Rear Hubs.

These Hubs are finish turned in these machines from the rough forging, right down to the finished size in one cut. Each machine finishes 230 of these hubs in 9 hours.

AGENTS

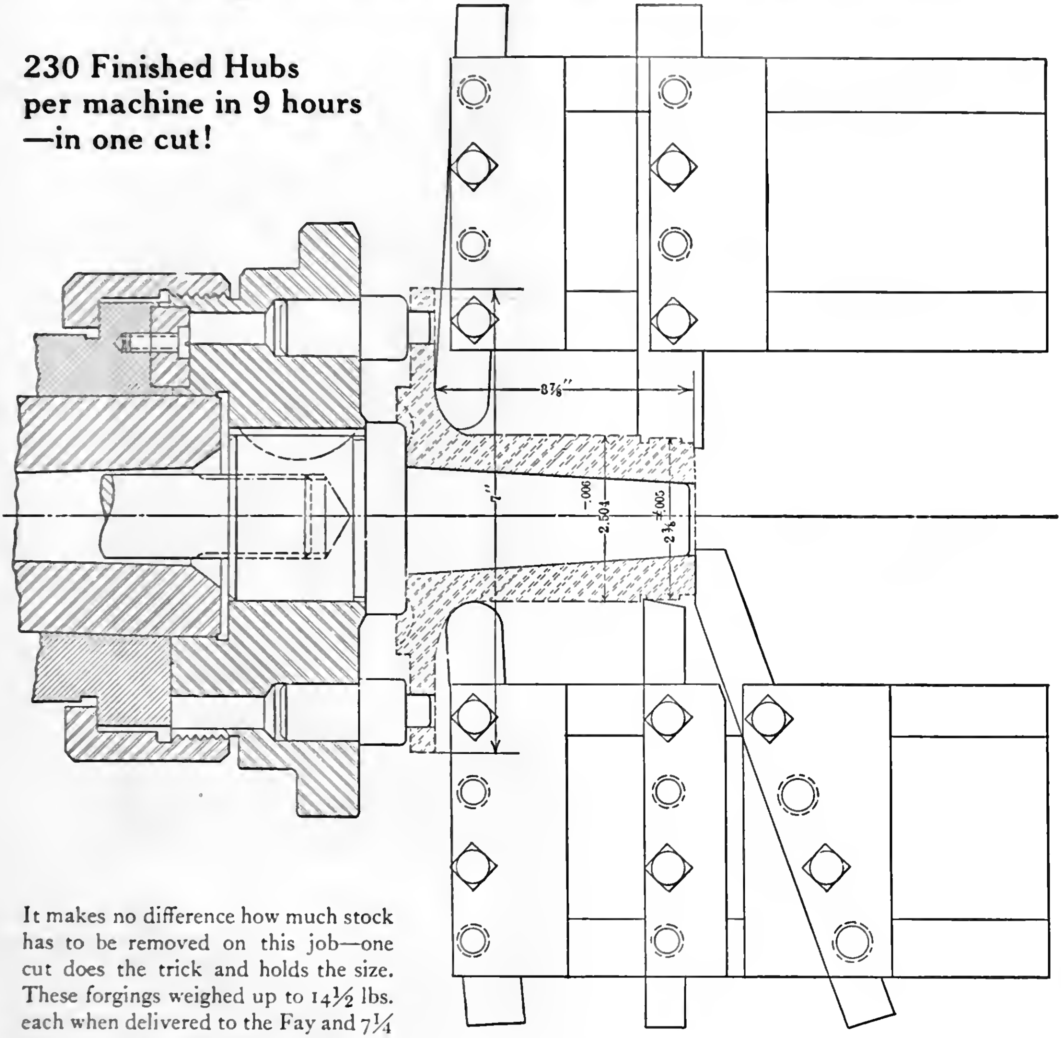
France, Spain and Belgium – F. Auberty & Co., 182 Rue Lafayette, Paris. Holland – Spliethoff, Beeuwkes & Co., Leuvehaven, wz, 159 Rotterdam.

Jones & Lamson

SPRINGFIELD, VERMONT, U.S.A.

Finished in 9 Hours on Each Fay Automatic Lathe

230 Finished Hubs per machine in 9 hours —in one cut!



It makes no difference how much stock has to be removed on this job—one cut does the trick and holds the size. These forgings weighed up to 14½ lbs. each when delivered to the Fay and 7¼ lbs. each after being turned as shown.

The Fay Way removes stock by the ton and yet holds the size!

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

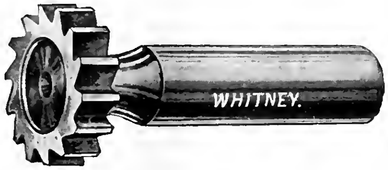
Machine Company

9-10 Water Lane, Queen Victoria St., London, E.C., Eng.
503 Market Street, San Francisco, California

AGENTS
Japan, Korea, etc., Mitsui & Co., Ltd., Tokio. Australasia—McPherson's Pty., Ltd., 554 Collins St., Melbourne, Sweden—A. Bol. Oscar Lindbom, Stockholm—Post Box 420.

“WHITNEY” KEY-SEAT CUTTERS

For the Woodruff System of Keying

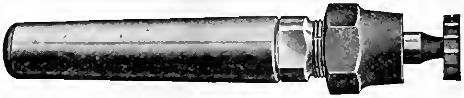


BE SURE AND GET OUR PRICES

Prompt Deliveries in Either Carbon or High-Speed Steel

Let us hear from you if you need cutters for the Woodruff System. Our cutters are all made with straight shanks ½-in. diameter and the sizes run from number one to Letter G inclusive.

For holding these cutters we recommend the “Whitney” Spring Collet, into which the cutters are quickly and easily inserted or removed with no possibility of injury to the shank.



The use of this collet insures the cutters running true and thus avoids the danger of breakage which frequently results from the use of ordinary collets, especially those provided with set screws. For heavy cuts we can furnish the cutters with keyed shanks, thus absolutely preventing the cutter from turning in the collet and damaging the shank.

“WHITNEY” KEYS

are made in sizes to correspond with “Whitney” Cutters and can be furnished in either High Carbon or Nickel Steel. They will fit the Keyseats made with our cutters without filing or fitting.

THE WHITNEY MFG. CO., Hartford, Conn.

CHAINS KEYS AND CUTTERS HAND MILLING MACHINES

FOREIGN AGENTS: Burton, Griffiths & Co., Ltd., London. Fenwick Freres & Co., Paris.
Rylander & Asplund, Stockholm

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

THE ENGINEERING INDEX *for* 1921

Annual Volume

Here is presented in convenient form a carefully digested record of the periodical engineering literature of a dozen countries published during 1920. Within its six hundred pages are to be found fully 12,000 major references to articles on over 4,000 different subjects, which appeared in the world's leading technical journals and the transactions of various societies.

The rapidly increasing number of subjects and the present extent of the world's technical literature make it almost hopeless for any engineer to keep in intimate touch with all of the important material pertaining to his business, even if he subscribes to a large number of periodicals. THE ENGINEERING INDEX makes it an easy task to keep abreast of the times, for it covers the entire field of technical literature.

Every engineer, no matter how highly specialized, will find hundreds of references to pertinent articles of particular interest to him, while the engineer in general practice will be readily directed to the sources of information regarding any subject on which he is engaged.

PRICE $6.00

To Members $5.00

Engineers in all parts of the world use THE ENGINEERING INDEX and subscribe for it regularly year after year. They find that it pays them. —You, too, will find it a profitable investment.

Published Annually by

The American Society of Mechanical Engineers

29 West 39th Street, New York, N. Y.

BOOTH 39

NATIONAL EXPOSITION POWER and MECHANICAL ENGINEERING

December 7-13

offers a convenient common meeting place at which your experts can discuss with our experts problems of

Vibration

NWA BALANCING EQUIPMENT will be exhibited, demonstrating conclusively the accuracy of our balancing principles.

Our experts will be glad to discuss with you the problems that have arisen in your plant.

We have a field service equipment, flexible in its utility, which can be shipped to your plant, and, under the supervision of one of our field engineers, the unbalanced —and therefor potentially dangerous— part may be placed in perfect balance, statically, and dynamically.

The cost of this field service is moderate, well within the range of every power plant owner—its value is incalculable.

Do not overlook this opportunity of discussing vibration problems.

Our booklet—
"Eliminating Vibrations"
sent upon request.

WE SOLVE VIBRATION PROBLEMS

VIBRATION SPECIALTY COMPANY

N. W. Akimoff, President

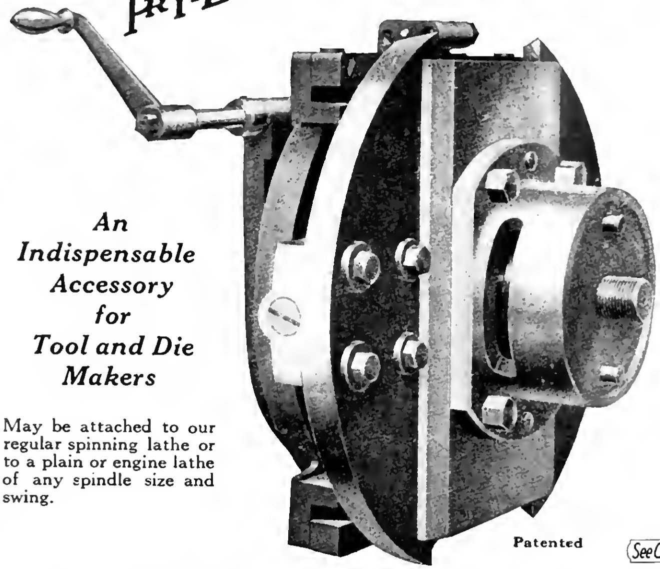
Harrison Bldg., Philadelphia, U. S. A.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

PRYIBIL OVAL CHUCKS

for

Spinning and Turning Oval Shapes



An Indispensable Accessory for Tool and Die Makers

May be attached to our regular spinning lathe or to a plain or engine lathe of any spindle size and swing.

These chucks are for spinning true ellipses and are made in several types and sizes. Can be used for machining tools, dies and cutters.

Many metal articles can be economically produced by spinning with these chucks.

Let us work with you on your problem—our staff of experts are at your service. Send us a blue print and the specifications.

Send for Pryibil Catalog of Metal Spinning Equipment.

Patented

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

P. PRYIBIL MACHINE COMPANY, Inc.

Manufacturers—Established 1859

512-524 West 41st Street New York, N. Y.

ANNOUNCING
A COMPLETE NEW LINE
of
FORBES'
IT THREADS PIPE ACCURATELY

PIPE THREADING and CUTTING MACHINES

Send for circulars and prices

THE CURTIS & CURTIS CO.

350 GARDEN STREET BRIDGEPORT, CT.

Bolt and Pipe Threading Machinery

A complete description and detailed specifications of Landis bolt threading die heads and machines, pipe threading die heads, pipe threading and cutting off machines and automatic screw cutting die heads will be found in the 1922 volume of the A.S.M.E. Condensed Catalogues.

Landis Machine Company, Inc.

Waynesboro, Pa., U. S. A.

The Engineer Should Know

PARKER HARDENED DRIVE SCREWS

They Cut Their Own Thread!

PAT. PEND.

For Fastening to Steel, Cast-Iron, Etc., there's nothing better!

Shall We Send You Samples and The Rest of The Story? Write Now!

PARKER SUPPLY CO., INC.

Dept. A.S. New York, N. Y.

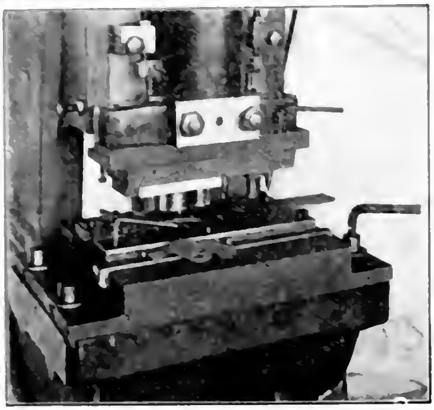
(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

SPECIALIZED CONSULTING SERVICE

in ALL BRANCHES of the ENGINEERING FIELD

The cards of Consulting Engineers appearing on pages 108, 109, 110, 111, 112 and 113 serve as an index to professional service in the mechanical field. Specialized service may be obtained through this section on such subjects as

Accounting
Appraising
Combustion
Construction
Copyrights
Cost Systems
Designing
Foundries
Heating and Ventilating
Hydraulic Work
Industrial Plants
Inspection
Machinery Designing
Management
Manufacturing Methods
Organization
Patent Law
Plant Construction
Power Plants
Power Transmission
Production
Refrigeration
Research
Special Machinery
Taxes
Testing
Tool Designing
Trade Marks
Water Purification
Water Supply



Illustrating the use of

ALLEN SOCKET HEAD CAP SCREWS

Made by the Allen process of cold-drawing the sockets, the socket-walls are perfectly-formed and true, down to the bottom of the hole. The metal strengthened by tremendous compression in the drawing process, and scientifically heat-treated. The threads are die-cut, accurate in pitch and perfect in lead. The head of the screw is finished all over and turned true to the body of the screw, so you can set it up in a counterbored hole without ever grinding off the sides, as so often is necessary with a slotted cap screw.

Allen process
Socket Head Cap Screws
for Punch, Die and Jig Work

Most of your punch press work calls for frequent adjustment of the dies and punches. This means a constant tightening and loosening of screws—until they soon loosen without any help, if hexagon head cap screws or slotted fillisters are used.

The Allen Socket Head Cap Screw gets away from the weak points of old-style cap screw design. There are no corners to round off and allow wrench-play. There's no slot to spread and lose its grip on the screwdriver. The *Allen* can be set up fully as tight as a *new* hexagon head screw; vastly tighter than an old, worn one. And you can work it in close quarters where there isn't room to apply an "S" wrench.

We've issued a little folder, adding somewhat to these facts and carrying a chart of sizes and prices. You'll feel it's worth sending for.

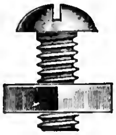
THE ALLEN MFG. CO. . . . .
131 Sheldon Street
HARTFORD, CONN.

Manufacturers of Safety Set Screws, Socket Head Cap Screws, Pipe Plugs, Tap Extensions and Socket Wrenches—Allen Process
Pacific Coast Branch Office: The Charles A. Dowd Sales Co., 320 Market Street, San Francisco, Cal.

TRADE MARK
MADE IN THE UNITED STATES OF AMERICA
WORCESTER, MASS.
RP

See
1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment for data concerning our products.

WOOD SCREWS, MACHINE SCREWS,
CAP SCREWS, SET SCREWS,
BOLTS, NUTS, RIVETS, BURRS,
SPECIALTIES.



REED & PRINCE MFG. CO.
MAIN OFFICE and Plant at WORCESTER, MASS.
BRANCH—121 N. JEFFERSON ST., CHICAGO, ILL.

BRASS FACTS

HELPING THE MANUFACTURER

EXPERIENCE of the most successful manufacturers has shown them that it is neither practicable nor efficient to make *all* parts under one roof. In this age of specialization and sub-division of industry, it pays them to resort to the specialist.

During the past 120 years our development and growth have put us into a most advantageous position, not only to make small parts or complete articles for other manufacturers, but also to supply them with the raw materials best suited to meet their own manufacturing needs.

How can we serve you?

Brass Mill Products
Manufactured Articles to Order
Mills and Factories — Waterbury, Conn.
Sales Offices: New York, Chicago, Boston, Cleveland, Philadelphia and San Francisco

ESTABLISHED 1802
SCOVILL
MANUFACTURING COMPANY

Border illustrates the microstructure of Brass Mag. 75x

THE H. A. WILSON COMPANY
97 Chestnut St.,
Newark, N. J.

Manufacturers of:

- Wilco Thermostatic Metal
- Wilco High Temperature Thermostatic Metal (patent pending)
- Wilco High Resistance Thermostatic Metal (patent appplied for)
- Wilco Non-Corrosive Thermostatic Metal (patent applied for)
- Platinum and Silver Contact Points (Rivets and Screws)
- Special Alloys—(Precious metals)

Refiners and workers of Platinum, Gold and Silver.

Descriptive booklet sent upon request.

WILCO

THE MINIMETER

A Precision Measuring Instrument

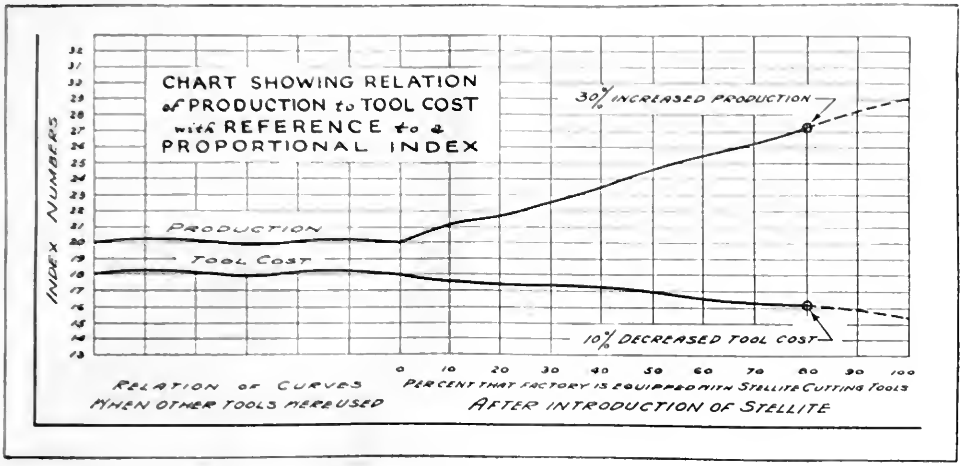
Combining Scientific Exactness with Commercial Adaptability

After once being set to a standard, it eliminates the personal error and permits precision measurements to be made with great rapidity. It brings to the measurement of ordinary bench and machine work the precision hitherto not available even by elaborate and costly methods.

Measures to 1/10,000 of an inch

The booklet will be sent on request

THE NORMA COMPANY OF AMERICA
Anable Avenue
Long Island City New York
BALL, ROLLER AND THRUST BEARINGS



A silent appeal to the deliberate thinker

Each week or each month you chart the various data on costs and production.

If the lines of "Production" and "Tool Cost" run parallel, you have a feeling of security. But, if you find those lines diverging—Production UP, Tool Cost DOWN—you know you are accomplishing *big things*. A large number of managers, especially in the Automotive Industry, are making these lines deflect in a surprising manner. Stellite Cutting Tools are the reason.

Wherever Stellite is used *increased production results*. Some jobs show as high as 221% increase. The average is about 30%.

What Stellite Tools and Stellite Service have done for others they can do for you. Tell us of *your job* and we will tell you of the increased production *you can get* and *how to get it!*

HAYNES-STELLITE COMPANY
Carbide and Carbon Building, 30 East 42nd Street, New York
Peoples Gas Building, Chicago **General Motors Building, Detroit** **4503 Euclid Avenue, Cleveland**

STELLITE
CUTTING TOOLS

Rotary Automatic Furnaces in series for a three operation heat-treatment– normalizing, hardening and drawing.

CONTINUOUS HEAT-TREATMENT

The ideal condition—*better heating at lower cost*—is approached when the heat is applied to each piece in the *same manner*, for the *same time*, at the *same rate*, and at the *same temperature*.

The automatic furnace most easily meets the requirements by insuring the gradual heating of each piece in the same manner, for the same time, at the same rate, and at the same temperature.

It also has the advantage of *increasing output* in proportion to labor, fuel and floor space, as one man with an automatic furnace can do more work, at less cost than two or three men with a furnace operating on the "hatch" principle

Many interesting applications of the continuous method to the field of industrial heating are shown in Bulletin 234-U. Write for copy to nearest branch.

BETTER HEATING
W. S. ROCKWELL CO.
INDUSTRIAL
ESTABLISHED 1888
FURNACES
50 CHURCH ST.
NEW YORK
LOWER COST

BRANCHES

CHICAGO	CLEVELAND	DETROIT
Ellsworth Bldg.	Engineers' Bldg.	Majestic Bldg.

British Representative: Gibbons Bros., Ltd.,
Dudley, Worc., England

CHARLES F. KENWORTHY, Inc.

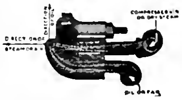
WATERBURY, CONN.

INDUSTRIAL FURNACES

Fuel or Electric Heated
For Every Purpose

Exclusive Builders of
"Non-Oxidizing" Annealing Furnaces

There is nothing better than the Best



To secure 100% Economy and 100% Efficiency use W. N. Best oil and tar burners and furnaces for Annealing, Case Hardening, Tempering, Forging, Heat Treating, etc.

SEND FOR CATALOG

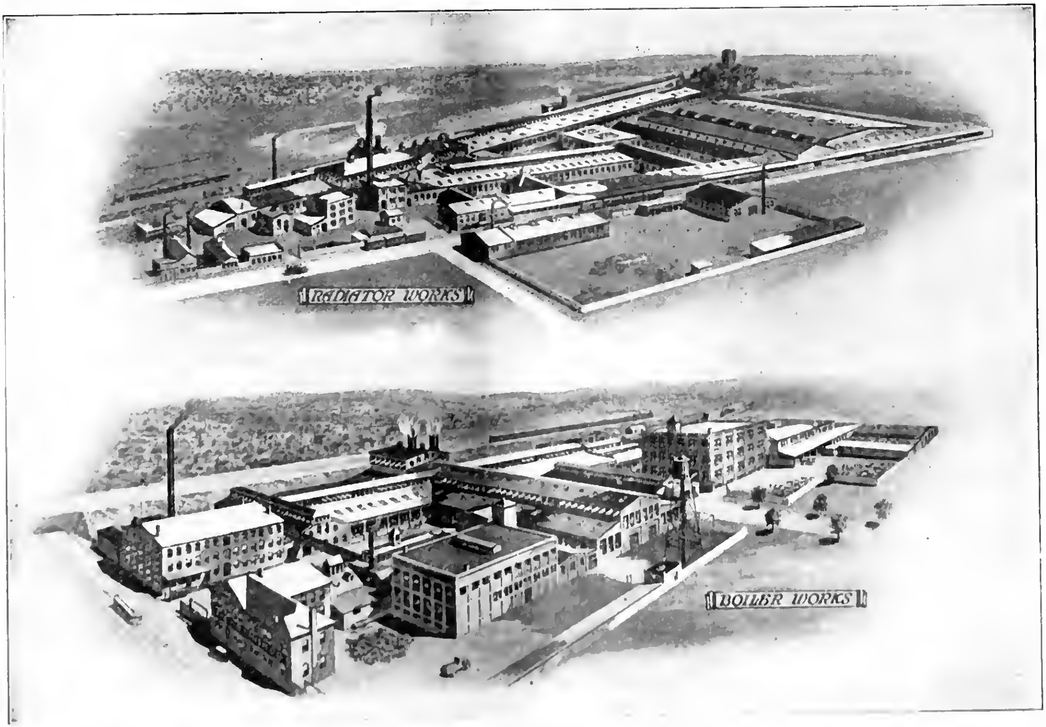
"There is nothing better than the Best"

W. N. Best Furnace & Burner Corp'n

11 Broadway New York City

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment

---

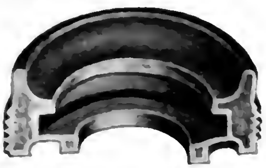


THE H. B. SMITH COMPANY

New York, N. Y., 10 E. 39th St. Philadelphia, Pa., 17th & Arch Sts. Boston, Mass., 640 Main St., Cambridge, Mass. Westfield, Mass.

AMERICAN METAL TREATMENT CO.
ELIZABETH, N. J.

SAMPLE OF CASE HARDENING BY THE GAS PROCESS



OUR SPECIALTIES
CASE HARDENING, HARDENING, ANNEALING
TEMPERING, GUN METAL COLORING, ETC.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

Union Drawn Steel Co.
Beaver Falls, Pa.
MAKERS OF
Bright Cold Finished Bessemer, Open Hearth, Crucible and Alloy Steels, in Rounds, Flats, Squares, Hexagons and Special Shapes

Shafting Screw Steel

SPECIALIZED CONSULTING SERVICE

in ALL BRANCHES of the ENGINEERING FIELD

The cards of Consulting Engineers appearing on pages 108, 109, 110, 111, 112 and 113 serve as an index to professional service in the mechanical field. Specialized service may be obtained through this section on such subjects as

Accounting
Appraising
Combustion
Construction
Copyrights
Cost Systems
Designing
Foundries
Heating and Ventilating
Hydraulic Work
Industrial Plants
Inspection
Machinery Designing
Management
Manufacturing Methods
Organization
Patent Law
Plant Construction
Power Plants
Power Transmission
Production
Refrigeration
Research
Special Machinery
Taxes
Testing
Tool Designing
Trade Marks
Water Purification
Water Supply

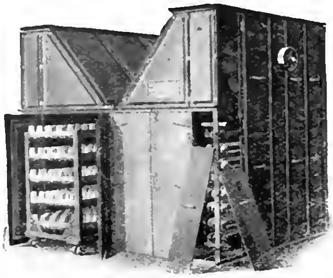
DOEHLER
The World's Largest Producer of
DIE-CASTINGS

In purchasing die-castings, you'll get just what you are willing to pay for—in the way of quality, accuracy, uniformity, strength, delivery. There's no such thing as a "bargain" in die-castings, as the word "bargain" is ordinarily used. Yet, it is a matter of repeated experience on the part of die-casting users the country over, that Doehler—with the unequalled facilities afforded by his large plants and with a mastery of the art gained in fourteen years of specialization—can and does produce and sell die-castings which you can use with maximum economy. You'll pay less for the service you get from a Doehler Die-Casting, than for any other. And it's the service a die-casting gives you that you are buying—not just so much metal.

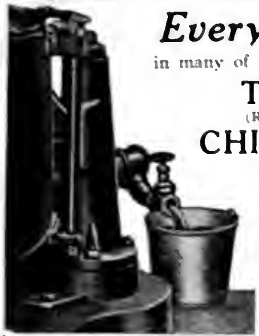
DOEHLER DIE-CASTING CO.
BROOKLYN, N.Y.
CHICAGO, ILL. TOLEDO, OHIO.

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

Doehler die-cast parts for automotive equipment




A SAFETY CODE FOR
ELEVATORS



Every 15 Minutes

in many of the country's important plants

TOLHURST
(Reg. U. S. Patent Office)
CHIP WRINGERS

Wring out an average of 12 gallons of cutting oil from a load of metal turnings and chips.

Tolhurst's are easily operated—easily filled and unloaded—have removable baskets with capacity of 8.7 and 12.5 cubic feet—can handle four loads of chips an hour.

TOLHURST MACHINE WORKS, Troy, N. Y.

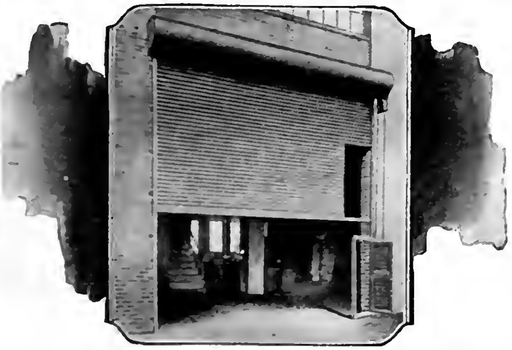
MANUFACTURED WEATHER—
to make "Every day a *good* day"
AIR CONDITIONING & DRYING

HUMIDIFICATION DEHUMIDIFICATION
HEATING VENTILATION PURIFICATION

Carrier Engineering Corporation

Offices & Laboratories
750 Frelinghuysen Ave., NEWARK, N. J.
Boston Buffalo Chicago New York Philadelphia

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)



Pusey & Jones Plant, Wilmington, Del.

WILSON

Standard for Forty-six Years

Rolling STEEL Doors

Underwriter or Commercial

MAKE BUILDINGS FIREPROOF

A safety precaution and building economy. Easily operated and maintained. Used in warehouses, industrial plants, freight and car sheds everywhere.

Also Rolling WOOD Doors. *Details in Sweet's Catalogues.*

THE J. G. WILSON CORPORATION
GENERAL OFFICES, 12 EAST 36th ST., N. Y.
Branch Offices In Principal Cities

SONNEBORN PRODUCTS

Perfect Concrete Floors

No Dusting—No Disintegration

Safeguard yourself—forestall any chance of clients' dissatisfaction, due to concrete floor troubles.

Lapidolith, the liquid chemical is now the standard specification for the dustproofing and wearproofing of old or new concrete floors.

Let us refer you to a lapidolized floor near you, or to engineers of your acquaintance who know Lapidolith and always specify it.

LAPIDOLITH
TRADE MARK
The Liquid Chemical Dustproofer and Wearproofer of Concrete Floors

completes the hydration of the Portland Cement and makes the mass granite-hard for all time.

It also increases the density of the concrete, so that it becomes impervious to water and so is widely used in treating concrete tanks and swimming pools.

Lapidolith is the original concrete hardener—standard for twelve years.

Write to Technical Dept. for specification forms, sample and details.

OTHER SONNEBORN PRODUCTS:

HYDROCIDE—	A black tacky material for waterproofing foundations and dampproofing the interior of exposed walls. No furring or lathing necessary.
HYDROCIDE INTEGRAL—	To be mixed with the cement for waterproofing mass concrete against water pressure. Powder or paste.
FERMO—A	liquid chemical which hastens the set of concrete and mortar. Saves time—prevents freezing.

L. SONNEBORN SONS, INC.
Dept. 19, 116 Fifth Avenue, New York, N. Y.

SONNEBORN

K & E MEASURING TAPES

"Home"
Steel Tape

are reliable and accurate. Material and workmanship high-grade. Our method of numbering—"Ready Reading"—is a great advantage, as it simplifies the reading of the tape and prevents errors.

Prices revised.
Send for new price list.

KEUFFEL & ESSER CO.

NEW YORK, 127 Fulton Street, General Office and Factories, HOBOKEN, N. J.

CHICAGO 516-20 S. Dearborn St.
ST. LOUIS 817 Locust St.
SAN FRANCISCO 30-34 Second St.
MONTREAL 6 Notre Dame St. W.

Drawing Materials, Mathematical and Surveying Instruments, Measuring Tapes

---

The Engineering Societies Library

One of the largest collections of engineering literature in the world is that found in the Engineering Societies Library, 29 West 39th Street, New York.

It comprises 150,000 volumes, including many rare and valuable reference works not readily accessible elsewhere. Over 1,300 technical journals and magazines are regularly received, including practically every important engineering journal published in the civil, mechanical, electrical, and mining fields.

The library is open from 9 a. m. to 10 p. m. with trained librarians in constant attendance. Its resources are at the service of the engineering and scientific public

---

The World's Most Famous Pencil

VENUS PENCILS

The largest selling Quality pencil in the world

First in the estimation of engineers because of the dependable smoothness, firmness and uniformity of the leads.

17 Black Degrees 3 Copying

For bold, heavy lines . .	6B-5B-4B-3B
For writing, sketching .	2B-B-HB-F-H
For clean, fine lines .	2H-3H-4H-5H-6H
For delicate, thin lines . . .	7H-8H-9H
Plain Ends, per doz. .	$1.00
Rubber Ends, per doz. .	1.20

At Stationers and Stores throughout the World

American Lead Pencil Co.
211 Fifth Ave., New York
also London, Eng.

The Midget Five-in-One Slide Rule

The Midget Five-In-One Slide Rule (Patented) is a combination Log-Log, Add and Subtract, Polymetric, Binary and Mannheim Slide Rule. It will solve any problem that can be solved by these types and has many additional advantages. This is an ideal slide rule; universal in use; easily carried and made to give years of service. It will handle from two to six factors at one setting and give continuous readings. The Engine-divided Scales are on white celluloid, mounted on aluminum and are grease and water proof. The Spiral Log-Log Scale is divided between 1.15 and 1,000,000. Diameter of rule 4", length of the C Scale 12".

Amongst the 1,000 testimonials on the Midget that we have received, an Engineer wrote, "I have owned a dozen slide rules during the past twenty years and like the Midget best. I have used mine for two years."

Price of the Midget Slide Rule, with Instructions, $1.50
Fabrikoid Carrying Case, 50c Extra.
Your money back if you are not satisfied.

GILSON SLIDE RULE CO., 14 Mill St., Niles, Mich.

For Factory and Institutional Equipment

—SPECIFY—

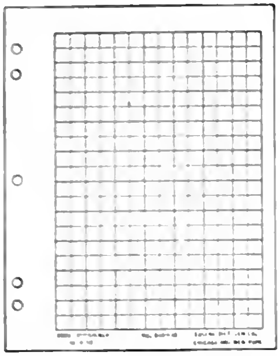
METAL
MEECO
PRODUCTS

DRINKING FOUNTAINS, WASH BOWLS;
METAL LOCKERS, CHAIRS, SHELVING,
TOILET ENCLOSURES, BOXES & CABINETS

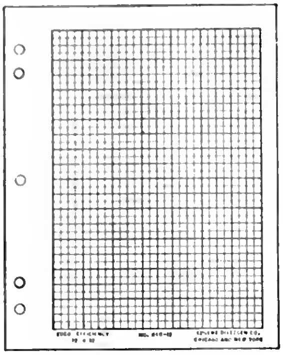
MFG. EQUIPMENT & ENGINEERING CO.
Framingham, Mass., U. S. A.

Valuable for use in Drafting Rooms, Manufacturing Plants, Colleges, Etc.

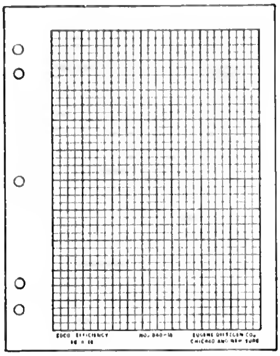
"EDCO" Efficiency Cross Section Papers



No. 340—10.
10 x 10 to one inch. Every fifth line slightly heavier. Extra heavy inch lines.



No. 340—12.
12x12 to one in. Every third and sixth line slightly heavier than the sub-dividing lines. Extra heavy inch lines.



No. 340—16.
16 x 16 to one inch. Every fourth and eighth line slightly heavier. Extra heavy inch lines.

Only the principal dividing lines are shown on above illustrations; all subdividing lines being omitted.

"EDCO" Efficiency Cross Section Papers are high-grade loose leaf record sheets and co-ordinate paper in letterhead size, 8 1-2x11 inches, for graphic charts, statistics, sketching, etc. All rulings are in neutral tint, imprinted on excellent medium thick Tracing Paper stock of sufficient transparency to permit Blue Printing. In addition to the three illustrations shown above, ten other rulings as well as two plain sheets, as described below, are carried in stock.

340—20. 20 x 20 to one inch. Every fifth and tenth line slightly heavier. Extra heavy inch lines.
340—M. Millimeter divisions, half centimeter, centimeter and 5 centimeter lines heavier than the subdividing lines.
340—L2. Logarithmic divisions, two cycles, 5 in. base.
340—L3. Semi-Logarithmic divisions in three cycles. Every fifth vertical line slightly heavier than the other lines, so that the width of the plate, 7 in., is divided into fourteen equal spaces.
340—L4. Semi-Logarithmic divisions in four cycles; otherwise similar to No. 340-L3.
340—P. Polar Co-ordinate divisions. Engraving 7 x 8¾ inches.
340—R. Record sheet, covers 6 months.
340—I. Isometric divisions.
340—22. Plain writing paper, no ruling.
340—23. Quadrille ruled, writing paper.
340—24. Record writing paper, ruled, with margin.
340—25. Drawing paper, white, no ruling.

BINDERS

341. Stiff cover, full black cloth, two rings.
342. Semi-Flexible, imitation leather, two rings.
343. Semi-Flexible, full leather, five rings.

Nos. 340-10 to I, $11.15 per 1000 sheets; Nos. 340-22 to 24, $18.00 per 100 fillers of 20 leaves each; No. 340-25, $18.00 per 100 fillers of 12 leaves each; No. 341, $0.95 each; No. 342, $1.65 each; No. 343, $3.75 each.

Descriptive circular fully illustrating the line mailed on request.

EUGENE DIETZGEN CO.

Right goods at right prices
continuously since Year 1885

Branches:
Chicago New York
New Orleans Pittsburgh
San Francisco

Sales Offices:
Philadelphia Washington
Factory:
Chicago, Illinois

Professional Engineering Service

CLASSIFIED INDEX

Card announcements of the Engineers listed below will be found alphabetically arranged on the following pages: Consulting Engineers, Page 109; Patent Attorneys, Page 113

Aeronautical
- Rowe, Jos. E.

Analysts
- Dickinson, W. N.

Appraisals
- Appraisal Engineering Co.
- Colwell, James V. V.
- Gantt Corporation
- Muhlfeld, John E.

Architects
- Wallace, Joseph H. & Co.

Audits
- Appraisal Engineering Co.
- Scovell, Wellington & Co.

—Industrial
- Scovell, Wellington & Co.

Automatic Machinery
- Griffiths, Wm. H.

Automotive
- Manly & Veal

Ballistic Problems
- Rowe, Jos. E.

Blast Furnaces
- Kennedy, Julian

Building Equipment
- Richardson & Gay

—Electrical
- Cheyney & Weschler

Buildings

—Industrial
- Freeman, Roger M.

Business and Engineering Projects Analyzed
- Dickinson, W. N.

Business Surveys
- Brill, Geo. M.

Chemical
- Rice, Cyrus Wm. & Co.
- Simsohn, Julian S.
- Von Eltz, K.

Chemical Works
- T-S-M-E Engineering Corporation

Civil
- Arnold Co.
- Wallace Joseph H & Co

Combustion
- Cary, Albert A.
- Collins, Hubert E.
- Muhlfeld, John E.

Constructing
- Ambursen Construction Co (Inc)
- Arnold Co
- Kidde, Walter & Co.
- McClellan & Junkersfeld
- Orenstein, Dr. H. (Germany)
- Rambuscheck, O. (Germany)
- Stone & Webster

Consultation
- Collins, Hubert E.
- Conrad, W. L.
- Dickinson, W. N.
- Gantt Corporation
- John, Griffith
- Kennedy, Julian
- Knoeppel, C E. & Co
- Lewis, D J. Jr.
- McDonald, Albert
- Simsohn, Julian S

Conveying
- Elmer, Nixon W

Copyrights
- Alexander & Dowell
- Wollheim, Walter E.

Cost Accounting
- Arison, Goodwin & Associates
- Gantt Corporation
- Gosselin, Edward N.
- Kidder, Walter M.
- McCall, Brownell & Co. (Inc.)
- Scovell, Wellington & Co.
- Van Ness, Frank W. & Associates

Dams
- Ambursen Construction Co. (Inc.)

Designing
- Griffin & Cathcart

—Structural
- Chapin, Warren W.

Die Sinking Equipment
- Keller, Joseph F.

Dies
- Keller, Joseph F.

Electrical
- Arnold Co.
- Cheyney & Weschler
- Kidd, Andrew Jr.
- Meyer, Strong & Jones
- Richardson & Gay
- Sargent & Lundy

Electrolytic Plants
- T-S-M-E Engineering Corp'n

Engineering Chemistry
- Cary, Albert A.
- Simsohn, Julian S.

Engines

—Diesel Oil
- Verhey, Hubert C.

—Gas
- Griffiths, Wm. H.
- Stumpf Una-Flow Engine Co (Inc.)

—Oil
- Griffiths, Wm. H
- Stumpf Una-Flow Engine Co. (Inc.)

Equipment
- Colwell, James V. V.

– Electrical & Mechanical
- Meyer, Strong & Jones

Examinations & Reports
- Appraisal Engineering Co.
- Collins, Hubert E.
- Hannah, Frederick A.
- Main, Chas T.
- Muhlfeld, John E.
- Public Service Production Co.
- Simsohn, Julian S.
- Wells, Geo. E.

Experimental
- Kaighn, Herbert E.

Factories

— Material Handling
- Elmer, Nixon W.
- Owen & Seabrook

—Organization
- Arison, Goodwin & Associates
- Kidder, Walter M.
- Scovell, Wellington & Co.

Fire Alarm Systems
- Croker, Edward F.
- Mitchell, Chas. W.

Fire Drills
- Croker, Edward F.
- Mitchell, Chas. W.

Fire Fighting Equipment
- Croker, Edward F.
- Mitchell, Chas. W.

Fire Protection
- Croker, Edward F.
- Mitchell, Chas. W.

Forge Shops
- Moore, W. E. & Co.

Foundries
- Lane, H. M. Co.
- Owen & Seabrook

Furnaces
- Cary, Albert A.
- Muhlfeld, John E.

—Electrical
- Moore, W. E. & Co.

Gas Plants
- White, J. G. Engineering Corp'n

Gasoline Extraction
- Hope Engrg. & Supply Co.

Gasoline Plants
- Beatie, Cecil E.
- Hope Engrg & Supply Co.

Heating
- Stevens, John A.

Heating & Ventilating
- Collier, Guy B.
- Collins, Hubert E
- Gerdes, Theo R. N.
- Pittelkow Heating & Engineering Co.

Hydraulic
- Halvorsen, Ole G.
- John, Griffith
- Richardson & Gay
- Wallace, Joseph H. & Co.

Hydro-electric Developments
- Ambursen Construction Co. (Inc)

Industrial
- Appraisal Engineering Co.
- Avram, M H. & Co.
- Bedaux, Chas. E. Co.
- Churchill, W. L.
- Clark, Wallace
- Conrad, W L.
- Gosselin, Edward N.
- Hannah, Frederick A
- Kidder, Walter M
- Knoeppel, C E. & Co
- Lane, H M Co
- Lewis, Warren B
- McCall, Brownell & Co.
- McDonald, Albert
- Manly & Veal
- Miller, Fred J.
- Orenstein, Dr. H (Germany)
- Owen & Seabrook
- Rambuscheck, O (Germany)
- Richardson & Gay
- Van Ness, Frank W. & Associates
- Von Eltz, K.
- Wallace, Joseph H. & Co.

Industrial Plants
- McClellan & Junkersfeld
- Main, Chas. T.
- White, J. G. Engrg. Corp'n

Industrial Processes
- Abbott, Wm. G. Jr.
- Brill, Geo. M.
- Van Ness, Frank W. & Associates

Inspection
- Colwell, James V. V.

—Ammunition
- Lea, E. S.

—Electrical Equipment
- Electrical Testing Lab.

—Gas Works Material
- Conard & Buzby

—Steel Works
- Chapin, Warren W.

—Water Works Material
- Conard & Buzby

Inventions
- Abbott, Wm. G. Jr.
- Roe, Walter H.

Investigations and Reports
- Appraisal Engineering Co.
- Arison, Goodwin & Associates
- Avram, M. H. & Co.
- Brill, Geo. M.
- Chapin, Warren W.
- Collins, Hubert E.
- Gantt Corporation
- Gilbreth, Frank B.(Inc.)
- Griffin & Cathcart
- Harris Harry E.
- Kaighn, Herbert E.
- Kidd, Andrew, Jr.
- Muhlfeld, John E.
- Owen & Seabrook (Inc.)
- Simsohn, Julian S.

Jigs and Fixtures
- Dove-Smith & Son

Kilns

– Rotary
- Kent, Robert Sayre (Inc.)

— Stationary
- Kent, Robert Sayre (Inc.)

Layouts (Factory)
- Elmer, Nixon W.
- Griffiths, Wm. H.
- Lane, H. M. Co.
- Owen & Seabrook

Lighting
- Stevens, John A.

Machinery Designing
- Dove-Smith & Son
- Gooding, Chas. S.
- Harris, Harry E.
- John, Griffith
- Modern Engrg. Co.
- Nikonow, J. P.
- Roe, Walter H.

Management
- Avram, M. H. & Co.
- Bedaux, Chas. E. Co.
- Churchill, W. L.
- Colwell, James V. V.
- Conrad, W. L.
- Gantt Corporation
- Gilbreth, Frank B.(Inc).
- Gosselin, Edward N
- Hannah, Frederick A.
- Knoeppel, C. E. & Co.
- Lewis, Warren B.
- McDonald, Albert
- Miller, Fred J.
- Public Service Production Co.
- Scovell, Wellington & Co.

Manufacturing Methods
- Arison, Goodwin & Associates
- Brill, Geo. M.
- Harris, Harry E.
- Manly & Veal

Marine
- Griffin & Cathcart

Material Handling
- Elmer, Nixon W.

Mechanical
- Arnold Co.
- Brinton, Willard C.
- Cheyney & Weschler
- Halvorsen, Ole G.
- Kennedy, Julian
- Kidde, Walter & Co.
- Lewis, D. J. Jr.
- Nikonow, J. P.
- Roe, Walter H.
- Sargent & Lundy

Mill Architects
- Wallace, Joseph H. & Co.

Mining
- Weed, M. B.

Mining Machinery
- Weed, M. B.

Motion Study
- Gilbreth, Frank B.(Inc.)

Natural Gas
- Beatie, Cecil E.

Naval
- Griffin & Cathcart

Office Methods
- Clark, Wallace

Oil Property Development
- Roberts, C. B. Engineering Co.

Oil Refineries
- Beatie, Cecil E.
- Roberts, C. B. Engineering Co.

Organization
- Arison, Goodwin & Associates
- Bedaux, Chas. E. Co.
- Hannah, Frederick A.
- Harris, Harry E.
- Knoeppel, C. E. & Co.
- McCall, Brownell & Co. (Inc.)
- Miller, Fred J.
- Scovell, Wellington & Co.

—Maintenance Department
- Collins, Hubert E.
- Van Ness, Frank W & Associates

Patents
- Orenstein, Dr. H. (Germany)
- Rambuscheck, O. (Germany)

Paper and Pulp
- Wallace, Joseph H. & Co.

Patent Experts
- Gooding, Chas. S.
- Greenwood, T. T.
- Newcomb, Benjamin R.
- Wollheim, Walter E.

Patent Lawyers
Alexander & Dowell
Gooding, Chas. S.
Nikonow, J. P
Wollheim, Walter E.

Petroleum
Beatie, Cecil E.
Roberts, C. B. Engineering Co.
—Analysis
Roberts, C. B Engineering Co.

Pipe Lines
Beatie, Cecil E

Powdered Coal
Muhlfeld, John E

Power Generation
Halvorsen, Ole G
Stevens, John A

Power Plants
Cary, Albert A.
Cheyney & Weschler
Halvorsen, Ole G.
Kidd, Andrew Jr
McClellan & Junkersfeld
Main, Chas. T.
Moore, W. E. & Co.
Norton, Fred. E
Pittelkow Heating & Engineering Co.
Stevens, John A.
Stone & Webster
Stumpf Una-Flow Engine Co. (Inc.)
T-S-M-E Engineering Corp'n
Von Eltz, K
Wells, Geo E.
White, J. G. Engrg Corp'n
—Construction
Norton, Fred E.
Public Service Production Co.
—Design
Norton, Fred E.
Public Service Production Co
Stumpf Una-Flow Engine Co. (Inc)
—Diesel Oil Engine
Verhey, Hubert C.
—Hydro-Electric
Freeman, Roger M.
—Operation
Norton Fred. E.
—Steam Turbine
Breslove, Jos.

Production
Arison, Goodwin & Associates
Bedaux, Chas. E. Co
Conrad, W. L.
Gantt Corporation
Gilbreth, Frank B.(Inc.)
Gosselin, Edward N
Griffiths, Wm. H
Kidder, Walter M.
Lewis, Warren B
Manly & Veal
Orenstein, Dr H. (Germany)
Rambuscheck, O. (Germany)
—Ammunition
Lea, E. S.

Public Utilities
Stone & Webster

Pulverized Fuel Equipment
Muhlfeld, John E.

Pumps, Centrifugal
Breslove, Jos

Railroads, Steam and Electric
McClellan & Junkersfeld
Muhlfeld, John E.
White, J. G. Engrg Corp'n

Refrigeration
Wells, Geo. E

Reorganization
Churchill, W. L

Research
Abbott, Wm G Jr
Avram, M. H. & Co.
Greenwood, T. T
Kaighn, Herbert E

Rolling Mills
Moore, W. E. & Co.

Rubber
McDonald, Albert

Sheet Metal Stamping
Modern Engrg. Co

Special Machinery
Abbott, Wm. G. Jr.
Collier, Guy B.
Dove-Smith & Son Co.
John, Griffith
Modern Engrg. Co.
Roe, Walter H.

Steel Forging Plants
Freeman, Roger M.
Kennedy, Julian

Strength of Materials
Rowe, Jos. E.

Structural
Chapin, Warren W
Collier, Guy B.
Wells, Geo. E.

Sugar Factories
Kent, Robert Sayre (Inc.)
Lewis, D. J. Jr.
T-S-M E Engineering Corp'n

Sugar Refineries
Kent, Robert Sayre (Inc.)
Lewis, D. J. Jr.

Tax Specialists
McCall, Brownell & Co. (Inc.)

Testing
Kidd, Andrew Jr.
—Electrical
Electrical Testing Lab.
—Laboratory
Electrical Testing Lab.

Textile Machinery
Cox, James W. Jr.

Textile Mills
Cox, James W. Jr.
Main, Chas T.

Textile Processes
Cox, James W. Jr.

Thermodynamics
Collier, Guy B.
Rowe, Jos. E.

Tool Designing
Dove-Smith & Son
Modern Engrg. Co.

Trade Marks
Alexander & Dowell
Newcomb, Benj R.
Wollheim, Walter E

Valuation
Appraisal Engineering Co.
—Power Plants
Muhlfeld, John E.

Ventilation
Gerdes, Theo R. N.

Water Power Developments
Ambursen Construction Co. (Inc.)
Stone & Webster

Water Purification
Rice, Cyrus Wm. & Co.
Simsohn, Julian S.
Von Eltz, K.

Water Supply Systems
Rice, Cyrus Wm. & Co.
Simsohn, Julian S.

Work Routing
Lane, H. M. Co.
Owen & Seabrook

CONSULTING ENGINEERS

ALPHABETICALLY ARRANGED

See pages 108 and 109 for Classified Index in which Engineers having cards are listed according to their specialties

W. G. ABBOTT, Jr.
Research Engineer
Development of Invention, Special Machinery and Industrial Processes, Chemical and Electrical.
Laboratory: WILTON, N. H.

AMBURSEN DAMS
Hydroelectric Developments
Water Supply and Irrigation Dams
DAMS ON DIFFICULT FOUNDATIONS
AMBURSEN CONSTRUCTION CO.
Incorporated
Grand Central Terminal, New York
Kansas City, Mo. Atlanta, Ga.

APPRAISAL ENGINEERING COMPANY
VALUATION ENGINEERS
Specialists in Appraisals of Industrial Properties
29 Broadway, New York, N. Y.

ARISON—GOODWIN and ASSOCIATES
Industrial Engineers
327 So. La Salle St., Chicago
Plant Layouts—Organizing Production, Personnel, Methods of Employment and Wage Plans—Time Studies—Audits—Costs—Accounting—Appraisals

THE ARNOLD COMPANY
Engineers—Constructors
Electrical—Civil—Mechanical
105 So. La Salle Street, CHICAGO

M. H. AVRAM & COMPANY, Inc.
Engineers–Industrial Managers
Investigations and Reports. Design and Development of Product or Equipment. Technical and Commercial Research. Management.
360 Madison Ave., New York City
950 Munsey Bldg., Washington, D. C.

PETROLEUM ENGINEERS
Refineries—Pipe Lines—Gasoline Plants
Designing—Construction—Operation
Examinations—Reports—Valuations
CECIL E. BEATIE
40 Rector Street New York

The Chas. E. Bedaux Company
Engineers
4500 Euclid Ave. Cleveland, Ohio
Originators of
The "Bedaux" Principle of Human Power Measurement.
Details gladly furnished interested executives

JOSEPH BRESLOVE
Mem. Am.Soc.M.E.
Consulting Engineer
STEAM POWER STATIONS
TRANSMISSION LINES
Oliver Building Pittsburgh, Pa.

GEORGE M. BRILL
CONSULTING ENGINEER
Manufacturing plants and processes
Investigations
for industrial and financial purposes
149 Broadway
New York
Trade Surveys
Production Programs

WILLARD C. BRINTON
Mem.Am.Soc. M.E.
Consulting Engineer
17 West 44th St., NEW YOR

ALBERT A. CARY
Mem. Am.Soc.M.E.
Power Plant Equipments Designed, Reconstructed or Tested to Produce the most efficient operating results. Furnaces Designed and Developed for Use of All Kinds of Fuel. Engineering Chemistry relating to Power Plant Investigations.
95 Liberty Street NEW YORK

WARREN W. CHAPIN
Consulting Engineer—Mem. A.S.M.E.
Structural Design in any Materials of Construction
Inspections and Reports on Existing Buildings
Inspections of Steelwork during construction
347 Madison Avenue New York City

CHEYNEY—AND—WESCHLER
CONSULTING ENGINEERS
Electrical Utility Systems, Power Plants, Mechanical and Electrical Equipment of Buildings and Industrial Plants.
Mills Building Washington, D. C.

W. L. CHURCHILL
Member Am. Soc. M.E.
MANAGEMENT ENGINEER
Specializing in Reorganization of Industrial Properties
300 Madison Ave. New York

Cards Continued on Next Page

CONSULTING ENGINEERS

ALPHABETICALLY ARRANGED

See pages 108 and 109 for Classified Index in which Engineers having cards are listed according to their specialties

WALLACE CLARK
Industrial Engineer

GANTT METHODS

50 West 12th St. NEW YORK

GUY B. COLLIER
Consulting & Designing Engineer
Structural Steel, Heating and Ventilating,
Mechanical, Electrical and
Thermodynamic Engineering.
Special Machinery & Development
of Inventions
371 Wadsworth Ave. Telephone
New York City Wadsworth 3355

HUBERT E. COLLINS
Consulting Engineer. Mem. Am.Soc.M.E.
Power Plant
Design—Construction—Operation
Heating & Ventilating
Consultation, Investigations & Reports, Valuations, Research, Maintenance Department Organization.
Winston Building Utica, N. Y.

JAMES V. V. COLWELL
Mem. Am.Soc.M.E.
Equipment Engineer
Inspection—Appraisals—Management
Logical mechanical arrangement of equipment for economical production.
105 W. 40th St., NEW YORK, N. Y.

W. R. CONARD **J. S. BUZBY**
Inspecting Engineers
and Consultants
Water & Gas Works Materials
BURLINGTON, N. J.

W. L. CONRAD
Mem. Am.Soc.M.E.
CONSULTING ENGINEER
Production Management
Gantt Methods
Singer Building New York, N. Y.

JAMES W. COX, Jr.
Consulting
TEXTILE ENGINEER
Unusual Processes
Special Machinery
Difficult Production
320 Broadway
New York City

Edward F. Croker
Ex-Chief N. Y.
Fire Dept.

Chas. W. Mitchell
Electrical
Engineer

FIRE PROTECTION ENGINEERS
Fire Alarm Engineers & Contractors
Fire Appliances, Fire Drills & Equipment.
22 W. 30th St. New York, N. Y.

W. N. DICKINSON
CONSULTING ANALYST
Aeolian Hall, 33 West 42nd St., New York
Telephones: Longacre 8196
Longacre 8645
Business and Engineering
Projects Analyzed
Member, A.S.M.E. Fellow, A.I.E.E.

DOVE-SMITH & SON
Member, A.S.M.E.
Consulting Trouble Engineers, Designers and Builders of Special Machinery, Tools, Jigs Fixtures, Punches and Dies, Gauges, etc. Modern well equipped Plant to work and measure to .0001", both decimal and metric dimensions.
2410 Cayuga Ave., Niagara Falls, N. Y.

ELECTRICAL TESTING LABORATORIES
Electrical and Mechanical Laboratories
Tests of Electrical Machinery, Apparatus and Supplies. Materials of Construction, Coal, Paper, etc. Inspection of Material and Apparatus at Manufactories.
80th St. & East End Ave., N.Y.CITY

CONVEYING

Nixon W. Elmer Quincy, Mass.

ROGER M. FREEMAN
Construction Engineer
Design and Construction of
Industrial Buildings, Steel Plants
and Hydro-Electric Developments.
8 West 40th St. New York City
Phone: Longacre 7742

Est. 1897 Inc. 1921
H. L. GANTT CORPORATION
Consulting Engineers
25th Year of Service to Manufacturers
Mr. Gantt's Former Organization is continuing his practice at the old address.
2905 SINGER BLDG., N. Y.
Address Correspondence, E.A. Lucey, Pres.

THEODORE R. N. GERDES, M.E.
VENTILATION
105 Bank Street New York
Tel. Watkins 2893

Copy for card announcements of Consulting Engineers must be in hand by the 6th of the month preceding date of publication.

FRANK B. GILBRETH
(Incorporated)
Consulting Engineers
Production Management
Motion Study Waste Elimination
Reports
68 Eagle Rock Way, Montclair, N. J.

EDWARD N. GOSSELIN
INDUSTRIAL ENGINEER
Management
Production Costs
Time Study Rate Setting
816—2nd National Bank Bldg.,
New Haven, Conn.

R. S. GRIFFIN W. L. CATHCART
Washington, D. C. New York, N. Y.
GRIFFIN and CATHCART
Consulting Engineers
Marine and Naval Engineering.
Investigations, Reports, Opinions, Expert Testimony
149 Broadway NEW YORK

WILLIAM H. GRIFFITHS
Mem. Am. Soc. M.E.
CONSULTING ENGINEER
Factory Layouts Rock Crushers
Gas and Oil Engines Automatic Machines
Small Tools Gearing
Production Manufacturing
Manufacturing Equipment
Guns:—Design & Manufacture
Box 339 Hartford, Conn.

OLE G. HALVORSEN
Formerly Professor of Mechanical, Hydraulic and Marine Engineering at The Technical College at Trondhjem, Norway
Specialist in
Steam and Hydraulic Power Engineering,
General Mechanical Engineering
Phone 1108 E. 44th St.
Atlantic 0313 Chicago, Ill.

MANAGEMENT
FREDERICK A. HANNAH
Member A.S.M.E.
32 West 40th St. NEW YORK

HARRY E. HARRIS
Consulting Engineer on Manufacturing
Methods and Equipment.
P.O. Box 1008, Bridgeport, Conn.

HOFE ENGINEERING AND SUPPLY COMPANY
Specialists
ABSORPTION AND COMPRESSION
GASOLINE PLANTS
Extracting Same from Natural Gas.
Farmers Bank Bldg., Pittsburgh, Pa.

CONSULTING ENGINEERS

ALPHABETICALLY ARRANGED

See pages 108 and 109 for Classified Index in which Engineers having cards are listed according to their specialties

GRIFFITH JOHN
Mem. Am.Soc.M.E.
CONSULTING ENGINEER
General Mechanical Engineering
Phone 1970 14 Getty Square
YONKERS, N. Y.

HERBERT E. KAIGHN
Mem. Am.Soc.M.E. Assoc. A.I.E.E.
Consulting Engineer
Research and development problems. Investigations and reports for investors. Planning and supervision of experimental work in connection with inventions, improvements, etc., for Inventors, Manufacturers and Executives. Personal service.
Room 3145, DuPont Bldg., Wilmington, Del.

DIES
JOSEPH F. KELLER
Specialist on Die Sinking Equipment
For Drop Forging, Embossing and Stamping metal, Composition, Bakelite, Rubber, Celluloid, etc.
60 Washington St., BROOKLYN, N. Y.

JULIAN KENNEDY
ENGINEER
Cable Address
Engineer, Pittsburgh
PITTSBURGH, PA., U. S. A.

ROBERT SAYRE KENT, INC.
ENGINEERS
Specialty Sugar Industrial Field
Sugar Refineries, Cane Mills, Filtration Plants, Stationary and Rotary Kilns for Fullers Earth and Bone Char.
383 Jay Street Brooklyn Borough
New York City.

ANDREW KIDD, JR.
Consulting Mechanical and Electrical Engineer
Design of Complete Power Plants
Investigations, Tests and Reports
95 Liberty Street New York

WALTER KIDDE & COMPANY
Incorporated
Engineers and Constructors
140 Cedar Street NEW YORK CITY

WALTER M. KIDDER
Consulting and Production Engineer
Factory Organization
Costs, Efficiency and Control
Enhancing Production
143 W. 82nd St., NEW YORK

Competent Industrial Counsel
Descriptive Bulletins Sent to Executives on Request.
C. E. KNOEPPEL & CO., INC.
Consulting Industrial Engineers
52 Vanderbilt Avenue New York

THE H. M. LANE COMPANY
INDUSTRIAL ENGINEERS
Detroit, Michigan Windsor, Ontario
Specializing in the design and detail of Foundries, Machine Shops and Mechanical Equipment.

E. S. LEA
Mem. Am.Soc.M.E.
Consulting Engineer
Specialist in production and inspection of artillery ammunition
229 Chestnut Ave., Trenton, N. J.
'Phone, Trenton 3268-W

D. J. LEWIS, JR.
Mem. Am. Soc. M.E.
ENGINEER
Expert in the use of centrifugals for the separation and drying of materials.
4701 Woolworth Bldg., New York, N. Y.

WARREN B. LEWIS
Consulting Engineer
Industrial Plants and Operations
10 Weybossett St., Providence, R. I.

Methods of
Graphic Production Control
Engineering Costs & Organization
Analytical Accountants
Tax Specialists
McCALL, BROWNELL & CO., Inc.
Industrial Engineers
Aeolian Building New York City

McCLELLAN & JUNKERSFELD
Incorporated
Engineering & Construction
New York 45 William St.
Philadelphia 112 South 16th St.

The rate for insertion of one inch card announcements of Consulting Engineers is $4.25 per month on yearly contract; $5.00 per issue for less than twelve consecutive insertions.

ALBERT McDONALD
Mem. A.S.M.E.
CONSULTING ENGINEER
Management Production
103 Park Ave., New York, N. Y.

CHAS. T. MAIN
Mem. Am. Soc. M.E.
Engineer
Plans and Specifications for Textile Mills and other Industrial Plants, Water Power and Steam Power Developments. Examinations and Reports on Plants with Reference to Their Value.
201 Devonshire St., Boston, Mass.

MANLY & VEAL
Members A.S.M.E. and S.A.E.
CONSULTING ENGINEERS
Mechanical—Automotive—Industrial
Coordination of engineering and manufacturing requirements in design, production and operation. Development, Specifications, Contracts, Organization, Inspection, Investigation, Tests and Reports.
250 West 54th Street, New York City

MEYER, STRONG and JONES, Inc.
Consulting engineers for the mechanical and electrical equipment of buildings and industrial plants, power plants, etc.
101 Park Avenue NEW YORK

FRED J. MILLER
Consultant in
Industrial Organization
and
Management
50 West 12th St., New York

W. E. MOORE & CO.
Engineers
Pittsburgh, Pa.
Designs and Supervision of
Rolling Mill, Forge Shop, Foundry and Mine Installations, Power Plants and Heavy Industrial Power Applications, Electric Furnaces for Steel, Iron and Brass.

JOHN E. MUHLFELD
Consulting Engineer
Railway and Industrial Equipment, Facilities, Investigations and Valuations
25 Broad Street New York

FRED E. NORTON
Consulting Engineer
Power Plant
Design—Construction—Operation
656 Main Street, Worcester, Mass.

Cards Continued on Next page

CONSULTING ENGINEERS

ALPHABETICALLY ARRANGED

See pages 108 and 109 for Classified Index in which Engineers having cards are listed according to their specialties

GERMANY and EUROPE
H. Orenstein Dr.-Engr. Mem. A.S.M.E.
O. Rambuscheck, Prof. Engr.
Inc. Industrial Consulting Engineers
Competent Technical Counsel
Utilization of Patents
Construction of Industrial Plants and Production
34 Geisbergstr. Berlin, Germany

JOSEPH EUGENE ROWE
Consulting Research Engineer
Mathematical Analysis of Problems in Research Engineering Involving Ballistics, Thermodynamics, Aeronautics, and Strength of Materials.
Member A.S.M.E.
Ph.D. Johns Hopkins University. Formerly Chief Ballistician Aberdeen Proving Grounds
Williamsburg, Virginia.

-T-S-M-E-
Engineering Corporation
Chemical and Mechanical Design or Construction, Power Plants, Factory Buildings and Equipment, Liquid Chlorine, Sulphur Chloride, Soda Ash, By-Products and Waste Products.
IROQUOIS BLDG., BUFFALO, N. Y.

OWEN & SEABROOK
INDUSTRIAL ENGINEERS
404 McKerchey Building, Detroit, Mich.
Charles Roberts Seabrook, Mem. A.S.M.E.
Elijah Hunter Owen, Assoc. Mem. A.S.C.E.
Industrial Buildings. Factory Layouts.
Mechanical Handling of Materials.
Valuation Surveys. Work Routing.

SARGENT & LUNDY
Incorporated
Mechanical and Electrical Engineers
1412 Edison Bldg., 72 West Adams Street
Chicago, Illinois

Frank W. Van Ness & Associates
INDUSTRIAL ENGINEERS
National City Building New York City
Executive Organization, Costs, Plant Layout, Methods & Processes, Incentives, Industrial Relations.

A. G. Pittelkow E. E. Harris
A.S.M.E. A.S.M.E.
A.S.Htg.&Vent.E. A.S.Htg.&Vent.E.
Pittelkow Heating and Engineering Co.
Contracting Engineers
Design and Install
Heating, Ventilating & Power Plants
312 West Larned St. Detroit, Michigan.

Industrial Surveys—
Production Control.
Personnel Relations
Cost and Accounting Systems
SCOVELL, WELLINGTON & CO.
110 State St. Boston.
New York, Chicago, Cleveland,
Springfield, Mass.

HUBERT C. VERHEY
Mem. A.S.M.E.
Mem. Soc. N.A. and M.E.
CONSULTING ENGINEER
Formerly Head of Diesel Engine Unit, Emergency Fleet Corp'n, U. S. Ship. Board.
MARINE DIESEL INSTALLATIONS
STATIONARY DIESEL POWER PLANTS
1028 Real Estate Trust Bldg., Phila., Pa.

Public Service Production Company
Engineers and Constructors
Design and Construction of Power Plants, Substations and Industrial Plants.
Examinations and reports, Valuation and Management of Public Utilities.
80 Park Place, Newark, N. J.

JULIAN S. SIMSOHN
and Associates
Chemical Engineers
Experts on Water Purification
Consultation Supervision Analysis
S. E. Cor. Broad & Girard Ave.
PHILADELPHIA

K. VON ELTZ
CONSULTING AND DESIGNING ENGINEER
Industrial, Chemical and Power Plants
Water Purification
23 East 26th Street NEW YORK

CYRUS WM. RICE & CO.
Water Purification Engineers
HIGHLAND BLDG. PITTSBURGH, PA.

JOHN A. STEVENS, ENGINEER
Mem. Am. Soc. M.E.
Light, Heat and Power Problems
POWER PLANTS
Consultation—Analysis—Design
Supervision of Construction
Purchased Power Contracts Negotiated
Cleveland LOWELL, MASS. Fall River

PULP PAPER POWER
Hydraulic Steam and Electrical
ENGINEERS
Industrial Design—Plant Improvement
Chemical Research—Reports.
JOSEPH H. WALLACE & CO., INC.
Temple Court Bldg New York, N. Y.

RICHARDSON & GAY
CONSULTING ENGINEERS BOSTON
220 Devonshire Street
Steam, Electric, Hydraulic, Industrial Developments—Building Equipment—Investigations—Reports.
Edward B. Richardson Harry Gay

STONE & WEBSTER
Incorporated
Examinations Reports Appraisals
on
Industrial and Public Service Properties
NEW YORK BOSTON CHICAGO

M. B. WEED
Consulting Mechanical, Mining and Geological Engineer
Specializing in Mining Machinery
Central Square, N. Y.

OIL REFINERY ENGINEERS
Petroleum Analysis and Process Work, Refinery Design and Construction, Operation, Reports and Betterment Work.
C. B. ROBERTS ENGINEERING CO.
19 Milk Street Boston, Mass.

STUMPFLOW DESIGNS
American Agents for Stumpf Patents and designs. Steam, oil and gas engine designing and power plant problems especially adapted to Una-Flow Engines.
E. N. Trump, Pres. C. C. Trump, V. P.
W.H.Blauvelt, Treas. W.Turnwald, Ch.Eng.
STUMPF UNA-FLOW ENGINE CO., INC.
206 E. Genesee St., Syracuse, N. Y.

GEO. E. WELLS
Mechanical and Structural Engineer
Cold Storage and Ice Making Plants
Power and Industrial developments
Plans—Examinations—Reports
Boatmen's Bank Bldg.,
St. Louis, Mo.

WALTER H. ROE
Member Amer. Soc. M. E.
Member S. A. E.
Mechanical-Consulting Engineer
Designing, Estimating and Consulting
Patent Development, Labor Saving and Automatic Machinery and Industrial Buildings
Spayth Block. TIFFIN, OHIO.

The rate for insertion of one inch card announcements of Consulting Engineers is $4.25 per month on yearly contract; $5.00 per issue for less than twelve consecutive insertions.

THE J. G. WHITE ENGINEERING CORPORATION
ENGINEERS CONSTRUCTORS
Industrial Plants, Buildings, Steam Power Plants, Water Powers, Gas Plants, Steam and Electric Railroads, Transmission Systems.
43 EXCHANGE PLACE NEW YORK

PATENT ATTORNEYS

ALPHABETICALLY ARRANGED

See pages 108 and 109 for Classified Index in which Engineers having cards are listed according to their specialties

Established 1857
ALEXANDER & DOWELL
Attorneys at Law
PATENTS: TRADE-MARKS
COPYRIGHTS
900 F Street, N.W., Washington, D. C.

T. T. GREENWOOD
Patents and Patent Causes
RESEARCH ENGINEER
40 Court Street, Boston, Mass.

J. P. NIKONOW
Mechanical and Electrical Engineer
Patent Attorney
Mem. A.S.M.E., A.I.E.E. and S.A.E.
3425 Giles Place,
New York City

CHARLES S. GOODING
Mechanical Engineer
Tech. Graduate
Mem Am Soc.M.E.
Registered Attorney
Patents Trade Marks
27 School Street, BOSTON, MASS.

BENJAMIN R. NEWCOMB
Patents and Trade Marks
Assoc. Mem. Soc. Automotive Engineers
Jun. Mem. Am. Soc. Mechanical Engineers
Formerly Chief Assistant to the late Edward Bruce Moore, Patent Lawyer and Ex-Commissioner of Patents
Victor Building Washington, D C.

WALTER E. WOLLHEIM
Mem.Am.Soc.M.E.
Registered Patent Attorney
PATENTS and TRADE-MARKS
Technical and Commercial
Development of Inventions
145 West 45th St. New York.

A.S.M.E. PUBLICATIONS and PAPERS

Combination Offers of Interest to the Engineer

Offer No. 1	A.S.M.E. Boiler Code, Power Test Code and any one Group of papers listed below.	**$2.50**
Offer No. 2	A.S.M.E. Boiler Code and set of Interpretations of the Boiler Code.	**$2.00**
Offer No. 3	Power Test Code, Shop Management (Paper binding) and any one Group of papers listed below.	**$2.25**
Offer No. 4	Elevator Code and any one Group of papers listed below.	**$1.45**
Offer No. 5	One Year's subscription to Mechanical Engineering and any one Group of papers listed below.	**$4.50**

Group No. 1

Circulation in Horizontal Water Tube Boilers. #1516

The Design of Riveted Butt Joints. #1707

Emergency Fleet Corpn. Water-Tube Boiler for Wood Ships. #1713

Constitutions and Properties of Boiler Tubes. #1767

Group No. 2

The Steam Motor in the Automotive Field. #1609

Recovering of Gasoline from Casing Head and Natural Gas. #1675

Advantages of Pressure and High Superheat as affecting Steam Plant Efficiency. #1683

Central-Station Heating in Detroit. #1694

Group No. 3

Fuel Economy Tests at a Large Oil Burning Electric Plant. #1213

Unnecessary Losses in Firing Fuel Oil. #1214

Preventable Waste of Coal in the United States. #1610

Pulverized Coal for Stationary Boilers. #1702

Group No. 4

Machine Shop Organization. #1590

Expenses and Costs. #1618

A Foundry Cost and Accounting System. #1639

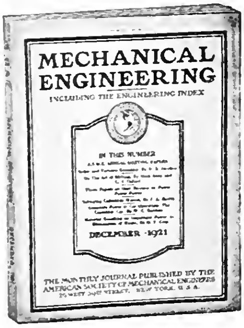
Industrial Organization as it Affects Executives and Workers. #1672

The American Society of Mechanical Engineers

29 West 39th Street, New York

Important Publications *Issued by*
The American Society of Mechanical Engineers

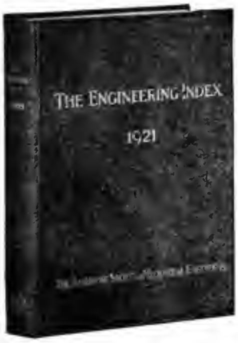
MECHANICAL ENGINEERING



This journal covers the entire field of mechanical engineering. Contains original articles on subjects of current interests, papers and discussions presented or for presentation at the Annual and Spring meetings of the A.S.M.E. and at the monthly meetings of its Local Sections in fifty centers; also correspondence departments devoted to current engineering matters; announcements and reports upon engineering affairs; employment bulletin, library notes, personal notes, and reviews and index of the world's technical press (The Engineering Index), etc. The papers are selected by committees of specialists. Published monthly. Size 9 in. x 12 in. Subscription price, $4.00 per year; 50 cents additional for Canadian postage; $1.00 additional for foreign postage.

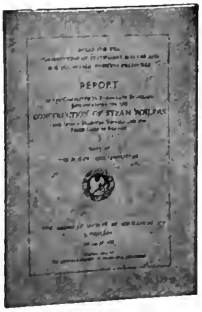
The Engineering Index

(Trade Mark Registered)



An Indexed Yearly Digest of the Technical Press of the World. Contains more than 11,000 descriptive references on over 4,000 subjects treated in engineering publications from every quarter of the globe. Published annually since 1884. 1921 volume, Price, $6.00. (To members, $5.00.) The Society is prepared to supply photostatic copies, white printing on brown background, of any of the articles listed in the Engineering Index. Price of each proof (up to 11 x 14 in. in size) 25 cents plus postage.

The Boiler Code



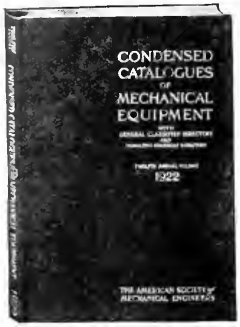
Contains standard specifications for construction, equipment and use of steam boilers. Operative as legal construction code in seventeen States and adopted as standard by many boiler insurance companies, boiler manufacturers and consulting engineers. 1918 Revised Edition, 147 pp., 35 illustrations. Appendices and indexes. Price bound in paper $1.00 ($0.75 to members).

Interpretations of the Boiler Code

Interpretations of the 1918 edition, formulated at the monthly meetings of the Boiler Code Committee, published in data sheet form, with index. Price $1.00 a set ($0.80 to members).

Condensed Catalogues *of* Mechanical Equipment

With General Classified Directory.

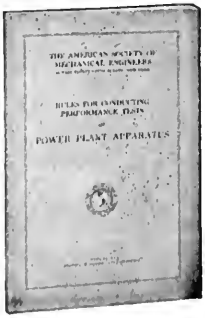


Comprising condensed, uniformly presented and illustrated catalogue information covering the products of a large proportion of the leading manufacturers of various classes of mechanical equipment; a cross-indexed classified list of mechanical equipment, containing 3,300 subject headings with the names and addresses of 4200 firms a classified list covering specialized lines of practice of members of the A.S.M.E. engaged in various branches of consulting engineering work. Published annually. Volume 12 (1922 edition) 8 v. Price $5.00 net. $4.00 to members.

Transactions of the A.S.M.E.

Contains all papers and discussions presented at regular (Annual and Spring) meetings of the Society and technical reports of Committees. Published annually since 1880, issued about August. 8vo. Special fabrikoid. Price, $11.00 net, to libraries $6.00 net.

Power Test Codes



Standard Rules for Conducting Performance Tests of Power Plant Apparatus. Contains a comprehensive set of testing codes relating to boilers, reciprocating steam engines, steam turbines, pumping machinery, compressors, blowers and fans, complete steam power plants, locomotives, gas producers, gas and oil engines, water wheels, etc. Price $2.00 a copy (to members $1.00 a copy).

The American Society of Mechanical Engineers

29 West 39th Street New York, N. Y.

CLASSIFIED ADVERTISEMENTS

Classified advertisements in MECHANICAL ENGINEERING are inserted at the rate of 40 cents a line; 30 cents a line to members of A.S.M.E. Eight words to the line average. Minimum insertion charge, 5 line basis; maximum 20 lines. No display matter carried. ***Copy must be in hand not later than the 6th of the month preceding date of publication.***

SALES ENGINEER, College man, over 30, invited to join as partner in manufacturing and marketing profitable patented electrical device. $45,000 to $50,000 required. Investigation invited. Address EX-442, care this Journal.

MANUFACTURER'S REPRESENTATIVE: An organization of sales engineers with headquarters in New York City, will place their sales, engineering, and executive ability at your service to perfect your distribution in Eastern New York, Connecticut and Northern New Jersey. Address Carlton, care of Mechanical Engineering.

EXPORT REPRESENTATIVE, Electrical and Mechanical Engineer. with established office in New York, desires one or more additional accounts. Exclusive export agency desired. Address EX-434, care this Journal.

EXECUTIVES—Qualified men—Technical, Commercial or Manufacturing—seeking new positions find our effective and confidential service extremely satisfactory. Our Mr. H. H. Harrison can negotiate a suitable connection for you as he has done for thousands of others since 1909. Inquiries invited; confidences respected. The National Business Bourse, Inc., Confidential Negotiators, Association Building, Chicago.

MACHINE SHOP FACILITIES offered by member in the line of building Special and Automatic machinery, Tools, Jigs, Fixtures and Labor Saving devices, Models, etc. Designing service. Location Philadelphia. Address EX-426, care this Journal.

SENIOR AND JUNIOR EXECUTIVES—COMMERCIAL, TECHNICAL. Business is swinging back to normal. Do not wait until Personnels are again complete, and all desirable positions filled. Let us negotiate in your behalf with hundreds of employers with whom we are in constant contact. Without obligation on your part write for details of our confidential personnel intermediary service. Business Survey Corporation, P. O. Drawer 81, Buffalo, N. Y.

CONSULTING PETROLEUM ENGINEER, four years' practice in New York, desires to join forces with a Mechanical Engineer of standing to go after the small Power Plant and Fuel Oil installation in and around New York. Address "EX-437," care this Journal.

WELL ESTABLISHED FIRM OF ENGINEERS with high class clientele invites negotiations as district sales representatives for power or industrial equipment of exceptional merit. Expert engineering service. Well located office with modern engineering and sales campaign equipment. Territory New York and vicinity. Address EX-435, care this Journal.

FROST PLUG, renewable, easily attachable, which breaks and automatically drains engine, compressor jackets, radiators, piping valves, etc., just before same can be damaged by frost has been perfected and patented. Manufacturers interested in same communicate with L. W., Box 100, Highlandtown, Baltimore, Md.

MECHANICAL ENGINEER, Mem. Am. Soc. M.E., with office in New York, wishes to represent engineering specialty of merit, or look out for interests of clients in Metropolitan district concerning their engineering projects. Designing service. Address EX-443, care this Journal.

SALES ENGINEERS wanted to sell a high grade low priced ELECTRIC SPOT WELDING MACHINE, to the metal trade east of the Mississippi River. Address EX-436, care this Journal.

FOR SALE—Rights in patent application for Tachometers. Employs principle of radially compensated centrifugal moments, translated into hydrostatic pressure and recorded or indicated by commercial pressure gauge in terms of R.P.M. Of inherent and enduring precision, affording a smooth record of rotational speeds, this instrument is of wide application in the growing use of autographic charts for the study and control of performances and processes. Address EX-429, care this Journal.

PACIFIC COAST, REPRESENTATIVE or Manager by executive 40 years old, broad engineering education, many years of practical experience, and an intimate knowledge of the details of production, accounting, plant management and sales, plus the ability to get results without friction. Address EX-438, care this Journal.

A SUCCESSFUL SALESMAN of electrical and mechanical products with sales management and executive experience desires to represent engineering lines on Pacific Coast or Southern California F. V. S. Box 81, Pasadena, Calif.

EXECUTIVES who can command a salary of from $2,500 to $25,000 and who are alert to grasp greater opportunities to communicate with us. Our dignified confidential service places you in a position of having responsible employers ask for your services. This without the slightest embarrassment and without jeopardizing your present connection in any way. Business Survey Corporation, P. O. Drawer 81, Buffalo, N Y.

AN ESTABLISHED FIRM of Sales Engineers with offices centrally located in New York City wish to represent a reputable manufacturer of a product of merit. Address EX-439, care this Journal.

Some Papers on Pumps

Title	Author	Order No	Prices To Members	Prices To Non-Members
The Baltimore Sewerage Pump Valve	A. F. Nagle	1366	.25	.40
Fire Pumps	Ezra Clark	1424	.25	.40
Influence of Disk Friction on Turbine Pump Design	F. zur Nedden	1478	.25	.40
The Evolution of Low-lift Pumping Plants in the Gulf Coast Country	W. B. Gregory	1534	.50	.65
The Design and Test of a Large Reclamation Pumping Plant	G. C. Noble	1548	.25	.40
A Dredging Pump of Novel Construction	Walter J. White	1716	.30	.45

No order filled for less than 50 cents

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West 39th Street, New York

Classified List of Mechanical Equipment

Manufactured by Firms Represented in MECHANICAL ENGINEERING

FOR ALPHABETICAL LIST OF ADVERTISERS, SEE PAGE 134

Accumulators, Hydraulic
* Hydraulic Press Mfg. Co.
Mackintosh-Hemphill Co.
* Worthington Pump & Mchy. Corp'n

Aerial Tramways
(See Tramways, Wire Rope)

Aftercoolers, Air
* Ingersoll-Rand Co.

Air Compressors, Receivers, etc.
(See Compressors. Receivers, etc., Air)

Air Conditioning Apparatus
* American Blower Co.
* Carrier Engineering Corp'n
Clarage Fan Co.

Air-Jet Lifts
* Schutte & Koerting Co.

Air Washers
* American Blower Co.
* Badger, E. B. & Sons Co.
* Carrier Engineering Corp'n
Clarage Fan Co.
* Cooling Tower Co. (Inc.)
* Spray Engineering Co.

Alloys
Phosphor Bronze Smelting Co.

Alternators
(See Generators, Electric)

Ammeters
* Bristol Co.
* General Electric Co.
Weston Electrical Instrument Co.

Ammonia Condensers, Fittings, etc.
(See Condensers, Fittings, etc., Ammonia)

Anemometers
Taylor Instrument Cos.

Annealing
* American Metal Treatment Co.
Rockwell, W. S. Co.

Arches, Boiler
* Illinois Stoker Co.
* Titusville Iron Works Co.

Arches, Ignition (Flat Suspended)
Green Engineering Co.

Asbestos Products
* Johns-Manville (Inc.)

Ash Handling Systems (Steam Jet)
Green Engineering Co.

Babbit Metal
American Crucible Products Co.
Cadman, A. W. Mfg. Co
* Medart Co

Baffle Walls, Boiler
Brinckerhoff, H. Gordon Co
* King Refractories Co. (Inc.)

Balanced Draft Systems
Brinckerhoff, H. Gordon Co

Balancing Machines
* Vibration Specialty Co.

Ball Bearings, Gages, etc.
(See Bearings, Gages, Ball)

Balls, Brass and Bronze
* Gwilliam Co.

Balls, Steel
* Gwilliam Co.
* S K F Industries (Inc.)

Barometers
* Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Cos.

Bearings, Ball
Fafnir Bearing Co.
Gurney Ball Bearing Co
* Gwilliam Co.
* Norma Co. of America
* S K F Industries (Inc.)
* U. S. Ball Bearing Mfg. Co.

Bearings, Bronze
American Crucible Products Co.
Phosphor Bronze Smelting Co.

Bearings, Roller
* Gwilliam Co.
* Norma Co. of America
* Royersford Fdy. & Mch. Co.
* Timken Roller Bearing Co.
* U. S Ball Bearing Mfg Co

Bearings, Self-Oiling
Brown, A. & F. Co.
* Doehler Die-Casting Co.
* Falls Clutch & Machinery Co.
* Jones, W. A. Foundry & Machine Co.
* Royersford Fdy & Mch Co.
* Wood's, T. B. Sons Co.

Bearings, Thrust
Fafnir Bearing Co.
* General Electric Co.
* Gwilliam Co.
* Norma Co. of America
* S K F Industries (Inc.)
* Timken Roller Bearing Co.
* U. S. Ball Bearing Mfg. Co.

Belt Dressing
Texas Co.

Belt Lacing, Steel
* Bristol Co.

Belting, Leather
Leather Belting Exchange

Belt Tighteners
Brown, A. & F. Co.
* Jones, W. A. Foundry & Machine Co.
* Medart Co.
* Smidth, F. L. & Co.
* Wood's, T. B. Sons Co.

Belting, Chain Link
(See Chain Belts and Links)

Benches, Work
Manufacturing Equipment & Engrg. Co.

Bending Machines, Hydraulic
* Hydraulic Press Mfg Co.

Bending & Straightening Machines
* Hydraulic Press Mfg. Co.
Long & Allstatter Co.

Bends, Pipe
* Frick Co. (Inc.)
* Vogt, Henry Machine Co.

Billets, Steel
* Timken Roller-Bearing Co.

Binder (Lenix)
* Smidth, F. L. & Co.

Bleaching Machinery
Philadelphia Drying Machinery Co.

Blinds, Rolling or Sliding
Wilson, J. G. Corp'n

Blocks, Tackle
Clyde Iron Works Sales Co.
* Roebling's, John A. Sons Co.

Blowers, Centrifugal
Clarage Fan Co.
* De Laval Steam Turbine Co
* General Electric Co.
* Ingersoll-Rand Co.
* Kerr Turbine Co.

Blowers, Fan
* American Blower Co.
Clarage Fan Co.
* Green Fuel Economizer Co

Blowers, Forge
Clarage Fan Co.

Blowers, Pressure
* American Blower Co
Clarage Fan Co.
Lammert & Mann Co.

Blowers, Rotary
Lammert & Mann Co.
* Schutte & Koerting Co.

Blowers, Soot
Bayer Co.
Diamond Power Specialty Corp'n

Blowers, Steam Jet
* Schutte & Koerting Co.

Blowers, Steam (Ring Type)
* McClave Brooks Co.

Blowers, Turbine
Brinckerhoff, H Gordon Co.
* Kerr Turbine Co.

Blueing
* American Metal Treatment Co.

Boards, Drawing
Dietzgen, Eugene Co.
Keuffel & Esser Co.

Boiler Compounds
(See Compounds, Boiler)

Boiler Coverings, Furnaces, Tube Cleaners, etc.
(See Coverings, Furnaces, Tube Cleaners, Etc., Boiler)

Boiler Fronts
* Brownell Co.
* O'Brien, John Boiler Works Co.
* Titusville Iron Works Co.

Boiler Settings, Steel Cased
* Brownell Co.
* Casey-Hedges Co.
* Illinois Stoker Co.
* O'Brien, John Boiler Works Co.
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.

Boilers, Heating
* Brownell Co.
* Casey-Hedges Co.
* Erie City Iron Works
Herbert Boiler Co.
* Keeler, E. Co.
* Leffel, James & Co.
Lidgerwood Mfg. Co.
* O'Brien, John Boiler Works Co.
* Titusville Iron Works Co.
Union Iron Works
* Walsh & Weidner Boiler Co.

Boilers, Locomotive
* Brownell Co.
* Casey-Hedges Co.
* Davis, J. F. & Sons Co.
* Keeler, E. Co.
* Leffel, James & Co.
* Titusville Iron Works Co.
Union Iron Works
* Walsh & Weidner Boiler Co.

Boilers, Marine (Scotch)
* Brownell Co.
* Casey-Hedges Co.
* Davis, J. F. & Sons Co.
* Leffel, James & Co.
* Titusville Iron Works Co.
* Walsh & Weidner Boiler Co.

Boilers, Marine (Water Tube)
* Babcock & Wilcox Co.
* Casey-Hedges Co.
Heine Boiler Co.
* O'Brien, John Boiler Works Co.
* Springfield Boiler Co.
* Titusville Iron Works Co.
* Walsh & Weidner Boiler Co.
* Ward, Charles Engineering Wks.

Boilers, Portable
* Brownell Co.
* Casey-Hedges Co.
* Erie City Iron Works
* Frick Co. (Inc.)
Herbert Boiler Co.
* Keeler, E Co
* Leffel, James & Co.
Lidgerwood Mfg. Co.
* O'Brien, John Boiler Works Co.
* Titusville Iron Works Co.
Union Iron Works
* Walsh & Weidner Boiler Co.

Boilers, Tubular (Horizontal Return)
* Bigelow Co.
* Brownell Co.
* Casey-Hedges Co.
* Cole, R. D Mfg. Co.
* Erie City Iron Works
Herbert Boiler Co.
* Keeler, E. Co.
* Leffel, James & Co.
Lidgerwood Mfg. Co.
* O'Brien, John Boiler Works Co.
* Titusville Iron Works Co
Union Iron Works
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.
* Ward, Charles Engineering Wks.
* Wickes Boiler Co.

Boilers, Tubular (Vertical Fire)
* Bigelow Co.
* Brownell Co.
* Casey-Hedges Co.
Clyde Iron Works Sales Co.
* Keeler, E. Co.
* Leffel, James & Co
Lidgerwood Mfg. Co.
* O'Brien, John Boiler Works Co.
* Titusville Iron Works Co.
Union Iron Works
* Walsh & Weidner Boiler Co.

Boilers, Water Tube (Horizontal)
* Babcock & Wilcox Co.
* Casey-Hedges Co.
* Cole, R. D. Mfg. Co.
* Edge Moor Iron Co.
* Erie City Iron Works
Heine Boiler Co.
Herbert Boiler Co.
* Keeler, E. Co.
* Ladd, George T. Co.
* O'Brien, John Boiler Works Co.
* Springfield Boiler Co
Union Iron Works
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.
* Wickes Boiler Co

Boilers, Water Tube (Inclined)
* Babcock & Wilcox Co.
* Bigelow Co.
* Casey-Hedges Co.
Heine Boiler Co.
* Keeler, E. Co.
* Ladd, George T. Co.
* O'Brien, John Boiler Works Co.
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.
* Ward, Charles Engineering Wks.

Boilers, Water Tube (Vertical)
* Babcock & Wilcox Co.
* Bigelow Co
* Casey-Hedges Co.
* Davis, J. F. & Sons Co.
* Erie City Iron Works
* Keeler, E. Co.
* Ladd, George T. Co.
* Walsh & Weidner Boiler Co.
* Wickes Boiler Co.

Bolts, Stove (Steel)
* Reed & Prince Mfg. Co.

Boxes, Carbonizing
Driver-Harris Co.

Boxes, Case Hardening
Driver-Harris Co.

Brake Blocks
* Johns-Manville (Inc.)

Brakes, Air
* Allis-Chalmers Mfg. Co.
* General Electric Co.

Brass Goods
* Scovill Mfg. Co.

Breechings, Smoke
* Brownell Co.
* Titusville Iron Works Co.
* Vogt, Henry Machine Co

Brewers' and Bottlers' Machinery
* Vilter Mfg. Co.

Brick, Fire
* Bernitz Furnace Appliance Co.
Brinckerhoff, H. Gordon Co.
* Celite Products Co.
* Drake Non-Clinkering Furnace Block Co.
* King Refractories Co. (Inc.)

Brick, Insulating
* Celite Products Co.
* Quigley Furnace Specialties Co.

Bridges, Coal & Ore Handling
* Brown Hoisting Machinery Co.

Buckets, Elevator
* Brown Hoisting Machinery Co.
* Gifford-Wood Co.
* Hendrick Mfg. Co.
* Jones, W. A. Foundry & Machine Co.

Buckets, Grab
* Brown Hoisting Machinery Co.
Clyde Iron Works Sales Co.
Lidgerwood Mfg. Co.

Buckets, Self-Dumping
* Brown Hoisting Machinery Co.
Clyde Iron Works Sales Co.

Burners, Gas
Rockwell, W. S. Co.

Burners, Oil
* Best, W. N. Furnace & Burner Corp'n
Rockwell, W. S. Co.
* Schutte & Koerting Co.
* Spray Engineering Co.

Burners, Powdered Fuel
* Quigley Furnace Specialties Co.

Burrs (Steel, Brass & Copper)
* Reed & Prince Mfg. Co.

Bushings, Bronze
American Crucible Products Co.
Phosphor Bronze Smelting Co.
* Wood's, T. B. Sons Co.

Cabinets and Tables, Blue Print Filing
Dietzgen, Eugene Co.
Keuffel & Esser Co.
Manufacturing Equipment & Engrg. Co.

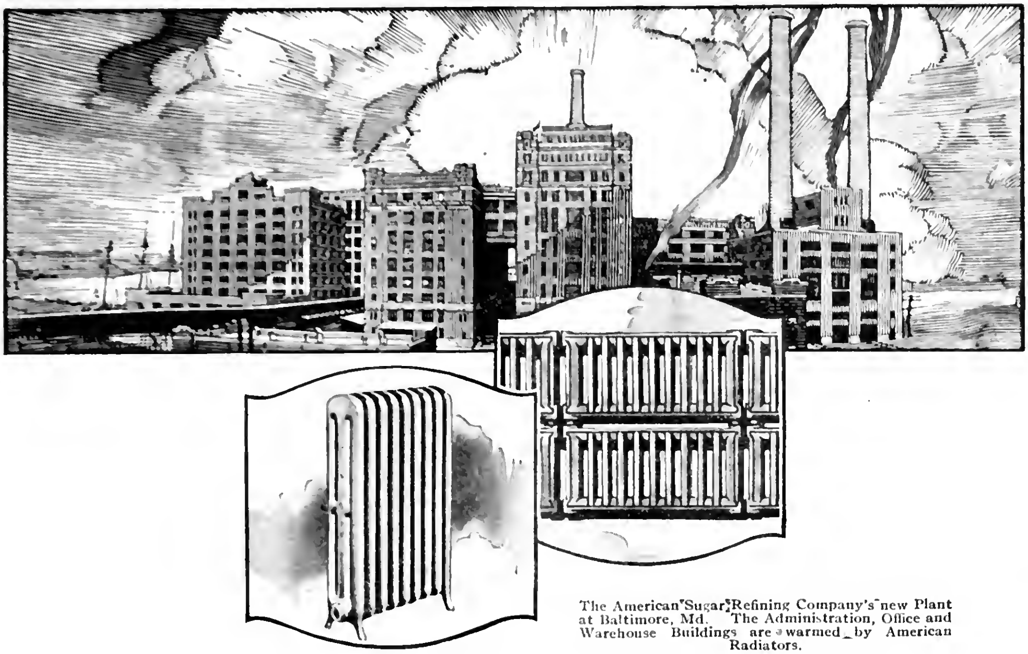
Cable Railways
(See Railways, Cable)

Cable Wire
(See Rope, Wire)

Cables, Electrical
(See Wire & Cables, Electrical)

Cableways, Excavating
Flory, S. Mfg. Co.
Lidgerwood Mfg. Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume*



The American Sugar Refining Company's new Plant at Baltimore, Md. The Administration, Office and Warehouse Buildings are warmed by American Radiators.

Another new chapter in an old story

THERE ARE many new details of architectural and engineering science in the plant of the American Sugar Refining Company just completed. But the heating is merely one more chapter in a very old story. Like so many other prominent important buildings throughout the world the plant is warmed by American Radiators.

American Peerless column radiators, totaling 4,000 feet, take care of the Administration buildings, steam being supplied from the exhaust of the central power plant.

In the warehouses, 8,000 additional feet of Peerless Wall Radiation are on duty. The remainder of the plant requires no heating system, as the machinery used in the processes of refining gives off sufficient warmth.

We welcome this distinguished addition to the list of plants where American Radiators are at work—a list which represents a roll-call of America's foremost industries.

Send for these two booklets

If you haven't these two authoritative booklets on direct radiation in your files, they are worth sending for. Just your name on your letterhead, sent to either address below, will bring them.

AMERICAN RADIATOR COMPANY

IDEAL Boilers and AMERICAN Radiators for every heating need

104 West 42nd St., Dept 108
NEW YORK

AMERICAN RADIATORS IDEAL BOILERS

816 So. Mich. Ave., Dept 108
CHICAGO

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued)

FOR ALPHABETICAL INDEX, SEE PAGE 134

Cableways, Hoisting and Conveying
Flory, S. Mfg. Co.
Lidgerwood Mfg. Co.

Calorimeters
* Precision Instrument Co.
* Sarco Co. (Inc.)
* Schaeffer & Budenberg Mfg. Co.

Cars, Freight Elevator
Eastern Machinery Co.

Casehardening
* American Metal Treatment Co.

Casings, Steel (Boiler)
* Brownell Co.
* Casey-Hedges Co.
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.

Castings, Acid Resistant
* United States Cast Iron Pipe & Fdry. Co.

Castings, Brass
Weatherly Foundry & Mfg. Co.

Castings, Brass & Bronze
* Lunkenheimer Co.

Castings, Bronze
American Crucible Products Co.
Phosphor Bronze Smelting Co.

Castings, Die-Moulded
* Doehler Die-Casting Co.
Veeder Mfg. Co.

Castings, Friction
Brown Clutch Co.

Castings, Gray Iron
Weatherly Foundry & Mfg. Co.

Castings, Heavy
* United States Cast Iron Pipe & Fdry. Co.

Castings, Iron
Brown, A. & F. Co.
Brown Clutch Co.
* Builders Iron Foundry
* Burhorn, Edwin Co.
* Casey-Hedges Co.
* Central Foundry Co.
* Cole, R. D. Mfg. Co.
* Falls Clutch & Machinery Co.
* Franklin Machine Co.
* Hooven, Owens, Rentschler Co.
* Jones, W. A. Foundry & Machine Co.
Lidgerwood Mfg. Co.
* Lunkenheimer Co.
* McClave Brooks Co.
* Royersford Fdry. & Mch. Co.
* United States Cast Iron Pipe & Fdry. Co.
* Vogt, Henry Machine Co.

Castings, Monel Metal
Driver-Harris Co. (in Canada)

Castings, Nichrome
Driver-Harris Co.

Castings, Semi-Steel
* Builders Iron Foundry
* Hooven, Owens, Rentschler Co.
* Lunkenheimer Co.
* Vogt, Henry Machine Co.

Castings, Steel
Mackintosh-Hemphill Co.

Castings, White Metal
* Doehler Die-Casting Co.

Cement, Refractory
* Celite Products Co.
* Johns-Manville (Inc.)
* King Refractories Co. (Inc.)
* Quigley Furnace Specialties Co.

Cement Machinery
* Allis-Chalmers Mfg. Co.
* Smidth, F. L. & Co.
* Worthington Pump & Machinery Corp'n

Centrifugal Blowers, Pumps
(See Blowers, Pumps, etc., Centrifugal)

Centrifugals, Chemical
Tolhurst Machine Works

Centrifugals, Metal Drying
Tolhurst Machine Works

Centrifugals, Sugar
Tolhurst Machine Works
* Worthington Pump & Mchy. Corp'n

Chain Belts and Links
* Diamond Chain & Mfg. Co.
* Gifford-Wood Co.
* Jones, W. A. Foundry & Machine Co.
Union Chain & Mfg. Co.
* Whitney Mfg. Co.

Chain Grate Stokers
(See Stokers, Chain Grate)

Chains, Block
Reading Chain & Block Corp'n

Chains, Crane
Reading Chain & Block Corp'n

Chains, Power Transmission
Baldwin Chain & Mfg. Co.
* Diamond Chain & Mfg. Co.
* Morse Chain Co.
Union Chain & Mfg. Co.
* Whitney Mfg. Co.

Chains, Pressed Steel
* Parker Supply Co.

Chimneys, Brick (Radial)
* American Chimney Corp'n
Heine Chimney Co.

Chimneys, Concrete
* American Chimney Corp'n
Heine Chimney Co.

Chimneys, Steel
(See Stacks, Steel)

Chucking Machines
* Jones & Lamson Machine Co.
* Warner & Swasey Co.

Chucks, Drill
* S K F Industries (Inc.)
* Whitney Mfg. Co.

Chucks, Magnetic
* Heald Machine Co.

Chucks, Tapping
* Whitney Mfg. Co.

Chutes
* Gifford-Wood Co.
* Hendrick Mfg. Co.

Cinder Mills
(See Mills, Cinder)

Circuit Breakers
* General Electric Co.

Circulators, Feed Water
* Schutte & Koerting Co.

Circulators, Steam Heating
* Schutte & Koerting Co.

Clamps, Wire Rope
(See Wire Rope Fastenings)

Cloth, Tracing
Dietzgen, Eugene Co.
Keuffel & Esser Co.

Clutches, Friction
* Allis-Chalmers Mfg. Co.
Brown, A. & F. Co.
Eastern Machinery Co.
* Falls Clutch & Machinery Co.
* Gifford-Wood Co.
Johnson, Carlyle Machine Co.
* Jones, W. A. Fdry. & Mch. Co.
* Medart Co.
* Wood's, T. B. Sons Co.

Coal
Pennsylvania Coal & Coke Co.

Coal Agitators
Ellis, W. E. Co.

Coal and Ash Handling Machinery
* Beaumont, R. H. Co.
* Brown Hoisting Machinery Co.
* Gifford-Wood Co.
* Illinois Stoker Co.
* Shepard Electric Crane & Hoist Co.

Coal Bins
* Brown Hoisting Machinery Co.

Coal Mine Equipment and Supplies
* General Electric Co.

Coal Mining Machinery
* General Electric Co.
* Ingersoll-Rand Co.

Coaling Stations, Locomotive
* Beaumont, R. H. Co.
* Gifford-Wood Co.

Cocks, Air and Gage
* American Steam Gauge & Valve Mfg. Co.
* Ashton Valve Co.
* Crane Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Vogt, Henry Machine Co.

Cocks, Blow-off
Cadman, A. W. Mfg. Co.
* Crane Co.
* Lunkenheimer Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)

Cocks, Three-Way and Four-Way
* American Steam Gauge & Valve Mfg. Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Lunkenheimer Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)

Coils, Pipe
* Badger, E. B. & Sons Co.
* Superheater Co.
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

Coke
Pennsylvania Coal & Coke Co.

Cold Storage Plants
* De La Vergne Machine Co.

Collars, Shafting
* Medart Co.
* Royersford Fdry. & Mch. Co.
* Wood's, T. B. Sons Co.

Coloring
* American Metal Treatment Co.

Combustion (CO_2) Recorders
* Precision Instrument Co.
* Republic Flow Meters Co.
* Sarco Co. (Inc.)
* Uehling Instrument Co.

Compounds, Boiler
Unisol Mfg. Co.

Compressors, Air
* Allis-Chalmers Mfg. Co.
* General Electric Co.
* Goulds Mfg. Co.
* Hooven, Owens, Rentschler Co.
* Ingersoll-Rand Co.
Mackintosh-Hemphill Co.
Norwalk Iron Works Co.
* Titusville Iron Works Co.
* Worthington Pump & Machinery Corp'n

Compressors, Air, Centrifugal
* De Laval Steam Turbine Co.
* General Electric Co.

Compressors, Air, Compound
* Ingersoll-Rand Co.
* Worthington Pump & Machinery Corp'n

Compressors, Ammonia
* Frick Co. (Inc.)
* Ingersoll-Rand Co.
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.
* Worthington Pump & Machinery Corp'n

Compressors, Gas
* De Laval Steam Turbine Co.
* General Electric Co.
* Hooven, Owens, Rentschler Co.
* Ingersoll-Rand Co.
Norwalk Iron Works Co.
* Worthington Pump & Machinery Corp'n

Concrete Hardener
Sonneborn, L. Sons (Inc.)

Condensers, Ammonia
* De La Vergne Machine Co.
* Frick Co. (Inc.)
* Ingersoll-Rand Co.
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

Condensers, Barometric
* Allis-Chalmers Mfg. Co.
Buffalo Steam Pump Co.
* Ingersoll-Rand Co.
* United States Cast Iron Pipe & Fdry. Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Condensers, Jet
* Allis-Chalmers Mfg. Co.
Buffalo Steam Pump Co.
Elliott Co.
* Ingersoll-Rand Co.
* Schutte & Koerting Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Condensers, Surface
* Allis Chalmers Mfg. Co.
Elliott Co.
* Ingersoll-Rand Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Conduits
* Johns-Manville (Inc.)

Contact Points (Electrical), Silver and Platinum
Wilson, H. A. Co.

Controllers, Automatic, for Temperature or for Pressure
(See Regulators)

Controllers, Electric
* General Electric Co.

Controllers, Filter Rate
* Builders Iron Foundry
* Simplex Valve & Meter Co.

Converters, Synchronous
* Allis-Chalmers Mfg. Co.
* General Electric Co.

Controllers, Liquid Level
* Davis, G. M. Regulator Co.
* General Electric Co.
* Simplex Valve & Meter Co.

Conveying Machinery
* Beaumont, R. H. Co.
* Brown Hoisting Machinery Co.
* Gifford-Wood Co.
* Jones, W. A. Foundry & Mach. Co

Conveyor Systems, Pneumatic
*Allington & Curtis Mfg. Co.

Conveyors, Belt
* Brown Hoisting Machinery Co.
* Gifford-Wood Co.

Conveyors, Bucket, Pan or Apron
* Brown Hoisting Machinery Co.
* Gifford-Wood Co.
* Jones, W. A. Fdry. & Mach Co.

Conveyors, Ice
* Gifford-Wood Co.

Conveyors, Screw
* Gifford-Wood Co.

Coolers, Brine
* Frick Co. (Inc.)

Cooling Ponds, Spray
* Badger, E. B. & Sons Co.
* Cooling Tower Co. (Inc.)
* Schutte & Koerting Co.
* Spray Engineering Co.

Cooling Towers
* Burhorn, Edwin Co.
* Cooling Tower Co. (Inc.)
* Spray Engineering Co.
* Wheeler, C. H. Mfg. Co.
* Worthington Pump & Machinery Corp'n

Copper, Drawn
* Roebling's, John A. Sons Co.

Copper Converting Machinery
* Allis-Chalmers Mfg. Co.
* Worthington Pump & Machinery Corp'n

Copper Work
* Badger, E. B. & Sons Co.

Corliss Engines
(See Engines, Steam, Corliss)

Counters, Revolution
* American Steam Gauge & Valve Mfg. Co.
* Ashton Valve Co.
* Bristol Co.
* Crosby Steam Gage & Valve Co.
* Schaeffer & Budenberg Mfg. Co.
Veeder Mfg. Co.

Countershafts
* Builders Iron Foundry
* Wood's, T. B. & Sons Co.

Couplings, Pipe
* Central Foundry Co.
* Crane Co.
* Lunkenheimer Co.

Couplings, Shaft (Flexible)
* Allis-Chalmers Mfg. Co.
Brown, A. & F. Co.
* Fawcus Machine Co.
* Hooven, Owens, Rentschler Co.
* Jones, W. A. Foundry & Machine Co.
* Medart Co.
Smith & Serrell

Couplings, Shaft (Rigid)
* Allis-Chalmers Mfg. Co.
Brown, A. & F. Co.
Cumberland Steel Co.
* Falls Clutch & Machinery Co.
* General Electric Co.
* Hooven, Owens, Rentschler Co.
* Jones, W. A. Foundry & Machine Co.
* Medart Co.
* Royersford Foundry & Machine Co.
Smith & Serrell
* Wood's, T. B. Sons Co.

Couplings, Union
(See Unions)

Couplings, Universal Joint
* Wood's, T. B. Sons Co.

Coverings, Steam Pipe
* Johns-Manville (Inc.)

Cranes, Electric Traveling
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.

Cranes, Floor (Portable)
Lidgerwood Mfg. Co.

Cranes, Gantry
* Brown Hoisting Machinery Co.
Northern Engineering Works

Cranes, Hand Power
* Brown Hoisting Machinery Co.
Clyde Iron Works Sales Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume*

MORSE DRIVES

SILENT CHAIN
THE MORSE "ROCKER JOINT"

DEPENDABLE POWER TRANSMISSION

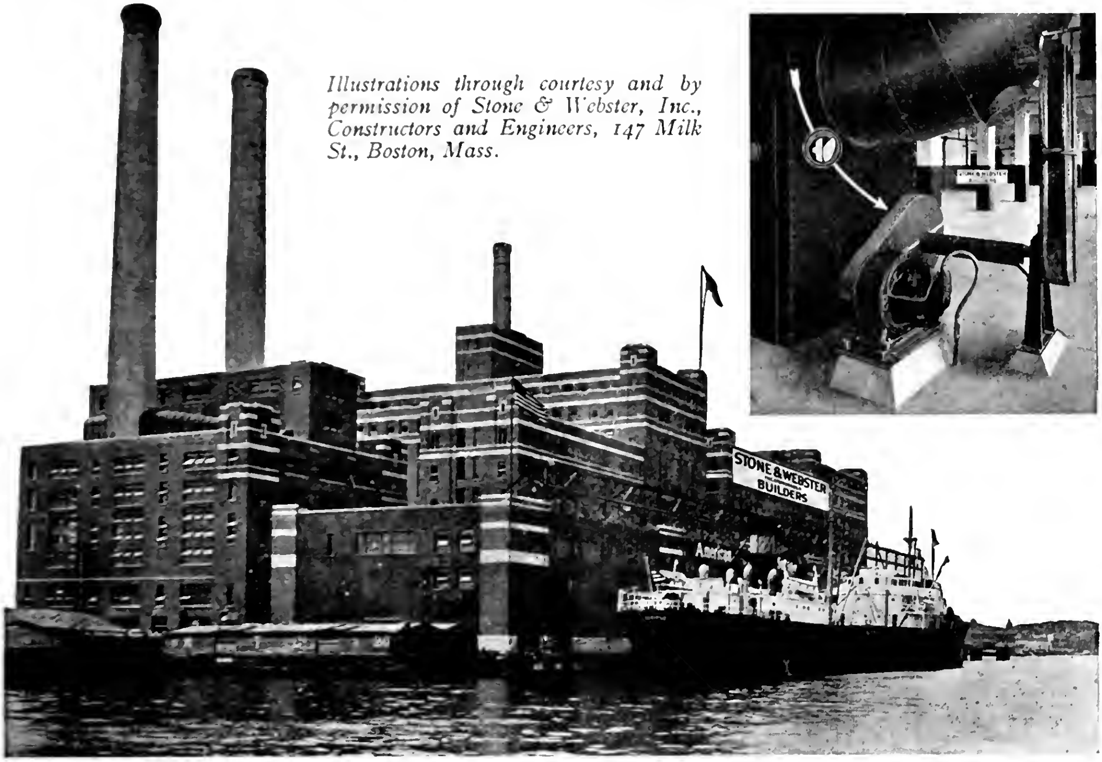
AT LOWEST POSSIBLE COST. RUN SMOOTHLY, AND CONTINUOUSLY. GIVE THE SERVICE NEEDED. SOLD ON ULTIMATE COST AND VALUE, DETERMINED BY—STABILITY OF EFFICIENCY, MAINTENANCE AND REDUCTION OF PRODUCTION COST

BUILT FOR UNINTERRUPTED SERVICE. TRIED, TESTED AND ENDORSED BY THE LEADING ENGINEERS AND ARCHITECTS

ASK OUR SATISFIED USERS

Permit Morse Engineers to cooperate to find your most economical and efficient power transmission.

Illustrations through courtesy and by permission of Stone & Webster, Inc., Constructors and Engineers, 147 Milk St., Boston, Mass.



The great Baltimore Refinery of The American Sugar Refining Company

Construction is over and the Wheels of Production are turning by Morse Silent Chain Drives

(See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

MORSE CHAIN CO.

LARGEST MANUFACTURERS OF SILENT CHAINS IN THE WORLD

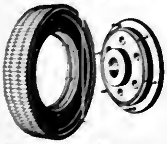
ITHACA, N. Y.

Morse Engineering Service

BENEFIT BY MORSE SERVICE AS OTHERS DO

Assistance Without Obligation

Address Nearest Office



Shear Pin Sprocket

ATLANTA, GA. .... Candler Bldg., Earl F. Scott & Co.
BALTIMORE, MD. .... 1402 Lexington Avenue
BOSTON, MASS. .... 141 Milk St.
CHARLOTTE, N. C. .... 404 Commercial Bank Bldg.
CHICAGO, ILL. .... Merchants L. & T. Bldg.
CLEVELAND, OHIO .... Engineers Bldg.
DETROIT, MICH. .... 1361 Abbott St.
KANSAS CITY, MO. .... Finance Bldg., Morse Eng'rg Co.
NEW YORK CITY .... 30 Church St.
MINNEAPOLIS, MINN., So. 3rd St., Strong-Scott Mfg. Co.
MONTREAL .... St. Nicholas Bldg., Jones & Glassco Reg'd
PHILADELPHIA, PA. .... Franklin Trust Bldg.
PITTSBURGH, PA. .... Westinghouse Bldg.
SAN FRANCISCO, CAL. .... Monadnock Bldg.
ST. LOUIS, MO. .... Chemical Bldg., Morse Eng'rg Co.
TORONTO, Bank of Hamilton Bldg., Jones & Glassco Reg'd
WINNIPEG, MAN. .... Dufferin St., Strong-Scott Mfg. Co.

Spring Sprocket

"Morse" is the Guarantee Always Behind the Efficiency, Durability and Service

Northern Engineering Works
* Shepard Electric Crane & Hoist Co.

Cranes, Jib
* Brown Hoisting Machinery Co.
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.

Cranes, Locomotive
* Brown Hoisting Machinery Co.

Cranes, Pillar
* Brown Hoisting Machinery Co.
Northern Engineering Works

Cranes, Portable
* Brown Hoisting Machinery Co.
Clyde Iron Works Sales Co.

Crucibles, Graphite
Dixon, Joseph Crucible Co.

Crushers, Coal
* Allis-Chalmers Mfg. Co.
* Smidth, F. L. & Co.
* Worthington Pump & Machinery Corp'n

Crushers, Jaw
* Worthington Pump & Machinery Corp'n

Crushers, Roll
Eastern Machinery Co.
* Worthington Pump & Machinery Corp'n

Crushing and Grinding Machinery
* Allis-Chalmers Mfg. Co.
* Smidth, F. L. & Co.
* Worthington Pump & Machinery Corp'n

Cupolas
* Bigelow Co.
Northern Engineering Works

Curtains, Steel, Rolling
Wilson, J. G. Corp'n

Cutters, Bolt
* Landis Machine Co. (Inc.)

Cutters, Milling
Haynes Stellite Co.
* Whitney Mfg. Co.

Damper Regulators
(See Regulators, Damper)

Dehumidifying Apparatus
* American Blower Co.
* Carrier Engineering Corp'n

Derricks and Derrick Fittings
Clyde Iron Works Sales Co.
Lidgerwood Mfg. Co.

Die Castings
(See Castings, Die Moulded)

Die Heads, Thread Cutting (Self-opening)
* Jones & Lamson Machine Co.
* Landis Machine Co. (Inc.)

Dies, Blanking
* Bliss, E. W. Co.

Dies, Punching
* Bliss, E. W. Co.

Dies, Sheet Metal Working
* Bliss, E. W. Co.

Dies, Thread Cutting
Curtis & Curtis Co.
* Jones & Lamson Machine Co.
* Landis Machine Co. (Inc.)

Diesel Engines
(See Engines, Oil, Diesel)

Digesters
* Bigelow Co.

Distilling Apparatus
* Vogt, Henry Machine Co.

Doors, Automatic Fire
Wilson, J. G. Corp'n

Doors, Disappearing, Folding, Sliding and Swinging
Wilson, J. G. Corp'n

Doors, Fireproof
Wilson, J. G. Corp'n

Doors, Underwriters'
Wilson, J. G. Corp'n

Doors, Steel or Wood, Rolling
Wilson, J. G. Corp'n

Drafting Room Furniture
Dietzgen, Eugene Co.
Keuffel & Esser Co.

Drawing Instruments
Dietzgen, Eugene Co.
Keuffel & Esser Co.

Drawing Materials
Dietzgen, Eugene Co.
Keuffel & Esser Co.

Dredges, Hydraulic
* Morris Machine Works

Dredging Machinery
Flory, S. Mfg. Co.
Lidgerwood Mfg. Co.
* Morris Machine Works

Drilling Machines, Sensitive
* Royersford Fdry. & Mach. Co.

Drilling Machines, Vertical
* Royersford Fdry, & Mch. Co.

Drills, Coal and Slate
* General Electric Co.

Drills, Core
* Ingersoll-Rand Co.

Drills, Rock
* General Electric Co.
* Ingersoll-Rand Co.

Drinking Fountains, Sanitary
* Johns-Manville (Inc.)
Manufacturing Equipment & Engrg. Co.

Drop Forgings, Hammers, etc.
(See Forgings, Hammers, etc., Drop)

Dryers, Rotary
* Bigelow Co.

Drying Apparatus
* American Blower Co.
* Carrier Engineering Corp'n
Clarage Fan Co.
Philadelphia Drying Machinery Co.

Dust Collecting Systems
* Allington & Curtis Mfg. Co.
* Allis-Chalmers Mfg. Co.
Clarage Fan Co.

Dust Collectors
* Allington & Curtis Mfg. Co.
* Allis-Chalmers Mfg. Co.

Dustproofing Materials
Sonneborn, L. Sons (Inc.)

Dyeing Machinery
Philadelphia Drying Machinery Co.

Dynamic Balancing Machines
(See Balancing Machines, Dynamic)

Dynamometers
* General Electric Co.
* Schaeffer & Budenberg Mfg. Co.
* Wheeler, C. H. Mfg. Co.

Economizers, Fuel
* Green Fuel Economizer Co.

Ejectors
* Lunkenheimer Co.
* Schutte & Koerting Co.

Electric Generators, Hoists, Trucks Welding, etc.
(See Generators, Hoists, Trucks, Welding, etc., Electric)

Electric Machinery
* Allis-Chalmers Mfg. Co.
* General Electric Co.

Electric Measuring Instruments
(See Instruments, Electrical Measuring)

Electric Supplies
* General Electric Co.
* Johns-Manville (Inc.)

Elevating and Conveying Machinery
* Brown Hoisting Machinery Co.
* Gifford-Wood Co.
* Jones, W. A. Fdry. & Mach. Co.

Elevators, Electric
Eastern Machinery Co.
Northern Engineering Works

Elevators, Inclined
Otis Elevator Co.

Elevators, Passenger and Freight
Eastern Machinery Co.
Northern Engineering Works
Otis Elevator Co.

Emery Wheel Dressers
* Builders Iron Foundry

Engine Repairs
* Franklin Machine Co

Engine Stops
* Schutte & Koerting Co.

Engineers, Consulting
(See Professional Engineering Service Section)

Engines, Blowing
* Allis-Chalmers Mfg. Co.
* Hooven, Owens, Rentschler Co.
Mackintosh-Hemphill Co.
* Worthington Pump & Machinery Corp'n

Engines, Distillate
Western Machinery Co.

Engines, Gas
* Allis-Chalmers Mfg. Co.
* De La Vergne Machine Co.
* Hooven, Owens, Rentschler Co.
* Ingersoll-Rand Co.
Otto Engine Works
* Titusville Iron Works Co.
Western Machinery Co.

Engines, Gasoline
* Climax Engineering Co.
Midwest Engine Corp'n
Otto Engine Works
* Titusville Iron Works Co.
Western Machinery Co.
* Worthington Pump & Machinery Corp'n

Engines, Hoisting
* Allis-Chalmers Mfg. Co.
* Climax Engineering Co.
Clyde Iron Works Sales Co.
Flory, S. Mfg Co.
Lidgerwood Mfg. Co.
* Morris Machine Works
Western Machinery Co.

Engines, Kerosene
* Climax Engineering Co.
Western Machinery Co.
* Worthington Pump & Machinery Corp'n

Engines, Marine
* Climax Engineering Co.
* Hooven, Owens, Rentschler Co.
* Ingersoll-Rand Co.
Johnson, Carlyle Machine Co.
* Ward, Chas. Engineering Wks.
* Worthington Pump & Machinery Corp'n

Engines, Marine, Oil
Western Machinery Co.

Engines, Oil
* Allis-Chalmers Mfg. Co.
* De La Vergne Machine Co.
* Ingersoll-Rand Co.
Midwest Engine Corp'n
Otto Engine Works
* Titusville Iron Works Co.
Western Machinery Co.
* Worthington Pump & Machinery Corp'n

Engines, Oil, Diesel
* Allis-Chalmers Mfg. Co.
* Climax Engineering Co.
Midwest Engine Corp'n.
Western Machinery Co.
* Worthington Pump & Machinery Corp'n

Engines, Pumping
* Allis-Chalmers Mfg. Co.
* Climax Engineering Co.
* Hooven, Owens, Rentschler Co.
* Ingersoll-Rand Co.
* Morris Machine Works
Western Machinery Co.
* Worthington Pump & Machinery Corp'n

Engines, Steam
* Allis-Chalmers Mfg. Co.
* Brownell Co.
Clarage Fan Co.
Clyde Iron Works Sales Co.
* Cole, R. D. Mfg. Co.
* Engberg's Electric & Mech. Wks.
* Erie City Iron Works
* Hooven, Owens, Rentschler Co.
* Ingersoll-Rand Co.
* Leffel, James & Co.
Lidgerwood Mfg. Co.
Mackintosh-Hemphill Co.
* Morris Machine Works
* Ridgway Dynamo & Engine Co.
* Titusville Iron Works Co.
* Troy Engine & Machine Co.
* Vilter Mfg. Co.
* Wheeler, C. H. Mfg. Co.

Engines, Steam, Automatic
* American Blower Co.
* Brownell Co.
Clarage Fan Co
* Engberg's Electric & Mech. Wks.
* Erie City Iron Works
* Leffel, James & Co.
* Troy Engine & Machine Co.

Engines, Steam, Corliss
* Allis-Chalmers Mfg. Co.
* Franklin Machine Co.
* Frick Co. (Inc.)
* Hooven, Owens, Rentschler Co.
Mackintosh-Hemphill Co.
* Vilter Mfg. Co

Engines, Steam, High Speed
* American Blower Co.
* Brownell Co.
Clarage Fan Co.
* Engberg's Electric & Mech. Wks.
* Erie City Iron Works

Engines, Steam, Poppet Valve
* Erie City Iron Works
* Vilter Mfg. Co.

Engines, Steam, Throttling
* Brownell Co.
Clarage Fan Co.
* Engberg's Electric & Mech. Wks.

Engines, Steam, Una-Flow
* Frick Co. (Inc)
* Ridgway Dynamo & Engine Co.
Stumpf Una-Flow Engine Co (Inc.)

Engines, Steam, Variable Speed
* Brownell Co.

Engines, Steam, Vertical (Fully Enclosed, Self-Oiling)
Clarage Fan Co.
* Engberg's Electric & Mech. Wks.
* Troy Engine & Machine Co.

Engines, Steering
Lidgerwood Mfg. Co.

Evaporators
* Vogt, Henry Machine Co.

Excavating Machinery
Clyde Iron Works Sales Co
Flory, S. Mfg. Co.
Lidgerwood Mfg. Co

Exhaust Systems
* Allington & Curtis Mfg. Co
* American Blower Co
Clarage Fan Co.

Exhausters, Gas
Clarage Fan Co
* General Electric Co
* Green Fuel Economizer Co
* Schutte & Koerting Co.

Expansion Joints
(See Joints, Expansion)

Extractors, Centrifugal
Tolhurst Machine Works

Extractors, Oil and Grease
*American Steam Gauge & Valve Mfg. Co.
* Kieley & Mueller (Inc.)

Factory Equipment, Metal
Manufacturing Equipment & Engrg. Co.

Fans, Exhaust
* American Blower Co.
Clarage Fan Co.
* General Electric Co.
* Green Fuel Economizer Co.
Philadelphia Drying Machinery Co.

Fans, Exhaust, Mine
Clarage Fan Co.

Feed Water Circulators, Heaters, Heaters and Purifiers, etc.
(See Circulators, Heaters, Heaters and Purifiers, etc., Feed Water)

Feed Water Controllers
(See Regulators, Feed Water)

Feeders, Pulverized Fuel
Combustion Engineering Corp'n
* Smidth, F. L. & Co.

Filters, Gravity
* Permutit Co.

Filters, Oil
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
Elliott Co.
* General Electric Co.

Filters, Pressure
* Permutit Co.

Filters, Water
Elliott Co.
* H.S.B.W.-Cochrane Corp'n
* Permutit Co.
* Scaife, Wm. B. & Sons Co.

Filtration Plants
* H.S.B.W.-Cochrane Corp'n
International Filter Co.
* Scaife, Wm. B. & Sons Co.

Fire Brick, Fire Hydrants, etc.
(See Brick, Hydrants, Fire, etc.)

Fire Tube Boilers
(See Boilers, Return and Vertical Tubular)

Fittings, Ammonia
* Crane Co.
* De La Vergne Machine Co.
* Frick Co. (Inc.)
Martin-Morse Corp'n
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

Fittings, Compression
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)

Fittings, Flanged
* Builders Iron Foundry
* Central Foundry Co.
* Crane Co.
Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
Martin-Morse Corp'n
* Nelson Valve Co
* Reading Steel Casting Co. (Inc.) (Reading Valve & Fittings Division)

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume*

Announcing

The Conveyor Division of The Brown Hoisting Machinery Company. This department is now manufacturing a complete line of Belt Conveyors, Chain Conveyors, Coal Crushers, Screens, etc.

The same fine quality that is found in all material handling machinery bearing the Brownhoist mark is maintained in these new products. We now solicit your inquiries on

Conveying Equipment.

The Brown Hoisting Machinery Co., *Cleveland, O.*
Branch Offices: New York, Chicago, Pittsburgh, San Francisco, New Orleans

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment

BROWNHOIST

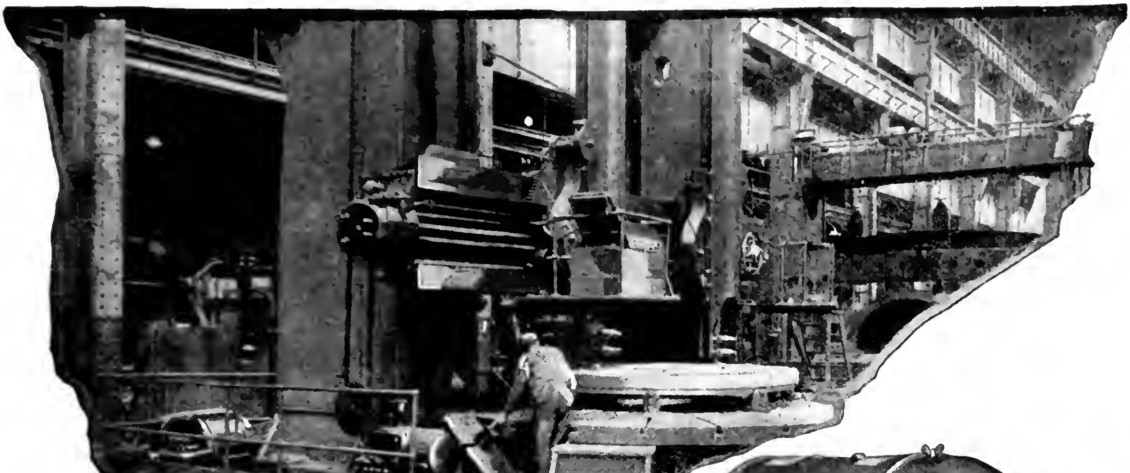
MATERIAL HANDLING EQUIPMENT

FOR ALPHABETICAL INDEX, SEE PAGE 134

  - * United States Cast Iron Pipe & Fdry Co.
  - * Vogt, Henry Machine Co.
- **Fittings, Hydraulic**
  - * Crane Co.
  - * Hydraulic Press Mfg. Co.
  - * Reading Steel Casting Co. (Inc.) (Reading Valve & Fittings Division)
  - * Vogt, Henry Machine Co.
- **Fittings, Pipe**
  - * Barco Mfg. Co.
  - * Central Foundry Co.
  - * Crane Co.
  - Kennedy Valve Mfg. Co.
  - * Lunkenheimer Co.
  - Martin-Morse Corp'n
  - * Reading Steel Casting Co. (Inc.) (Reading Valve & Fittings Division)
  - * Vogt, Henry Machine Co.
  - Weatherly Foundry & Mfg. Co.
- **Fittings, Steel**
  - * Crane Co.
  - * Lunkenheimer Co.
  - * Nelson Valve Co.
  - * Reading Steel Casting Co. (Inc.) (Reading Valve & Fittings Division)
  - * Vogt, Henry Machine Co.
- **Flanges**
  - * American Spiral Pipe Works
  - * Crane Co.
  - Kennedy Valve Mfg. Co.
  - * Lunkenheimer Co.
  - * Reading Steel Casting Co. (Inc.) (Reading Valve & Fittings Division)
  - * Vogt, Henry Machine Co.
- **Floor Stands**
  - * Chapman Valve Mfg. Co.
  - * Crane Co.
  - * Jones, W. A. Fdry. & Mach. Co.
  - Kennedy Valve Mfg. Co.
  - * Lunkenheimer Co
  - * Nelson Valve Co.
  - * Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
  - * Schutte & Koerting Co.
  - * Wood's, T. B. Sons Co.
- **Flour Milling Machinery**
  - * Allis-Chalmers Mfg. Co.
- **Fly Wheels**
  - * Medart Co.
  - * Wood's, T. B. Sons Co.
- **Forges**
  - * Best, W. N. Furnace & Burner Corp'n
- **Forges, Oil**
  - Rockwell, W. S. Co.
- **Forges, Rivet**
  - Rockwell, W. S. Co.
- **Forgings, Drop**
  - * Vogt, Henry Machine Co.
- **Forming Machines, Hydraulic**
  - * Hydraulic Press Mfg. Co.
- **Foundry Equipment**
  - Northern Engineering Works
- **Friction Clutches, Hoists, etc.**
  - (See Clutches, Hoists, etc., Friction)
- **Friction Drives**
  - Rockwood Mfg. Co.
- **Frictions, Paper and Iron**
  - Rockwood Mfg. Co.
- **Fuel Economizers**
  - (See Economizers, Fuel)
- **Furnace Construction**
  - Furnace Engineering Co.
- **Furnace Linings**
  - (See Linings, Furnace)
- **Furnaces, Annealing and Tempering**
  - * Best, W. N. Furnace & Burner Corp'n
  - * General Electric Co.
  - Kenworthy, Chas. F (Inc.)
  - Rockwell, W. S. Co.
- **Furnaces, Boiler**
  - * American Engineering Co.
  - * American Spiral Pipe Wks.
  - * Babcock & Wilcox Co
  - * Bernitz Furnace Appliance Co.
  - * Best, W. N. Furnace & Burner Corp'n
  - * Combustion Engineering Corp'n
  - * Detroit Stoker Co.
  - Green Engineering Co.
  - * Murphy Iron Works
  - * Riley, Sanford Stoker Co.
- **Furnaces, Case Hardening**
  - Kenworthy, Chas. F. (Inc.)
- **Furnaces, Down Draft**
  - * O'Brien, John Boiler Works Co
- **Furnaces, Electric**
  - Kenworthy, Chas. F. (Inc.)
  - Rockwell, W S. Co.
- **Furnaces, Forging**
  - Kenworthy, Chas. F. (Inc.)
- **Furnaces, Gas**
  - Rockwell, W. S. Co.
- **Furnaces, Hardening**
  - Kenworthy, Chas. F. (Inc.)
- **Furnaces, Heat Treating**
  - * Best, W N. Furnace & Burner Corp'n
  - * General Electric Co
  - Kenworthy, Chas. F. (Inc.)
  - Rockwell, W. S. Co.
- **Furnaces, Melting**
  - * Best, W. N. Furnace & Burner Corp'n
  - * General Electric Co.
  - Rockwell, W. S. Co.
- **Furnaces, Non-Ferrous**
  - Rockwell, W. S. Co.
- **Furnaces, Non-Oxidizing**
  - Kenworthy, Chas. F. (Inc.)
- **Furnaces, Oil**
  - * Best, W. N. Furnace & Burner Corp'n
  - Rockwell, W. S. Co.
- **Furnaces, Smokeless**
  - * American Engineering Co.
  - * Babcock & Wilcox Co.
  - * Combustion Engineering Corp'n
  - * Detroit Stoker Co.
  - * Gibby Engineering Co.
  - Green Engineering Co.
  - Herbert Boiler Co.
  - * Illinois Stoker Co.
  - * Murphy Iron Works
  - * Riley, Sanford Stoker Co
- **Fuses**
  - * General Electric Co.
  - * Johns-Manville (Inc.)
- **Gage Boards**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - * Crosby Steam Gage & Valve Co.
  - * Schaeffer & Budenberg Mfg. Co.
- **Gage Glasses**
  - * Schaeffer & Budenberg Mfg. Co.
- **Gage Testers**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - * Crosby Steam Gage & Valve Co.
  - * Schaeffer & Budenberg Mfg. Co.
- **Gages, Altitude**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - * Crosby Steam Gage & Valve Co
  - * Schaeffer & Budenberg Mfg. Co.
- **Gages, Ammonia**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - * Crosby Steam Gage & Valve Co.
  - * Schaeffer & Budenberg Mfg. Co.
  - * Vogt, Henry Machine Co.
- **Gages, Ball**
  - * S K F Industries (Inc.)
- **Gages, Differential Pressure**
  - Bacharach Industrial Instrument Co.
  - * Bailey Meter Co.
  - * Precision Instrument Co.
  - * Schaeffer & Budenberg Mfg. Co.
  - * Uehling Instrument Co.
- **Gages, Draft**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - Bacharach Industrial Instrument Co.
  - * Bailey Meter Co.
  - Brinckerhoff, H. Gordon Co.
  - * Bristol Co.
  - * Precision Instrument Co.
  - * Schaeffer & Budenberg Mfg. Co.
  - Taylor Instrument Cos
  - * Uehling Instrument Co.
- **Gages, Hydraulic**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - * Crosby Steam Gage & Valve Co.
  - * Hydraulic Press Mfg. Co.
  - * Schaeffer & Budenberg Mfg. Co.
- **Gages, Liquid Level**
  - * Bristol Co.
  - * Lunkenheimer Co.
  - * Precision Instrument Co.
  - * Simplex Valve & Meter Co.
- **Gages, Loss of Head**
  - * Builders Iron Foundry
  - * Simplex Valve & Meter Co.
- **Gages, Measuring (Surface, Depth, Dial, etc.)**
  - * Norma Co. of America
  - * S K F Industries (Inc.)
- **Gages, Pressure**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - Bacharach Industrial Instrument Co.
  - * Bailey Meter Co.
  - * Bristol Co
  - * Crosby Steam Gage & Valve Co.
  - * Precision Instrument Co.
  - * Schaeffer & Budenberg Mfg. Co.
  - * Uehling Instrument Co
- **Gages, Rate of Flow**
  - Bacharach Industrial Instrument Co.
  - * Bailey Meter Co.
  - * Builders Iron Foundry
  - * Precision Instrument Co.
  - * Simplex Valve & Meter Co.
- **Gages, Vacuum**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - Bacharach Industrial Instrument Co.
  - Brinckerhoff, H. Gordon Co.
  - * Bristol Co.
  - * Crosby Steam Gage & Valve Co.
  - * Precision Instrument Co.
  - * Schaeffer & Budenberg Mfg. Co.
  - Taylor Instrument Cos.
  - * Uehling Instrument Co.
- **Gages, Water**
  - * American Steam Gauge & Valve Mfg. Co.
  - * Ashton Valve Co.
  - * Bristol Co.
  - * Crane Co.
  - * Jenkins Bros.
  - * Lunkenheimer Co.
  - * Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
  - * Simplex Valve & Meter Co.
- **Gages, Water Level**
  - * Bristol Co.
  - * Schaeffer & Budenberg Mfg. Co.
  - * Simplex Valve & Meter Co.
- **Gas Analysis Apparatus**
  - * Precision Instrument Co.
- **Gas Burners, Compressors, Engines, Exhausters, Producers, etc.**
  - (See Burners, Compressors, Engines, Exhausters, Producers, etc., Gas)
- **Gas Burning Equipment**
  - Rockwell, W. S. Co.
- **Gas Collectors**
  - * Precision Instrument Co.
- **Gas Plant Machinery**
  - * Cole, R. D. Mfg. Co.
  - Rockwell, W. S. Co.
- **Gaskets**
  - * Goetze Gasket & Packing Co.
  - * Jenkins Bros.
  - * Johns-Manville (Inc.)
  - * Sarco Co. (Inc.)
- **Gasoline**
  - Texas Co
  - * Tide Water Oil Sales Corp'n
- **Gates, Blast**
  - Rockwell, W. S. Co.
- **Gates, Sluice**
  - * Chapman Valve Mfg. Co.
- **Gear Cutting Machines**
  - * Jones, W. A. Fdry. & Mch. Co.
- **Gear Hobbing Machines**
  - * Jones, W. A. Fdry. & Mch. Co.
- **Gears, Cut**
  - Brown, A. & F. Co.
  - * De Laval Steam Turbine Co.
  - * Fawcus Machine Co.
  - * Foote Bros. Gear & Machine Co.
  - Hindley Gear Co.
  - * James, D. O. Mfg. Co.
  - Johnson, Carlyle Machine Co.
  - * Jones, W. A. Fdry. & Mch. Co.
  - Mackintosh-Hemphill Co.
  - * Medart Co.
  - Northern Engineering Works
- **Gears, Fibre**
  - * General Electric Co.
  - * James, D. O. Mfg. Co.
- **Gears, Machine Moulded**
  - Brown, A. & F. Co.
  - * Jones, W. A. Fdry. & Mch. Co.
- **Gears, Rawhide**
  - * James, D. O. Mfg. Co.
- **Gears, Speed Reduction**
  - * De Laval Steam Turbine Co.
  - * Fawcus Machine Co.
  - * Foote Bros. Gear & Machine Co.
  - * General Electric Co.
  - * James, D. O. Mfg. Co.
  - * Jones, W. A. Fdry. & Mch. Co.
  - * Kerr Turbine Co.
  - * Moore Steam Turbine Corp'n
- **Gears, Worm**
  - * Cleveland Worm & Gear Co.
  - * Fawcus Machine Co.
  - * Foote Bros. Gear & Machine Co.
  - * Gifford-Wood Co.
  - Hindley Gear Co.
  - * James, D. O. Mfg. Co.
  - * Jones, W. A. Fdry. & Mach. Co.
- **Generating Sets**
  - * Allis-Chalmers Mfg. Co.
  - * American Blower Co.
  - Clarage Fan Co.
  - * De Laval Steam Turbine Co.
  - * Engberg's Electric & Mech. Wks.
  - * General Electric Co.
  - * Kerr Turbine Co.
  - Midwest Engine Corp'n
- **Generators, Electric**
  - * Allis-Chalmers Mfg. Co.
  - * De Laval Steam Turbine Co.
  - * Engberg's Electric & Mech. Wks.
  - * General Electric Co.
  - * Ridgway Dynamo & Engine Co.
- **Governors, Gas**
  - Equitable Meter Co.
- **Governors, Pump**
  - * Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
  - Davis, G. M. Regulator Co.
  - * Illinois Engineering Co.
  - * Kieley & Mueller (Inc.)
- **Governors, Water Wheel**
  - * Worthington Pump & Machinery Corp'n
- **Granulators**
  - * Smidth, F. L. & Co.
- **Graphite, Flake (Lubricating)**
  - * Dixon, Joseph Crucible Co.
- **Grate Bars**
  - * Casey-Hedges Co.
  - * Combustion Engineering Corp'n
  - * Erie City Iron Works
  - * McClave Brooks Co.
  - * Titusville Iron Works Co.
  - * Vogt, Henry Machine Co.
- **Grate Bars (for Overfeed and Underfeed Stokers)**
  - Furnace Engineering Co.
- **Grates, Dumping**
  - * Brownell Co.
  - * Combustion Engineering Corp'n
  - * McClave Brooks Co.
  - * Titusville Iron Works Co.
  - * Vogt, Henry Machine Co.
- **Grates, Kiln**
  - * McClave Brooks Co.
- **Grates, Rocking**
  - * Brownell Co.
- **Grates, Shaking**
  - * Brownell Co.
  - * Casey-Hedges Co.
  - * Combustion Engineering Corp'n
  - * Erie City Iron Works
  - * McClave Brooks Co.
  - * Springfield Boiler Co.
  - * Titusville Iron Works Co.
  - * Vogt, Henry Machine Co.
- **Grease Cups**
  - (See Oil and Grease Cups)
- **Grease Extractors**
  - (See Separators, Oil)
- **Greases**
  - Dixon, Joseph Crucible Co.
  - * Royersford Foundry & Machine Co.
  - Texas Co.
  - * Tide Water Oil Sales Corp'n
  - Vacuum Oil Co.
- **Grinding Machinery**
  - Brown, A. & F. Co.
  - * Smidth, F. L. & Co.
- **Grinding Machines, Chaser**
  - * Landis Machine Co. (Inc.)
- **Grinding Machines, Floor**
  - * Builders Iron Foundry
  - * Royersford Foundry & Machine Co.
- **Grinding Machines, Internal**
  - * Heald Machine Co.
- **Grinding Machines, Surface**
  - * Heald Machine Co.
- **Gun Metal Finish**
  - * American Metal Treatment Co.
- **Hammers, Drop**
  - * Bliss, E. W. Co.
  - * Franklin Machine Co.
  - Long & Allstatter Co.
- **Hammers, Pneumatic**
  - * Ingersoll-Rand Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume*

Ease and accuracy of operating Boring Mills is obtained by their complete electrical equipment



Positive Control at a Touch

Electrical control of this big machine from points within convenient reach gives the operator full command of its operations. Such control is a part of the General Electric Company's complete electrical equipment for Boring Mills—which includes main driving and auxiliary direct-current motors, contactor panels for each motor, and control stations.

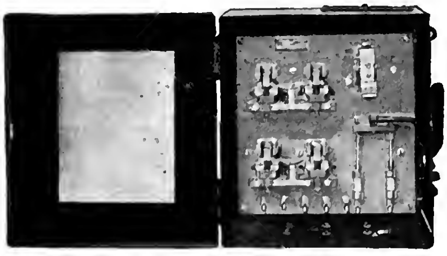
The electric motor could not have worked its wonders without handy provision to start, jog, reverse, regulate speed, brake, and stop at a moment's notice—all due to proper control. Even the big machines have thus been made safe and flexible to operate.

A feature of this G-E equipment is the Magnetic Controller, actuated by Push Button Station, which permits a flexibility of operation of Boring Mills which cannot be obtained by any other method.

With Magnetic Control it is only necessary to locate the Push Button at some point convenient for the operator, thus facilitating operation. The Push Button Station may be used as a pendent switch, permitting the operator to control his machine even from inside the casting on the table.

G-E Type RC Direct-Current Motor for auxiliary drives has solid top half covers which protect the motor from dust and dirt

G-E Push Button Station for actuating Magnetic Controllers



G-E Magnetic Controller (small panel for auxiliary drive)—all units assembled in sheet metal enclosing case

General Electric Company

General Office
Schenectady, N.Y.

Sales Offices in
all large cities

43B-640

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued)

FOR ALPHABETICAL INDEX, SEE PAGE 134

Hangers, Shaft
Brown, A. & F. Co.
* Falls Clutch & Machinery Co.
* Jones, W. A. Fdry. & Mach. Co.
* Medart Co.
* Royersford Foundry & Machine Co.
* Wood's, T. B. Sons Co.

Hangers, Shaft (Ball and Roller Bearing)
* Jones, W. A. Fdry. & Mach. Co.
* S K F Industries (Inc.)

Hardening
* American Metal Treatment Co.
Rockwell, W. S. Co.

Heat Treating
* American Metal Treatment Co.
Rockwell, W. S. Co.

Heaters, Feed Water (Closed)
* Brownell Co.
* Erie City Iron Works
* Schutte & Koerting Co.
* Walsh & Weidner Boiler Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Heaters, Feed Water, Locomotive (Open)
* Worthington Pump & Machinery Corp'n

Heaters, Water Supply
Herbert Boiler Co.

Heaters, Water Supply (Garbage Burner)
Herbert Boiler Co.

Heaters & Mixers, Water, Instantaneous
Manufacturing Equipment & Engrg. Co.

Heaters and Purifiers, Feed Water (Open)
* Brownell Co.
Elliott Co.
* Erie City Iron Works
* H.S.B.W.-Cochrane Corp'n
* Springfield Boiler Co.
* Wickes Boiler Co.
* Worthington Pump & Machinery Corp'n

Heaters and Purifiers, Feed Water Metering
* H.S.B.W.-Cochrane Corp'n

Heating Systems, Vacuum
* Illinois Engineering Co.

Heating and Ventilating Apparatus
* American Blower Co.
* American Radiator Co.
Clarage Fan Co.

Hoisting and Conveying Machinery
* Brown Hoisting Machinery Co.
Clyde Iron Works Sales Co.
* Gifford-Wood Co.
* Jones, W. A. Fdry. & Mach. Co.
Lidgerwood Mfg. Co.
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.

Hoists, Air
* Ingersoll-Rand Co.
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.

Hoists, Belt
Clyde Iron Works Sales Co.
Lidgerwood Mfg. Co.

Hoists, Chain
Northern Engineering Works
Reading Chain & Block Corp'n

Hoists, Electric
* Allis-Chalmers Mfg. Co.
* Brown Hoisting Machinery Co.
Clyde Iron Works Sales Co.
Flory, S. Mfg. Co.
* General Electric Co.
Lidgerwood Mfg. Co.
Northern Engineering Works
Reading Chain & Block Corp'n
* Shepard Electric Crane & Hoist Co.

Hoists, Friction
Brown Clutch Co.
Eastern Machinery Co.

Hoists, Gas and Gasoline
Flory, S. Mfg. Co.
Lidgerwood Mfg. Co.
Western Machinery Co.

Hoists, Head Gate
Smith, S. Morgan Co.

Hoists, Mine
Flory, S. Mfg. Co.
Lidgerwood Mfg. Co.
Western Machinery Co.

Hoists, Skip
* Beaumont, R. H. Co.
* Brown Hoisting Machinery Co.
Flory, S. Mfg. Co.
Lidgerwood Mfg. Co.
Otis Elevator Co.

Hoists, Steam
(See Engines, Hoisting)

Holders, Nipple
Curtis & Curtis Co.

Hose, Metallic
* Johns-Manville (Inc.)

Humidifiers
* American Blower Co.
* Carrier Engineering Corp'n

Humidity Control
* American Blower Co.
* Carrier Engineering Corp'n

Hydrants, Fire
Kennedy Valve Mfg. Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Worthington Pump & Machinery Corp'n

Hydraulic Machinery
* Allis-Chalmers Mfg. Co.
Hydraulic Press Mfg. Co.
* Ingersoll-Rand Co.
Mackintosh-Hemphill Co.
* Worthington Pump & Machinery Corp'n

Hydraulic Rams, Presses, Turbines, etc.
(See Rams, Presses, Turbines, etc., Hydraulic)

Hydrokineters
* Schutte & Koerting Co.

Hydrometers
Taylor Instrument Cos.

Hygrometers
Taylor Instrument Cos.

Ice Making Machinery
* De La Vergne Machine Co.
* Frick Co. (Inc.)
* Ingersoll-Rand Co.
* Johns-Manville (Inc.)
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

Ice Tools
* Gifford-Wood Co.

Idlers (Lenix)
* Smidth, F. L. & Co.

Indicator Posts
* Crane Co.
Kennedy Valve Mfg. Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)

Indicators, CO_2
Bacharach Industrial Instrument Co.
Brinckerhoff, H. Gordon Co.
* Precision Instrument Co.
* Uehling Instrument Co.

Indicators, Engine
* American Steam Gauge & Valve Mfg. Co.
Bacharach Industrial Instrument Co.
* Crosby Steam Gage & Valve Co.
* Schaeffer & Budenberg Mfg. Co.

Indicators, Sight Flow
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)

Indicators, Speed
* Schaeffer & Budenberg Mfg. Co.
Veeder Mfg. Co.
Weston Electrical Instrument Co.

Injectors
* Lunkenheimer Co.
* Schutte & Koerting Co.

Instruments, Electrical Measuring
* General Electric Co.
* Republic Flow Meters Co.
Taylor Instrument Cos.
Weston Electrical Instrument Co.

Instruments, Recording
* American Steam Gauge & Valve Mfg. Co.
* Ashton Valve Co.
Bacharach Industrial Instrument Co.
* Bailey Meter Co.
Brinckerhoff, H. Gordon Co.
* Bristol Co.
* Builders Iron Foundry
* Crosby Steam Gage & Valve Co.
* General Electric Co.
* Precision Instrument Co.
* Republic Flow Meters Co.
* Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Cos.
* Uehling Instrument Co.

Instruments, Scientific
Taylor Instrument Cos.

Instruments, Surveying
Dietzgen, Eugene Co.
Keuffel & Esser Co.

Insulating Materials (Electric)
* General Electric Co.
* Johns-Manville (Inc.)

Insulating Materials(Heat and Cold)
* Celite Products Co.
* Johns-Manville (Inc.)
* King Refractories Co. (Inc.)
* Quigley Furnace Specialties Co.

Irrigation Systems
* Spray Engineering Co.

Joints, Expansion
* Badger, E. B. & Sons Co.
* Crane Co.
* Illinois Engineering Co.
* Lunkenheimer Co.
* Wheeler, C H Mfg. Co.

Joints, Flanged Pipe
* Crane Co.

Joints, Flexible
* Barco Mfg. Co.

Joints, Swing and Swivel
* Barco Mfg. Co.

Kettles, Soda
Manufacturing Equipment & Engrg. Co.

Kettles, Steam Jacketed
* Cole, R. D. Mfg. Co.
* Titusville Iron Works Co.

Kerosene
* Tide Water Oil Sales Corp'n

Keys, Machine
* Whitney Mfg. Co.

Keyseating Machines
* Whitney Mfg. Co.

Kilns, Dry (Brick, Lumber, Stone, etc.)
* American Blower Co.

Ladles
Northern Engineering Works

Lamps, Incandescent
* General Electric Co.
* Johns-Manville (Inc.)

Land-Clearing Machinery
Clyde Iron Works Sales Co.

Lathe Attachments, Pipe-Threading
Curtis & Curtis Co.

Lathes, Automatic
* Jones & Lamson Machine Co.

Lathes, Brass
* Warner & Swasey Co.

Lathes, Chucking
* Jones & Lamson Machine Co.

Lathes, Engine
* Builders Iron Foundry

Lathes, Metal-Spinning
Pryibil, P. Machine Co.

Lathes, Turret
* Jones & Lamson Machine Co.
* Warner & Swasey Co.

Leather Belting, Packing, etc.
(See Belting, Packing, etc., Leather)

Levers, Flexible (Wire)
* Gwilliam Co.

Lightning Arresters
* General Electric Co.

Linings, Brake
* Johns-Manville (Inc.)

Linings, Furnace
* Best, W. N. Furnace & Burner Corp'n
Brinckerhoff, H. Gordon Co.
* Celite Products Co.
* Johns-Manville (Inc.)
* King Refractories Co. (Inc.)
* Quigley Furnace Specialties Co.

Linings, Stack
* Johns-Manville (Inc.)

Liquid Fuel Equipment
* Best, W. N. Furnace & Burner Corp'n

Loaders, Wagon
* Gifford-Wood Co.

Lockers, Metal
Manufacturing Equipment & Engrg. Co.

Lockers, Steel or Wood
Wilson, J. G. Corp'n

Locomotives, Electric
* General Electric Co.

Locomotives, Storage Battery
* General Electric Co.

Logging Machinery
Clyde Iron Works Sales Co.
Lidgerwood Mfg. Co.

Lubricants
* Royersford Fdry. & Mach. Co.
Texas Co.
* Tide Water Oil Sales Corp'n
Vacuum Oil Co.

Lubricating Systems
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)

Lubricators, Cylinder
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
* Lunkenheimer Co.

Lubricators, Force-Feed
* Bowser S F. & Co (Inc.) (Richardson-Phenix Division)
* Lunkenheimer Co.

Lubricators, Hydrostatic
* Crosby Steam Gage & Valve Co.
* Lunkenheimer Co.

Lubricators (Sight Feed)
* Crosby Steam Gage & Valve Co.

Machine Work
Brown, A. & F. Co.
* Builders Iron Foundry
* Franklin Machine Co.
Johnson, Carlyle Machine Co.
* Jones, W. A. Fdry. & Mch. Co.
Lammert & Mann Co.

Machinery
(Is classified under the headings descriptive of character thereof)

Manometers
Bacharach Industrial Instrument Co.
* Republic Flow Meters Co.
* Simplex Valve & Meter Co.

Mechanical Draft Apparatus
* American Blower Co.
Clarage Fan Co.
* Green Fuel Economizer Co

Mechanical Stokers
(See Stokers)

Metal Cutting Machines
(See Cutting-off Machines, Metal)

Metal Equipment
Manufacturing Equipment & Engrg. Co.

Metal Reclaiming Mills
(See Mills, Metal Reclaiming)

Metal Treating
* American Metal Treatment Co
Rockwell, W. S. Co.

Metals, Bearing
American Crucible Products Co.
* General Electric Co.
Phosphor Bronze Smelting Co.

Metals, Perforated
* Hendrick Mfg. Co.

Metals, Thermostatic
Wilson, H. A. Co.

Meter Provers
Equitable Meter Co.

Meters, Air and Gas
Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Builders Iron Foundry
* General Electric Co.
* Republic Flow Meters Co.

Meters, Boiler Performance
* Bailey Meter Co.

Meters, Condensation
* Simplex Valve & Meter Co.

Meters, Electric
* General Electric Co.
Weston Electrical Instrument Co.

Meters, Feed Water
* Bailey Meter Co.
* Builders Iron Foundry
* General Electric Co.
* H.S.B.W.-Cochrane Corp'n
* Precision Instrument Co.
* Republic Flow Meters Co.
* Simplex Valve & Meter Co.
* Worthington Pump & Machinery Corp'n

Meters, Flow
Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* General Electric Co.
* Republic Flow Meters Co
* Simplex Valve & Meter Co.
* Spray Engineering Co.

Meters, Gas
Equitable Meter Co.

Meters, Oil
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
* General Electric Co.
* H S B W.-Cochrane Corp'n
* Simplex Valve & Meter Co.
* Worthington Pump & Machinery Corp'n

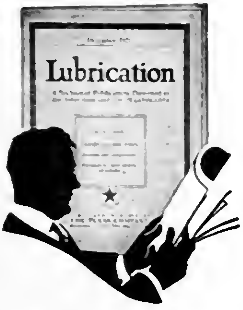
Meters, Pitot Tube
* American Blower Co.
* Republic Flow Meters Co.
* Simplex Valve & Meter Co

Meters, Steam
* Bailey Meter Co.
* Builders Iron Foundry

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume*

This Page

is reprinted from "Lubrication." It accompanies an excellent article on Lubrication of Elevators, which will interest all engineers who are in charge of equipment of this type.



Every month our Magazine "Lubrication" publishes an article of interest to engineers, power plant executives, factory manufacturers, purchasing agents and all others whose professional activities require an understanding of the economical selection and use of lubricants.

Sent free if you use the Coupon.

TEXACO LUBRICANTS FOR ELEVATORS

A SUGGESTIVE LIST

giving recommendations for various parts of most commonly used types of elevators

HYDRAULIC ELEVATORS

Plunger or Piston Rods Texaco Crater Compound No. 1

Pumping Systems:

Steam Cylinders: Texaco Draco Cylinder Oil or Texaco Pinnacle Cylinder Oil
External Lubrication: Texaco Aleph Oil or Texaco Altair Oil

Emulsifying Compound for water in the System: Texaco Soluble Oil
Sheave Bearings: Texaco Aleph Oil or Texaco Altair Oil

Control Operating Mechanism:

Gear Teeth, etc.: Texaco Thuban Compound
Other Operating Parts: Texaco Aleph Oil or Texaco Altair Oil

Guides:

For Grease Cup Service: Texaco No. 1 Cup Grease
For Hand Application: Texaco Thuban Compound

ELECTRIC ELEVATORS

Gearless Traction Machines:

Motor and Sheave Bearings:
For Chain Oiling Systems: Texaco Aleph Oil
For Roller Bearings: Texaco Petrolatum

Geared Traction Machines:

Motor and Sheave Bearings: Same as above
Worm Gears: Texaco Thuban Compound—Compound B
For Grease Cup Seal and Lubrication of Worm Shaft: Texaco No. 2 Cup Grease
Driving Sheave: Bearing lubrication in special cases, if ordinary gear lubricant is unsuitable, use Texaco Altair Oil or Texaco Ursa Oil.

Guides:

For Cup Grease Service: Texaco Cup Grease No. 1
For Hand Application: Texaco Thuban Compound

Safety Devices: Texaco Aleph Oil

WIRE ROPE LUBRICATION

Texaco Crater Compound No. 2 for ordinary conditions.
Texaco Crater Compound No. 5 where a very heavy lubricant is recommended.

NOTE: If the grade of oil to use for any specific part or machine is not covered in the above list, kindly call on us and we shall be glad to tell you the right oil to use.

If your elevator is operating under unusual conditions which require individual treatment, let us know the name of the manufacturer, the type of machine, the general operating conditions, and we shall be glad to advise you as to the right Texaco Lubricant which will give you the best possible service.

COUPON

Become a free subscriber to our magazine, "Lubrication," published monthly by us and devoted exclusively to the scientific selection and use of lubricants. Fill out the coupon below and mail to:

THE TEXAS COMPANY, U. S. A.
Texaco Petroleum Products
Dept. ME, 17 Battery Place, New York City
Sold the world over.

Name ....
Street ....
City ....
State ....

12-22

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued)

FOR ALPHABETICAL INDEX, SEE PAGE 134

- • General Electric Co.
- • Republic Flow Meters Co.

Meters, V-Notch
- • Bailey Meter Co.
- • General Electric Co.
- • H S.B.W.-Cochrane Corp'n

Meters, Venturi
- • Builders Iron Foundry
- • National Meter Co.
- • Republic Flow Meters Co.
- • Simplex Valve & Meter Co.

Meters, Water
- • General Electric Co.
- • H S B W Cochrane Corp'n
- • National Meter Co.
- • Simplex Valve & Meter Co.
- • Worthington Pump & Machinery Corp'n

Milling Machines, Hand
- • Whitney Mfg. Co.

Milling Machines, Keyseat
- • Whitney Mfg. Co.

Milling Machines, Plain
- • Warner & Swasey Co.

Mills, Ball
- • Allis-Chalmers Mfg. Co.
- • Smidth, F. L. & Co.
- • Worthington Pump & Machinery Corp'n

Mills, Blooming and Slabbing
- Mackintosh-Hemphill Co.

Mills, Grinding
- • Smidth, F L. & Co.

Mills, Sheet and Plate
- Mackintosh-Hemphill Co

Mills, Structural, Rail and Bar
- Mackintosh-Hemphill Co.

Mills, Tube
- • Allis-Chalmers Mfg. Co.
- • Smidth, F. L. & Co.
- • Worthington Pump & Machinery Corp'n

Mining Machinery
- • Allis-Chalmers Mfg. Co.
- • General Electric Co.
- • Ingersoll-Rand Co.
- • Worthington Pump & Machinery Corp'n

Monel Metal
- Driver-Harris Co.

Monorail Systems
- (See Tramrail Systems, Overhead)

Motor-Generators
- • Allis-Chalmers Mfg. Co.
- • General Electric Co.
- • Ridgway Dynamo & Engine Co

Motors, Electric
- • Engberg's Electric & Mech. Wks.
- • General Electric Co.
- • Shepard Electric Crane & Hoist Co.

Motors, Synchronous
- • Ridgway Dynamo & Engine Co.

Nickel, Sheet
- Driver-Harris Co.

Nipple Threading Machines
- • Landis Machine Co. (Inc.)

Nitrogen Gas
- Linde Air Products Co.

Non-Return Valves
- (See Valves, Non-Return)

Nozzles, Aerating
- • Spray Engineering Co.

Nozzles, Blast
- • Schutte & Koerting Co.

Nozzles, Sand and Air
- • Lunkenheimer Co.

Nozzles, Spray
- • Badger, E. B. & Sons Co.
- • Cooling Tower Co. (Inc.)
- • Schutte & Koerting Co.
- • Spray Engineering Co.

Nuts, Machine Screw (Steel & Brass)
- • Reed & Prince Mfg. Co.

Odometers
- Veeder Mfg. Co.

Ohmeters
- • General Electric Co.
- Weston Electrical Instrument Co.

Oil and Grease Cups
- • Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
- • Crane Co.
- • Lunkenheimer Co.

Oil and Grease Guns
- • Royersford Foundry & Machine Co

Oil Burners, Engines, Filters, Pumps, Separators, etc.
- (See Burners, Engines, Filters, Pumps, Separators, etc., Oil)

Oil Burning Equipment
- • Best, W. N. Furnace & Burner Corp'n

- Rockwell, W. S. Co.
- • Schutte & Koerting Co.

Oil Filtering and Circulating Systems
- • Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)

Oil Mill Machinery
- • Worthington Pump & Machinery Corp'n

Oil Refinery Equipment
- • Vogt, Henry Machine Co.

Oil Storage and Distributing Systems
- • Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)

Oil Tanks
- • Scaife, Wm. B. & Sons Co.

Oil Well Machinery
- • Brownell Co.
- • Ingersoll-Rand Co.
- • Titusville Iron Works Co.
- • Worthington Pump & Machinery Corp'n

Oilers, Sight Feed
- • Lunkenheimer Co.

Oiling Devices
- • Bowser, S F. & Co. (Inc.) (Richardson-Phenix Division)
- • Lunkenheimer Co.

Oiling Systems
- • Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
- • Lunkenheimer Co.

Oils, Fuel
- Texas Co
- • Tide Water Oil Sales Corp'n

Oils, Lubricating
- Texas Co.
- • Tide Water Oil Sales Corp'n
- Vacuum Oil Co

Ore Handling Machinery
- • Brown Hoisting Machinery Co.

Overhead Track System
- (See Tramrail Systems, Overhead)

Oxy-Acetylene Supplies
- Linde Air Products Co.

Oxygen Gas
- Linde air Products Co.

Packing, Ammonia
- France Packing Co.

Packing, Asbestos
- • Johns-Manville (Inc.)

Packing, Hydraulic
- France Packing Co.
- • Johns-Manville (Inc.)

Packing, Metallic
- France Packing Co.
- • Goetze Gasket & Packing Co.
- • Johns-Manville (Inc.)

Packing, Rod (Piston and Valve)
- France Packing Co.
- • Jenkins Bros
- • Johns-Manville (Inc.)

Packing, Rubber
- • Jenkins Bros.
- • Johns-Manville (Inc.)

Packing, Sheet
- • Goetze Gasket & Packing Co.
- • Jenkins Bros.
- • Johns-Manville (Inc.)

Paint "Diffuselite," Light Reflecting
- Wilson, J. G. Corp'n

Paint, Metal
- • General Electric Co.
- • Johns-Manville (Inc.)

Paper, Drawing
- Dietzgen, Eugene Co.
- Keuffel & Esser Co.

Paper Sensitized
- Dietzgen, Eugene Co.
- Keuffel & Esser Co.

Paraffine Wax Plant Equipment
- • Vogt, Henry Machine Co.

Partitions, Metal
- Wilson, J. G. Corp'n

Partitions, Steel or Wood, Rolling or Folding
- Wilson, J. G. Corp'n

Pasteurizers
- • Vilter Mfg. Co.

Pencils, Drawing
- American Lead Pencil Co.
- Dietzgen, Eugene Co.
- Dixon, Joseph Crucible Co.
- Keuffel & Esser Co.

Penstocks
- Smith, S. Morgan Co.

Perforated Metals
- (See Metals, Perforated)

Petroleum Products
- Texas Co
- • Tide Water Oil Sales Corp'n

Pile Drivers
- Clyde Iron Works Sales Co.
- Lidgerwood Mfg. Co.

Pinions, Rolling Mill
- Mackintosh-Hemphill Co.

Pinions, Steel
- • General Electric Co.

Pipe, Cast Iron
- • Builders Iron Foundry
- • Central Foundry Co.
- • United States Cast Iron Pipe & Fdry. Co.
- Weatherly Foundry & Mfg. Co.

Pipe, Riveted
- • American Spiral Pipe Wks.
- • Titusville Iron Works Co.
- • Walsh & Weidner Boiler Co.

Pipe, Riveted Steel
- • Springfield Boiler Co.

Pipe, Soil
- • Central Foundry Co.

Pipe, Steel
- • Crane Co.

Pipe Welded
- • American Spiral Pipe Wks.
- • Crane Co.

Pipe, Wrought Iron
- • Crane Co.

Pipe Bending Machines
- • Hydraulic Press Mfg. Co.

Pipe Coils, Covering, Fittings, etc.
- (See Coils, Covering, Fittings, etc., Pipe)

Pipe Cutting-off Machines
- Curtis & Curtis Co.

Pipe Cutting and Threading Machines
- • Crane Co.
- Curtis & Curtis Co.
- • Landis Machine Co. (Inc.)

Pipe Joint Clamps
- (See Clamps, Pipe Joint)

Piping, Ammonia
- • Frick Co. (Inc.)

Piping, Power
- • Crane Co.
- • Vogt, Henry Machine Co.

Pitot Tubes
- (See Tubes, Pitot)

Planimeters
- • American Steam Gauge & Valve Mfg. Co.
- • Bristol Co.
- • Crosby Steam Gage & Valve Co.
- Dietzgen, Eugene Co.

Plate Metal Work
- (See Steel Plate Construction)

Platinum
- Wilson, H. A. Co

Pneumatic Tools, Tubes, etc.
- (See Tools, Tubes, etc., Pneumatic)

Pointers, Bolt
- • Landis Machine Co. (Inc.)

Polishing Machinery
- • Builders Iron Foundry
- • Royersford Foundry & Machine Co.

Poppet Valve Engines
- (See Engines, Steam, Poppet Valve)

Powdered Fuel Equipment (for Boiler and Metallurgical Furnaces)
- • Allis-Chalmers Mfg. Co.
- • Combustion Engineering Corp'n
- • Quigley Furnace Specialties Co.
- • Smidth, F L. & Co.
- • Worthington Pump & Machinery Corp'n

Power Transmission Machinery
- • Allis-Chalmers Mfg. Co.
- Brown, A. & F. Co.
- Eastern Machinery Co.
- • Falls Clutch & Machinery Co.
- • Franklin Machine Co.
- • General Electric Co.
- • Jones, W. A. Fdry. &. Mch. Co.
- • Medart Co.
- • Morse Chain Co.
- Prylbil, P Machine Co.
- • Royersford Foundry & Machine Co.
- • Smidth, F. L. & Co.
- Smith, S. Morgan Co.
- • Woods T B. Sons Co.

Presses, Baling
- • Franklin Machine Co.
- • Hydraulic Press Mfg. Co.
- Philadelphia Drying Machinery Co

Presses, Blanking
- • Bliss, E. W. Co.
- • Hydraulic Press Mfg. Co.

Presses, Draw
- • Bliss, E. W. Co.
- • Hydraulic Press Mfg. Co.

Presses, Embossing
- • Hydraulic Press Mfg. Co.

Presses, Extruding
- • Bliss, E. W. Co.
- • Hydraulic Press Mfg. Co.

Presses, Foot
- • Bliss, E. W. Co.
- • Royersford Foundry & Machine Co.

Presses, Forging
- • Bliss, E. W. Co.
- • Hydraulic Press Mfg. Co.

Presses, Forming
- • Hydraulic Press Mfg. Co.

Presses, Hydraulic
- • Falls Clutch & Machinery Co.
- • Hydraulic Press Mfg. Co.
- Mackintosh-Hemphill Co.
- Philadelphia Drying Machinery Co.

Presses, Punching and Trimming
- • Bliss, E. W. Co.
- Long & Allstatter Co.
- • Royersford Foundry & Machine Co.

Presses, Sheet Metal Working
- • Bliss, E. W. Co.

Presses, Wax
- • Vogt, Henry Machine Co.

Pressure Gages, Regulators, etc.
- (See Gages, Regulators, etc., Pressure)

Producers, Gas
- • De La Vergne Machine Co.
- Otto Engine Works
- • Worthington Pump & Machy. Corp'n

Propellers
- • Morris Machine Works

Pulleys, Friction Clutch
- • Allis-Chalmers Mfg. Co.
- Brown, A. & F. Co.
- Eastern Machinery Co.
- • Falls Clutch & Machinery Co.
- Johnson, Carlyle Machine Co.
- • Jones, W. A. Fdry. & Machine Co.
- • Medart Co.
- Wood's, T. B. & Sons Co.

Pulleys, Iron
- Brown, A. & F. Co.
- • Falls Clutch & Machinery Co
- • Gifford-Wood Co.
- • Jones, W. A. Fdry. & Mch. Co.
- • Medart Co.
- • Wood's, T. B. Sons Co.

Pulleys, Paper
- Rockwood Mfg. Co.

Pulleys, Steel
- • Medart Co.

Pulleys, Wood
- • Medart Co.

Pulling Tables (For Annealing Furnaces)
- Kenworthy, Chas. F. (Inc.)

Pulverized Fuel Feeders
- (See Feeders, Pulverized Fuel)

Pulverizers
- Brown, A. &. F. Co.
- • Smidth, F. L. & Co.

Pump Governors, Valves, etc.
- (See Governors, Valves, etc., Pump)

Pumping Engines
- (See Engines, Pumping)

Pumping Systems, Air Lift
- • Ingersoll-Rand Co.

Pumps, Acid
- Buffalo Steam Pump Co.
- • Davidson, M. T. Co.
- • Ingersoll-Rand Co.
- • Titusville Iron Works Co.

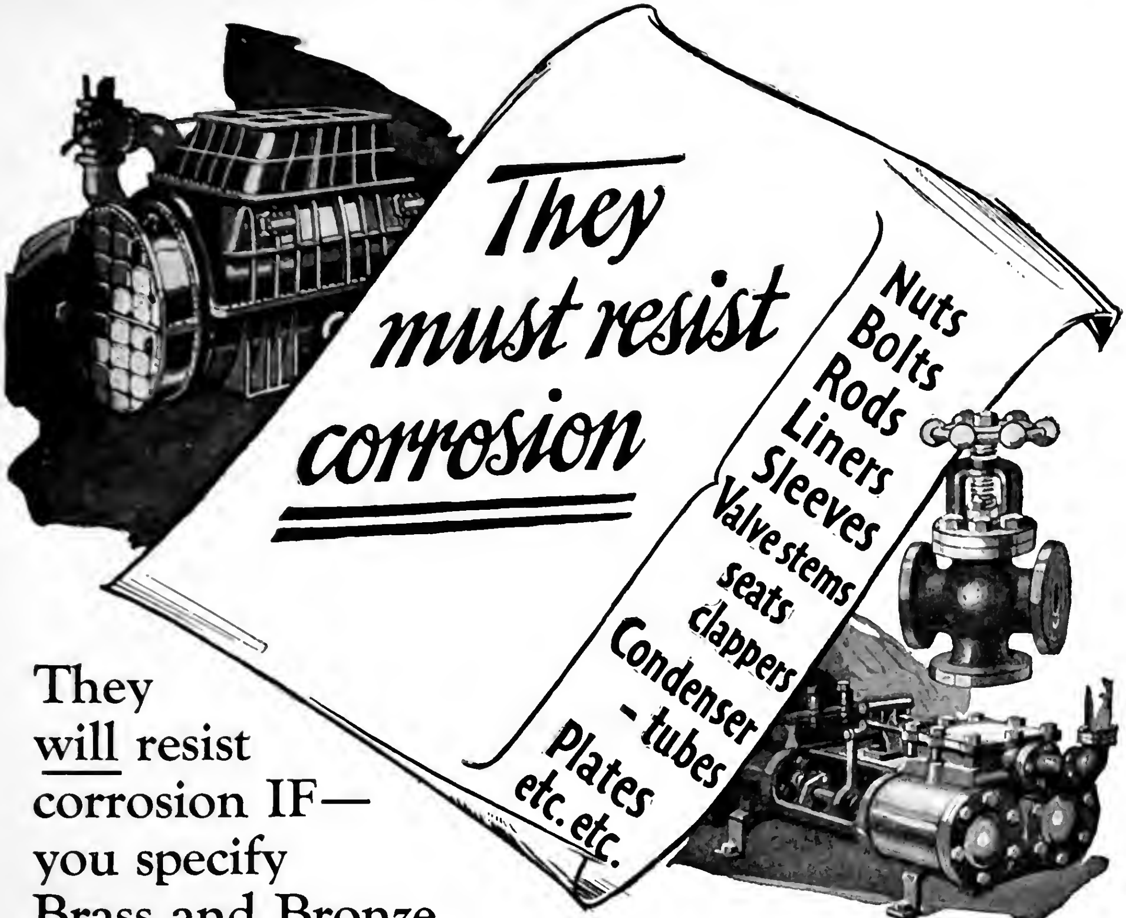
Pumps, Air
- • Goulds Mfg. Co.
- • Ingersoll-Rand Co.
- • Wheeler, C. H. Mfg. Co.

Pumps, Ammonia
- Buffalo Steam Pump Co.
- • Davidson, M. T. Co.
- • Ingersoll-Rand Co.
- • Vogt, Henry Machine Co.
- • Worthington Pump & Machinery Corp'n

Pumps, Boiler Feed
- • Allis-Chalmers Mfg. Co.
- Buffalo Steam Pump Co.
- • Davidson, M. T. Co.
- • De Laval Steam Turbine Co.
- • Goulds Mfg Co.
- • Ingersoll Rand Co.
- • Kerr Turbine Co.
- Midwest Engine Corp'n
- • Wheeler, C. H. Mfg. Co.
- • Worthington Pump & Machinery Corp'n

Pumps, Centrifugal
- • Allis-Chalmers Mfg. Co.
- Buffalo Steam Pump Co.

Catalogue data of firms marked • appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume


They must resist corrosion
Nuts
Bolts
Rods
Liners
Sleeves
Valve stems
seats
clappers
Condenser-tubes
Plates
etc. etc.

* Cramp, Wm. & Sons Ship & Engine Bldg. Co.
* De Laval Steam Turbine Co.
* Goulds Mfg Co
* Ingersoll-Rand Co.
* Kerr Turbine Co.
Lammert & Mann Co.
Midwest Engine Corp'n.
* Morris Machine Works.
Taber Pump Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co
* Worthington Pump & Machinery Corp'n

Pumps, Condensation
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Wheeler, C. H Mfg. Co.

Pumps, Deep Well
* Allis-Chalmers Mfg Co.
* Davidson, M. T. Co.
* Goulds Mfg. Co.
* Ingersoll-Rand Co
Midwest Engine Corp'n
* Morris Machine Works
* Worthington Pump & Machinery Corp'n

Pumps, Deep Well, Axial
Midwest Engine Corp'n.

Pumps, Dredging
* Ingersoll-Rand Co.
* Morris Machine Works.
* Worthington Pump & Machinery Corp'n

Pumps, Dry Vacuum
(See Pumps, Vacuum)

Pumps, Electric
* Allis-Chalmers Mfg. Co.
Buffalo Steam Pump Co.
* Goulds Mfg. Co.
* Ingersoll-Rand Co.
* Morris Machine Works
* Worthington Pump & Machinery Corp'n

Pumps, Elevator
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Worthington Pump & Machinery Corp'n

Pumps, Filter Press
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Hydraulic Press Mfg. Co.

Pumps, Hand
* Goulds Mfg. Co.

Pumps, Hydraulic Pressure
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Goulds Mfg. Co.
* Hydraulic Press Mfg. Co
* Ingersoll-Rand Co.
* Morris Machine Works
* Worthington Pump & Machinery Corp'n

Pumps, Measuring (Gasoline or Oil)
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)

Pumps, Oil
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Goulds Mfg. Co.
* Ingersoll-Rand Co.
* Lunkenheimer Co.
* Worthington Pump & Machinery Corp'n

Pumps, Oil, Force-Feed
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
* Lunkenheimer Co.

Pumps, Oil (Hand)
* Bowser, S. F & Co. (Inc.) (Richardson-Phenix Division)

Pumps, Power
* Allis-Chalmers Mfg. Co.
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Goulds Mfg. Co.
* Ingersoll-Rand Co.
Midwest Engine Corp'n
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Pumps, Rotary
* Goulds Mfg Co.
Lammert & Mann Co.
Taber Pump Co.

Pumps, Steam
* Allis-Chalmers Mfg. Co.
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Ingersoll-Rand Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Pumps, Sugar House
* Allis-Chalmers Mfg. Co.
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Ingersoll-Rand Co.
* Worthington Pump & Machinery Corp'n

Pumps, Sump
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Goulds Mfg. Co.
* Morris Machine Works
* Smidth, F. L. & Co

Pumps, Tank
Buffalo Steam Pump Co.
* Davidson, M. T. Co.
* Goulds Mfg. Co.
* Ingersoll-Rand Co.
* Wheeler, C. H Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Pumps, Turbine
* Allis-Chalmers Mfg. Co.
Buffalo Steam Pump Co.
* De Laval Steam Turbine Co.
* General Electric Co.
* Ingersoll-Rand Co.
* Kerr Turbine Co.
* Morris Machine Works.
* Worthington Pump & Machinery Corp'n

Pumps, Vacuum
Buffalo Steam Pump Co.
* Davdison, M. T. Co.
* Goulds Mfg. Co.
* Ingersoll-Rand Co.
Lammert & Mann Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Punches, Metal (Hand Power)
* Parker Supply Co.

Punches, Multiple
* Bliss, E. W. Co.
Long & Allstatter Co.
Mackintosh-Hemphill Co.

Punches, Power
* Bliss, E. W. Co.
* Royersford Fdry. & Mch. Co.

Punches and Dies
* Bliss, E. W. Co.
* Royersford Fdry. & Mch. Co.

Punching and Coping Machines
Long & Allstatter Co.

Punching and Shearing Machines
* Bliss, E. W. Co.
Long & Allstatter Co.
* Royersford Fdry. & Mch. Co.

Purifiers, Ammonia
* Frick Co. (Inc.)

Purifiers, Oil
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
Elliott Co

Purifying and Softening Systems, Water
International Filter Co.
* Scaife, Wm. B. & Sons Co.

Pyrometers, Electric
* Bristol Co.
* Crosby Steam Gage & Valve Co.
* Schaeffer & Budenberg Mfg. Co.
* Superheater Co
Taylor Instrument Cos.

Pyrometers, Optical
Taylor Instrument Cos.

Pyrometers, Pneumatic
* Uehling Instrument Co

Pyrometers, Radiation
Taylor Instrument Cos.

Racks, Machine, Cut
* Brownell Co.
* James, D. O. Mfg. Co.
* Jones, W. A. Fdy. & Mch. Co.

Racks, Storage, Metal
Manufacturing Equipment & Engrg. Co.

Radiators, Steam and Water
* American Radiator Co.
* Smith, H. B. Co

Rams, Hydraulic
* Goulds Mfg. Co.
* Worthington Pump & Machinery Corp'n

Receivers, Air
* Brownell Co.
* Ingersoll-Rand Co.
* Scaife, Wm. B. & Sons Co.
* Walsh & Weidner Boiler Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Receivers, Ammonia
* Frick Co. (Inc.)

Recording Instruments
(See Instruments, Recording)

Reducing Motions
* Crosby Steam Gage & Valve Co.

Refractories
* King Refractories Co. (Inc.)

Refrigerating Machinery
* De La Vergne Machine Co.
* Frick Co. (Inc.)
* Ingersoll-Rand Co.
* Johns-Manville (Inc.)
Norwalk Iron Works Co.
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

Refuse Destructors
(See Destructors, Refuse)

Regulators, Blower
* Davis, G. M. Regulator Co.

Regulators, Damper
* Davis, G. M. Regulator Co.
* Kieley & Mueller (Inc.)
* Parker Supply Co.

Regulators, Electric
* General Electric Co.

Regulators, Feed Water
Elliott Co.
* Kieley & Mueller (Inc.)

Regulators, Flow (Steam)
* Davis, G. M. Regulator Co.
* Schutte & Koerting Co.

Regulators, Pressure
* Davis, G. M. Regulator Co.
Equitable Meter Co.
* General Electric Co.
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
Taylor Instrument Cos.

Regulators, Pump
(See Governors, Pump)

Regulators, Temperature
* Bristol Co.
* Kieley & Mueller (Inc.)
* Powers Regulator Co.
* Sarco Co. (Inc.)
Taylor Instrument Cos.
Wilson, H. A. Co.

Reservoirs, Aerating
* Spray Engineering Co

Resistance Material (Electrical)
Driver-Harris Co.

Revolution Counters
(See Counters, Revolution)

Rivet Heaters, Electric
* General Electric Co.

Riveters, Hydraulic
Mackintosh-Hemphill Co

Riveters, Pneumatic
* Ingersoll-Rand Co.

Riveting Machines
Long & Allstatter Co.

Rivets (Steel, Brass & Copper)
* Reed & Prince Mfg. Co.

Rods, Bronze
Phosphor Bronze Smelting Co.

Roller Bearings
(See Bearings, Roller)

Rolling Doors and Shutters
(See Doors and Shutters, Steel or Wood, Rolling)

Rolling Mill Machinery
Mackintosh-Hemphill Co.

Rolls, Crushing
* Worthington Pump & Machinery Corp'n

Rolls, Steel
Mackintosh-Hemphill Co.

Roofing
* Johns-Manville (Inc.)
Texas Co.

Roofing, Asbestos
* Johns-Manville (Inc.)

Rope, Bronze
Phosphor Bronze Smelting Co.

Rope, Hoisting
Clyde Iron Works Sales Co.
Phosphor Bronze Smelting Co.
* Roebling's, John A. Sons Co.

Rope, Transmission
Phosphor Bronze Smelting Co.
* Roebling's, John A. Sons Co.

Rope, Wire
Clyde Iron Works Sales Co.
* Roebling's, John A. Sons Co.

Rope Drives
* Allis-Chalmers Mfg. Co.
Brown, A. & F. Co.
* Falls Clutch & Machinery Co.
* Medart Co.
* Wood's, T. B. Sons Co.

Rubber Goods, Mechanical
* Jenkins Bros.

Sand Blast Apparatus
* De La Vergne Machine Co.

Saw Mill Machinery
* Allis-Chalmers Mfg. Co.

Saw Mills, Portable
* Frick Co. (Inc.)

Scales, Fluid Pressure
* Crosby Steam Gage & Valve Co.

Screens, Perforated Metal
* Hendrick Mfg. Co.

Screens, Revolving
* Allis-Chalmers Mfg. Co
* Gifford-Wood Co.
* Hendrick Mfg. Co.
* Smidth, F. L. & Co.

Screens, Shaking
* Allis-Chalmers Mfg. Co.
* Gifford-Wood Co.
* Hendrick Mfg. Co.

Screw Cutting Dies
(See Dies, Thread Cutting)

Screws, Drive (Hardened)
* Parker Supply Co.

Screw Machines, Hand
* Jones & Lamson Mch. Co.
* Warner & Swasey Co.

Screws, Cap
* Scovill Mfg. Co.

Screws, Cap & Set
Allen Mfg. Co.
* Reed & Prince Mfg. Co.

Screws, Cap & Set (Steel)
* Reed & Prince Mfg. Co.

Screws, Machine (Steel and Brass)
* Reed & Prince Mfg. Co.

Screws, Safety Set
Allen Mfg. Co.
* Bristol Co.

Screws, Self-Tapping (Hardened)
* Parker Supply Co.

Screws, Wood (Steel, Brass and Bronze)
* Reed & Prince Mfg. Co.

Separators, Ammonia
* De La Vergne Machine Co.
Elliott Co.
* Frick Co. (Inc.)
Milwaukee Steam Appliance Co.
* Vogt, Henry Machine Co.

Separators, Oil
* Crane Co.
* De La Vergne Machine Co.
Elliott Co.
* H.S.B.W.-Cochrane Corp'n
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
Milwaukee Steam Appliance Co.
* Vogt, Henry Machine Co.

Separators, Steam
* Crane Co.
Elliott Co.
* H.S.B.W.-Cochrane Corp'n
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
Milwaukee Steam Appliance Co
* Vogt, Henry Machine Co.

Shafting
* Allis-Chalmers Mfg. Co.
Brown, A. &. F. Co.
Cumberland Steel Co.
* Falls Clutch & Mchy. Co.
* Medart Co.
* Union Drawn Steel Co.
* Wood's, T. B. Sons Co.

Shafting, Bronze
Phosphor Bronze Smelting Co

Shafting, Cold Drawn
* Medart Co.

Shafting, Flexible
* Gwilliam Co.

Shapes, Cold Drawn Steel
* Union Drawn Steel Co.

Sharpening Devices, Rock Drill
* Ingersoll-Rand Co.

Shears, Alligator
Long & Allstatter Co.
* Royersford Foundry & Machine Co.

Twenty Thousand Engineers from many industries, who specify or otherwise influence the selection of mechanical equipment

will be present in person, or spirit at the forthcoming Annual Meeting of

The American Society of Mechanical Engineers

Time and Place

The 1922 A.S.M.E. Annual Meeting will be held as usual at the Engineering Societies Building, New York City, from December 4th to December 7th inclusive.

Program

This Meeting will be notable for five Joint Sessions which are to be held respectively with the American Economic Association, The American Society of Refrigerating Engineers, The American Society of Safety Engineers, The American Engineering Standards Committee and the Stoker Manufacturers Association.

An outstanding feature will be the general session of Wednesday evening, December 6th, at which E. M. Herr, President of the Westinghouse Electric & Manufacturing Co., will talk on "The Human Problem in Industry" and Dr. Wesley C. Mitchell, Director of the National Bureau of Economic Research, will speak on the subject of "Making Money and Making Goods."

Important professional sessions will be held on Management, Materials Handling, Machine Shop Methods, Railroads, Power Plants, Forest Products, Ordnance, Aeronautics, Refrigeration, Fuels, Safety Engineering, Training for the Industries, etc., at each of which addresses will be made by engineers of distinction and special experience along lines indicated by the titles of their respective papers.

A.S.M.E. Annual Meeting Report

A complete and accurate report of this meeting will naturally be of great interest to the 17,000 members of the Society, as well as to those other thousands of engineers and industrial executives who have registered their interest in its constructive activities by subscribing for its monthly journal, *Mechanical Engineering*.

A.S.M.E. Annual Meeting Number

Mechanical Engineering for January, 1923, will contain a full report of the entire meeting; and will be read with keen appreciation by all who attend, as well as by those whose business affairs prevent their attendance, and who are thereby compelled to depend upon it for an authoritative account of the many important facts that will be brought out.

Each month *Mechanical Engineering* contains the advertising of leading manufacturers in practically all divisions of mechanical equipment. Many of these advertisers increase their space for the January issue; while many other manufacturers who do not use space regularly recognize the extra importance of this number, and arrange for special representation therein. Both in point of editorial interest, and in the volume of advertising carried, it is always the most noteworthy issue of the year.

Circulation

The constantly growing circulation of *Mechanical Engineering* now exceeds 21,500 a month, while additional demands for the January number will require us to print a total of at least 22,000 copies. This circulation represents in one grouping the largest number of prominent engineers identified with the selection and purchase of mechanical equipment ever recorded as readers of a monthly engineering publication.

We Can Help Prepare Your Advertisement

Our Copy Service Department is composed of men who combine advertising experience with an accurate knowledge of engineering matters, and they will be glad to coöperate in preparing copy which will insure a satisfactory representation for your firm. Upon request, a complete advertising suggestion will be submitted for your consideration.

What Space Costs

Rates for single insertions of new advertisers in the January issue are as follow:

Full page.............	$115.00
Half page.............	62.00
Quarter page..........	33.00

(Annual rates on application)

Adequate listings of products in the Classified Index are included if order is received in time to permit of the necessary rearrangements of the Index.

Closing Date—December 4, 1922

Because of the increased size of both editorial and advertising sections in the January number we cannot promise to submit proof on any copy received after December 4. Earlier copy will naturally secure more careful attention than that received at the last minute. Please make your reservation promptly and let us have copy and cuts as soon as possible thereafter.

MECHANICAL ENGINEERING

29 West 39th Street New York

Shears, Hydraulic
Mackintosh-Hemphill Co.

Shears, Plate
Long & Allstatter Co.
Mackintosh-Hemphill Co.

Shears, Squaring
* Bliss, E. W. Co.

Sheaves, Rope
Brown, A. & F. Co.
Clyde Iron Works Sales Co.
* Falls Clutch & Machinery Co.
* Jones, W. A. Fdry. & Mch. Co.
Mackintosh-Hemphill Co.
* Medart Co.
* Wood's, T. B. Sons Co.

Sheet Metal Work
* Allington & Curtis Mfg. Co.
* Hendrick Mfg. Co.

Sheet Metal Working Machinery
* Bliss, E. W. Co.

Sheets, Brass
* Scovill Mfg. Co.

Sheets, Bronze
* Hendrick Mfg. Co.
Phosphor Bronze Smelting Co

Shelving, Metal
Manufacturing Equipment & Engrg. Co.

Shutters, Automatic Fire
Wilson, J. G. Corp'n

Shutters, Fireproof
Wilson, J. G. Corp'n

Shutters, Steel or Wood, Rolling
Wilson, J. G. Corp'n

Siphons (Steam-Jet)
* Schutte & Koerting Co.,

Sirens
(See Whistles, Steam)

Slide Rules
Dietzgen, Eugene Co.
Gilson Slide Rule Co.
Keuffel & Esser Co.

Slitting Machines
* Bliss, E. W. Co.

Sluice Gates
(See Gates, Sluice)

Smoke Recorders
* Sarco Co. (Inc.)

Smoke Stacks and Flues
(See Stacks, Steel)

Sockets, Wire Rope
(See Wire Rope Fastenings)

Soot Blowing Systems
Bayer Co.
Diamond Power Specialty Corp'n

Special Machinery
Brown, A. & F. Co.
* Builders Iron Foundry
* Cramp, Wm & Sons Ship & Engine Bldg. Co.
* Fawcus Machine Co.
* Franklin Machine Co.
Lammert & Mann Co.
Mackintosh-Hemphill Co.
* Smidth, F. L. & Co.
* Vilter Mfg. Co.

Speed Reducing Transmissions
* Cleveland Worm & Gear Co.
* De Laval Steam Turbine Co.
* General Electric Co.
* James, D. O. Mfg. Co.
* Jones, W. A. Fdry. & Mch. Co.

Spray Cooling Systems
* Cooling Tower Co. (Inc.)
* Spray Engineering Co.

Spray Nozzles
(See Nozzles, Spray)

Sprays, Water
* Badger, E. B. & Sons Co.
* Cooling Tower Co. (Inc.)
* Spray Engineering Co.

Springs, Coiled
New York Wire & Spring Co.

Springs, Steel
New York Wire & Spring Co.

Springs, Vanadium
New York Wire & Spring Co.

Springs, Wire
New York Wire & Spring Co.

Sprinklers, Spray
* Cooling Tower Co. (Inc.)
* Spray Engineering Co.

Sprockets
Baldwin Chain & Mfg. Co.
* Gifford-Wood Co.
* Medart Co.

Stacks, Steel
* Bigelow Co.
* Brownell Co.
* Casey-Hedges Co.
* Cole, R. D. Mfg. Co.
Heine Boiler Co.
* Hendrick Mfg. Co.
* Titusville Iron Works Co.
Union Iron Works
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.

Standpipes
* Cole, R. D. Mfg. Co.
* Walsh & Weidner Boiler Co.

Standpipes, Concrete
Heine Chimney Co.

Steam Engines, Separators, Superheaters, Traps, Turbines, etc.
(See Engines, Separators, Superheaters, Traps, Turbines, etc., Steam)

Steam Specialties
* Crane Co.
* Davis, G. M. Regulator Co.
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
* Lunkenheimer Co.
Milwaukee Steam Appliance Co.
* Sarco Co. (Inc.)

Steel, Alloy
* Union Drawn Steel Co.

Steel, Bright Finished
* Union Drawn Steel Co.

Steel, Cold Drawn
* Union Drawn Steel Co.

Steel, Cold Rolled
* Union Drawn Steel Co.
Cumberland Steel Co.

Steel, High Speed
Haynes Stellite Co.

Steel, Nickel
* Union Drawn Steel Co.

Steel, Open-Hearth
* Union Drawn Steel Co.

Steel, Rock Drill
* Ingersoll-Rand Co.

Steel, Screw, Cold Drawn
* Union Drawn Steel Co.

Steel, Strip (Cold Rolled)
Driver-Harris Co.

Steel, Tool
Haynes Stellite Co.

Steel, Vanadium
* Union Drawn Steel Co.

Steel Plate Construction
* Bigelow Co.
* Brownell Co.
* Burhorn, Edwin Co.
* Casey-Hedges Co.
* Cole, R. D. Mfg. Co.
Heine Boiler Co.
* Hendrick Mfg. Co.
* Keeler, E. Co.
* Titusville Iron Works Co.
Union Iron Works
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co

Steering Engines
(See Engines, Steering)

Stills
* Vogt, Henry Machine Co.

Stocks and Dies
Curtis & Curtis Co.
* Landis Machine Co. (Inc.)

Stokers, Chain Grate
* Babcock & Wilcox Co.
* Combustion Engineering Corp'n
Green Engineering Co.
* Illinois Stoker Co.

Stokers, Hand Operated
* Gibby Engineering Co.
* McClave Brooks Co.

Stokers, Overfeed
* Detroit Stoker Co.
* Gibby Engineering Co.
* McClave Brooks Co.
* Murphy Iron Works

Stokers, Underfeed
* American Engineering Co.
* Combustion Engineering Corp'n
* Detroit Stoker Co.
* Riley, Sanford Stoker Co.

Stools and Chairs, Metal
Manufacturing Equipment & Engrg. Co.

Strainers, Oil
* Bowser, S. F. & Co. (Inc.)
(Richardson-Phenix Division)

Strainers, Steam
* Kieley & Mueller (Inc.)

Strainers, Water
Elliott Co.
* Kieley & Mueller (Inc.)
* Schutte & Koerting Co.

Structural Steel Work
* Hendrick Mfg. Co.
* Walsh & Weidner Boiler Co.

Sugar Machinery
* Hooven, Owens, Rentschler Co.
* Walsh & Weidner Boiler Co.

Superheaters, Steam
* Babcock & Wilcox Co.
Brinckerhoff, H. Gordon Co.
Heine Boiler Co.
* Power Specialty Co.
* Superheater Co.

Superheaters, Steam (Locomotive)
* Power Specialty Co.
* Superheater Co.

Superheaters, Steam (Marine)
* Power Specialty Co.
* Superheater Co.

Switchboards
* General Electric Co.

Switches, Electric
* General Electric Co.

Synchroscopes
Weston Electrical Instrument Co.

Synchronous Converters
(See Converters, Synchronous)

Tables, Drawing
Dietzgen, Eugene Co.
Keuffel & Esser Co.

Tachometers
* Bristol Co.
* Schaeffer & Budenberg Mfg. Co.
Veeder Mfg. Co.
Weston Electrical Instrument Co.

Tachoscopes
* Schaeffer & Budenberg Mfg. Co.

Tackle Blocks
(See Blocks, Tackle)

Tank Work (Air, Gas, Oil, Water)
* Bigelow Co.
* Casey-Hedges Co.
* Cole, R. D. Mfg. Co.
Heine Boiler Co.
* Hendrick Mfg. Co.
* Scaife, Wm. B. & Sons Co.
Union Iron Works
* Walsh & Weidner Boiler Co.

Tanks, Acid
* Walsh & Weidner Boiler Co.

Tanks, Copper
* Badger, E. B. & Sons Co.

Tanks, Ice
* Frick Co. (Inc.)

Tanks, Oil
* Hendrick Mfg. Co.
* Titusville Iron Works Co.
* Walsh & Weidner Boiler Co.

Tanks, Pressure
* Brownell Co.
* Hendrick Mfg. Co.
* Titusville Iron Works Co.
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.

Tanks, Steel
* Brownell Co.
Heine Boiler Co.
* Hendrick Mfg. Co.
* Titusville Iron Works Co.
Union Iron Works
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.

Tanks, Storage
* Brownell Co.
* Cole, R. D. Mfg. Co.
Green Engineering Co.
* H.S.B.W.-Cochrane Corp'n
* Hendrick Mfg. Co.
Herbert Boiler Co.
* Scaife, Wm. B. & Sons Co.
* Titusville Iron Works Co.
* Vogt, Henry Machine Co.
* Walsh & Weidner Boiler Co.

Tanks, Tower
* Walsh & Weidner Boiler Co.

Tanks, Welded
* Cole, R. D. Mfg. Co.
* Scaife, Wm. B. & Sons Co.

Tap Extensions
Allen Mfg. Co.

Tapping Attachments
* Whitney Mfg. Co.

Temperature Regulators
(See Regulators, Temperature)

Testing Laboratories, Cement
* Smidth, F. L. & Co.

Textile Machinery
* Franklin Machine Co.

Thermometers
* American Steam Gauge & Valve Mfg. Co.
* Ashton Valve Co.
* Bristol Co.
* Sarco Co. (Inc.)
* Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Cos.

Thermometers, Distance
Taylor Instrument Cos.

Thermometers, High Range (Recording)
* Bailey Meter Co.
Taylor Instrument Cos.

Thermostats
* Bristol Co.
* General Electric Co.
* Powers Regulator Co.
Wilson, H. A. Co.

Thread Cutting Tools
* Crane Co.
* Jones & Lamson Machine Co.
* Landis Machine Co. (Inc.)

Threading Machines, Pipe
* Landis Machine Co. (Inc.)

Tie Tamping Outfits
* Ingersoll-Rand Co.

Time Controllers
(See Regulators, Time)

Time Recorders
* Bristol Co.

Tongs, Crane
Kenworthy, Chas. F. (Inc.)

Tools, Brass-Working Machine
* Warner & Swasey Co.

Tools, Lathe
Haynes Stellite Co.

Tools, Planer
Haynes Stellite Co.

Tools, Pneumatic
* Ingersoll-Rand Co.

Torches, Hand
* Best, W. N. Furnace & Burner Corp'n

Track, Industrial
Northern Engineering Works

Tractors
* Allis-Chalmers Mfg. Co.

Tramrail Systems, Overhead
* Brown Hoisting Machinery Co.
Northern Engineering Wks.
Reading Chain & Block Corp'n
* Shepard Electric Crane & Hoist Co.

Tramways, Wire Rope
Clyde Iron Works Sales Co.
Lidgerwood Mfg. Co.
* Roebling's, John A. Sons Co.

Transformers, Electric
* Allis-Chalmers Mfg. Co.
* General Electric Co.

Transmission Machinery
(See Power Transmission Machinery)

Transmissions, Automobile
* Foote Bros. Gear & Machine Co.

Traps, Radiator
* American Radiator Co.
* Sarco Co. (Inc.)

Traps, Return
* American Blower Co.
* Crane Co.
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)

Traps, Steam
* American Blower Co.
* American Steam Gauge & Valve Mfg. Co.
* Crane Co.
* Davis, G. M. Regulator Co.
Elliott Co.
* Illinois Engineering Co.
* Jenkins Bros.
* Johns-Manville (Inc.)
* Kieley & Mueller (Inc.)
Milwaukee Steam Appliance Co.
* Reading Steel Casting Co. (Inc.)
(Pratt & Cady Division)
* Sarco Co. (Inc.)
* Schutte & Koerting Co.
* Vogt, Henry Machine Co.

Traps, Vacuum
* American Blower Co.
* American Steam Gauge & Valve Mfg Co.
* Crane Co.
* Illinois Engineering Co.
* Sarco Co. (Inc.)

Trolleys
* Brown Hoisting Machinery Co.
Reading Chain & Block Corp'n

Tube Cleaners, Boiler
* Johns-Manville (Inc.)

Tubes, Pitot
Bacharach Industrial Instrument Co.

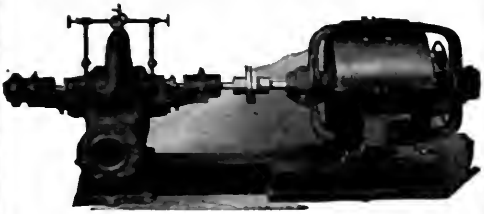
*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume*

TABER-PUMPS

Rotary & Centrifugal

Our **Centrifugal** Pumps are of the most approved design and construction for handling water, or equivalent fluids.

Our **Rotary** Pumps are used where Centrifugals cannot be applied, namely for handling heavy oils, tar, asphalt, molasses, etc.



Send for our handy Conversion Scale for water head in feet to pressure in pounds per square inch.

We solicit your inquiries and specifications

TABER PUMP CO. **Buffalo, N. Y.**

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment

---

Lammert Rotary Vacuum Pumps and Pressure Blowers

FOR ANY HIGH DRY VACUUM SERVICE OR PRESSURE WORK UP TO 25 POUNDS

EFFICIENT, DEPENDABLE, AND DURABLE—

AUTOMATIC OILERS MAKE THESE PUMPS PRACTICALLY SELF OPERATING

"Two Stage Type" for Highest Vacuum

DIFFERENT TYPES AND SIZES FOR THE VARIOUS SERVICE REQUIREMENTS —ANY KIND OF POWER DRIVE—

SEND FOR CATALOG B3-C.

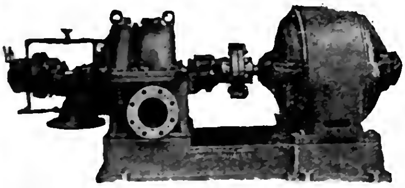
LAMMERT & MANN CO.

ENGINEERS **MACHINISTS**

215-21 N. WOOD ST. CHICAGO, ILL.

ESTABLISHED 1894

On the Job with MORRIS



Horizontally Split Multi-Stage Pump

This type of pump is needed when operating under high heads and pressures, such as supplying water to hydraulic giants, etc. It is especially adapted for high efficiency and for operating at high speed. Suction and discharge openings are in the bottom half of the shell, therefore top can be removed without disconnecting them. Write for Bulletin No. 19A-1.

See Our Data in 1922 A.S.M.E. Condensed Catalogues of Mechanical Equipment.

Boston, Mass.
79 Milk St.
New York
39-41 Cortland St.

Detroit, Mich.
Penobscot Bldg.
Cleveland
Engineers Bldg.

Charlotte, N. C.
Realty Bldg.
Chicago
217 N. Jefferson St.

Philadelphia, Pa., Forrest Bldg.

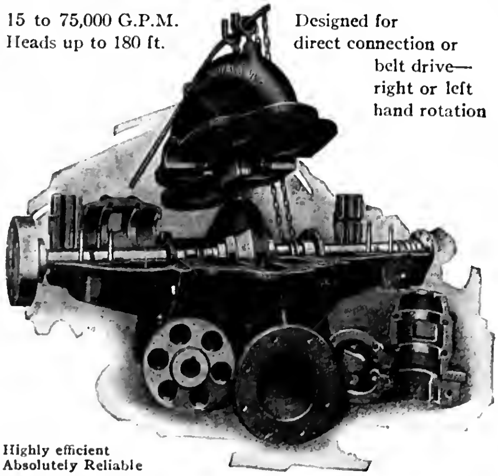
Since 1864
Builders of Dredges
Centrifugal
Pumps Steam
Engines

MORRIS MACHINE WORKS
BALDWINSVILLE, N.Y. BRANCH OFFICES IN PRINCIPAL CITIES

---

15 to 75,000 G.P.M.
Heads up to 180 ft.

Designed for direct connection or belt drive—right or left hand rotation



Highly efficient
Absolutely Reliable

Easily Get-at-able Pumps

Horizontally divided casing permits inspection or removal of inner parts without disturbing pipe connections.

These Class "S" Pumps are in hydraulic balance under all conditions of head and pressure. Get the whole story from Dept. No. 80 if you want high efficiency and 35 years proven reliability.

Buffalo Steam Pump Company
Buffalo, N. Y.

Tumbling Barrels
Northern Engineering Works
* Royersford Fdry. & Mch. Co.

Turbines, Hydraulic
* Allis-Chalmers Mfg. Co.
* Cramp, Wm. & Sons Ship & Engine Bldg. Co.
* Leffel, James & Co.
Smith, S. Morgan Co.
* Worthington Pump & Mchy Corp'n

Turbines, Steam
* Allis-Chalmers Mfg. Co.
* De Laval Steam Turbine Co.
* General Electric Co.
* Kerr Turbine Co.
Midwest Engine Corp'n
* Moore Steam Turbine Corp'n
* Ridgway Dynamo & Engine Co
* Terry Steam Turbine Co.

Turbo-Blowers
Brinckerhoff, H. Gordon Co.
* General Electric Co.
* Ingersoll-Rand Co.
* Kerr Turbine Co.
* Moore Steam Turbine Corp'n

Turbo-Compressors
* Ingersoll-Rand Co.

Turbo-Generators
* Allis-Chalmers Mfg. Co.
* De Laval Steam Turbine Co.
* General Electric Co.
* Kerr Turbine Co.
Midwest Engine Corp'n
* Moore Steam Turbine Corp'n
* Ridgway Dynamo & Engine Co.
* Terry Steam Turbine Co.

Turbo-Pumps
* Kerr Turbine Co.
* Moore Steam Turbine Corp'n
* Terry Steam Turbine Co.
* Wheeler Condenser & Engineering Co.

Turret Machines
(See Lathes, Turret)

Turntables
Northern Engineering Works

Underfeed Stokers
(See Stokers, Underfeed)

Unions
* Crane Co.
* Lunkenheimer Co.
* Vogt, Henry Machine Co.

Unions, Flange
* Hydraulic Press Mfg. Co.

Unloaders, Air Compressor
* Ingersoll-Rand Co.
* Worthington Pump & Machinery Corp'n

Unloaders, Ballast
Lidgerwood Mfg. Co.

Vacuum Dryers, Pans, Pumps, Traps, etc.
(See Pans, Pumps, Traps, etc., Vacuum)

Valve Discs
* Goetze Gasket & Packing Co.
* Jenkins Bros
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)

Valves, Air, Automatic
* Davis, G. M. Regulator Co.
* Jenkins Bros.
* Simplex Valve & Meter Co.
* Smith, H. B. Co.

Valves, Air, Relief
* American Steam Gauge & Valve Mfg Co.
* Lunkenheimer Co.
* Schutte & Koerting Co.

Valves, Altitude
* Simplex Valve & Meter Co.

Valves, Ammonia
* American Steam Gauge & Valve Mfg Co.
* Crane Co.
* De La Vergne Machine Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Vilter Mfg. Co
* Vogt, Henry Machine Co.

Valves, Back Pressure
* Crane Co.
* Davis, G. M. Regulator Co.
* H S.B.W.-Cochrane Corp'n
* Illinois Engineering Co.
* Jenkins Bros.
* Kieley & Mueller (Inc.)
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.

Valves, Balanced
* Crane Co.
* Davis, G. M. Regulator Co.
* Kieley & Mueller (Inc.)
* Lunkenheimer Co.
* Schutte & Koerting Co.

Valves, Blow-off
* Ashton Valve Co.
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
Cadman, A. W. Mfg. Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
Elliott Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)

Valves, Butterfly
* Crane Co.
* Lunkenheimer Co.
* Schutte & Koerting Co.

Valves, Check
* American Steam Gauge & Valve Mfg. Co.
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
* Chapman Valve Mfg. Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Jenkins Bros.
Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.
* Vogt, Henry Machine Co.
* Worthington Pump & Machinery Corp'n

Valves, Electrically Operated
* Chapman Valve Mfg. Co.
* Dean, Payne (Ltd.)
* General Electric Co.
Kennedy Valve Mfg. Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.

Valves, Exhaust Relief
* Crane Co.
* Davis, G. M. Regulator Co.
* H.S.B.W.-Cochrane Corp'n
* Illinois Engineering Co.
* Jenkins Bros.
* Kieley & Mueller (Inc.)
* Schutte & Koerting Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.

Valves, Float
* American Steam Gauge & Valve Mfg. Co.
* Crane Co.
* Davis, G. M. Regulator Co.
* Dean, Payne (Ltd.)
* Kieley & Mueller (Inc.)
* Schutte & Koerting Co
* Simplex Valve & Meter Co.

Valves, Foot
* Crane Co.
* Worthington Pump & Machy. Corp'n

Valves, Gate
* Chapman Valve Mfg. Co.
* Crane Co.
* Jenkins Bros.
Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.

Valves, Globe, Angle and Cross
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
* Crane Co
* Crosby Steam Gage & Valve Co.
* Jenkins Bros.
Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Vogt, Henry Machine Co.

Valves, Hose
* Crane Co.
* Jenkins Bros.
Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)

Valves, Hydraulic
Cadman, A. W. Mfg. Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Hydraulic Press Mfg. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.
* Vogt, Henry Machine Co.

Valves, Hydraulic Operating
* Hydraulic Press Mfg. Co.
Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.

Valves, Non-Return
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Davis, G. M. Regulator Co.
* Illinois Engineering Co.
* Jenkins Bros.
* Kieley & Mueller (Inc.)
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.

Valves, Plug
Cadman, A. W. Mfg. Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)

Valves, Pop Safety
* American Steam Gauge & Valve Mfg. Co.
* Ashton Valve Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Lunkenheimer Co.

Valves, Pump
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
* Goulds Mfg. Co.
* Jenkins Bros.
* Johns-Manville (Inc.)

Valves, Radiator
* American Radiator Co.
* Crane Co.
* Dean, Payne (Ltd.)
* Jenkins Bros.
Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)

Valves, Radiator, Packless
* American Radiator Co.

Valves, Reducing
* Davis, G. M. Regulator Co.
Elliott Co.
* Kieley & Mueller (Inc.)

Valves, Regulating
* Crane Co.
* Davis, G. M. Regulator Co.
* Dean, Payne (Ltd.)
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
* Lunkenheimer Co
* Simplex Valve & Meter Co.

Valves, Relief (Water)
* Ashton Valve Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Lunkenheimer Co.

Valves, Safety
* American Steam Gauge & Valve Mfg. Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Jenkins Bros.
* Lunkenheimer Co.

Valves, Stop & Check
(See Valves, Non-Return)

Valves, Superheated Steam (Steel)
* Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)
* Crane Co.
* Illinois Engineering Co.
* Jenkins Bros.
Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.
* Vogt, Henry Machine Co.

Valves, Thermostatically Operated
* Dean, Payne (Ltd.)

Valves, Throttle
* Crane Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Steel Casting Co. (Inc.) (Pratt & Cady Division)
* Schutte & Koerting Co.

Ventilating Systems
* American Blower Co.
Clarage Fan Co.

Vibration Indicating Machines
* Vibration Specialty Co.

Voltmeters
* Bristol Co.
* General Electric Co.
Weston Electrical Instrument Co.

Vulcanizers
* Bigelow Co

Wash Bowls
Manufacturing Equipment & Engrg. Co.

Water Cinder Mills
(See Mills, Cinder, Water)

Water Circulators, Filters, Gages, Heaters, Meters, Strainers, etc.
(See Circulators, Filters, Gages, Heaters, Meters, Strainers, etc., Water)

Water Columns
* American Steam Gauge & Valve Mfg. Co.
* Ashton Valve Co.
* Kieley & Mueller (Inc.)
* Lunkenheimer Co.

Water Purifying Plants
International Filter Co.
* Scaife, Wm. B. & Sons Co.

Water Softeners
Brinckerhoff, H. Gordon Co.
* H.S.B.W.-Cochrane Corp'n
International Filter Co.
* Permutit Co.
* Scaife, Wm. B. & Sons Co.

Water Tube Boilers
(See Boilers, Water Tube)

Water Wheels
(See Turbines, Hydraulic)

Waterbacks, Furnace
Green Engineering Co.

Waterproofing Materials
* Johns-Manville (Inc.)
Texas Co.

Wattmeters
* Bristol Co.
* General Electric Co.
Weston Electrical Instrument Co.

Welding and Cutting Work
Linde Air Products Co.

Welding Equipment, Electric
* General Electric Co.

Wheels, Polishing Paper
Rockwood Mfg. Co.

Whistles, Steam
* American Steam Gauge & Valve Mfg. Co.
* Ashton Valve Co.
Brown, A. & F. Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Lunkenheimer Co.

Winches
* Brown Hoisting Machinery Co.
Lidgerwood Mfg. Co.

Wire, All Metals
Driver-Harris Co.

Wire, Brass and Copper
* Roebling's, John A. Sons Co

Wire, Bronze
Phosphor Bronze Smelting Co.

Wire, Flat
* Roebling's, John A. Sons Co

Wire, Iron and Steel
* Roebling's, John A. Sons Co.

Wire and Cables, Electrical
* General Electric Co.
* Roebling's, John A. Sons Co.

Wire Mechanism (Bowden Wire)
* Gwilliam Co.

Wire Rope
(See Rope, Wire)

Wire Rope Fastenings
Lidgerwood Mfg. Co.
* Roebling's, John A. Sons Co.

Wire Rope Slings
* Roebling's, John A. Sons Co

Wiring Devices
* General Electric Co.

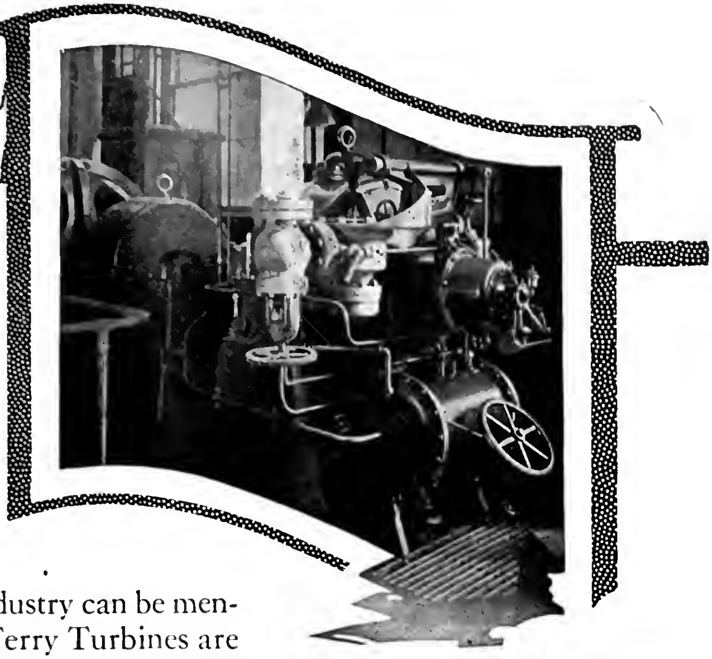
Wood Working Machinery
Pryibil, P. Machine Co.

Worm Gear Drives
* Cleveland Worm & Gear Co.
* Foote Bros. Gear & Mach. Co.
Hindley Gear Co.
* James, D. O. Mfg. Co.
* Jones, W. A., Fdy. & Mach. Co.

Wrenches
* Roebling's, John A. Sons Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume*

helping to make Ice



SCARCELY an industry can be mentioned in which Terry Turbines are not performing some duty, either driving generators, fans, blowers, compressors, pumps or line shafting. Here at the Arctic Hygeia Ice Mfg. Co. they are driving generators.

The fact that the exhaust is free from oil makes the Terry Turbine a superior drive in many installations. Whether that exhaust is to be condensed and made into ice or whether it is to be returned to the boiler, there is a saving which makes this feature an important one to consider when selecting a prime mover. Remember, there is no oil in the exhaust of

T-746

THE TERRY TURBINE

Offices in Principal Cities
in U.S.A. also in Important
Industrial Foreign Countries

The Terry Steam Turbine Co.
Terry Sq. Hartford, Conn. U.S.A.

Alphabetical List of Advertisers

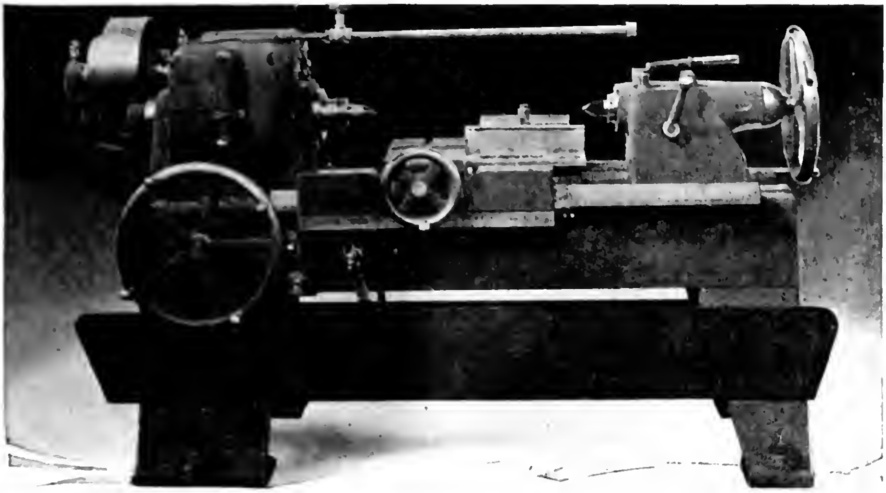
See Pages 116-132 for Classified List of Mechanical Equipment

Advertisements of Firms with page number marked "EI" appear in the Engineering Index Section

		Page
A	Allen Mfg. Co.	99
	*Allington & Curtis Mfg. Co.	90
	*Allis-Chalmers Mfg. Co.	9
	*American Blower Co.	104
	*American Chimney Corp'n	45
	American Crucible Products Co.	83
	*American Engineering Co.	51
	American Lead Pencil Co.	106
	*American Metal Treatment Co.	103
	*American Radiator Co.	117
	*American Spiral Pipe W'ks	64
	*American Steam Gauge & Valve Mfg. Co.	68
	*Ashton Valve Co.	61
B	*Babcock & Wilcox Co.	45
	Bacharach Industrial Instrument Co.	75
	*Badger, E. B. & Sons Co.	—
	*Bailey Meter Co.	28
	Baldwin Chain & Mfg. Co.	82
	*Barco Mfg. Co.	64
	Bayer Company	54
	*Beaumont, R. H. Co.	22, 23
	*Bernitz Furnace Appliance Co.	21
	*Best, W. N. Furnace & Burner Corp'n	102
	*Bigelow Co.	39
	*Bliss, E. W. Co.	92
	*Bowser, S. F. & Co. (Inc.) (Richardson-Phenix Division)	69
	Brinckerhoff, H. Gordon Co.	64
	*Bristol Co.	74
	Brown, A. & F. Co.	77
	Brown Clutch Co.	77
	*Brown Hoisting Machinery Co.	121
	*Brownell Co.	—
	Buffalo Steam Pump Co.	131
	*Builders Iron Foundry	72
	*Burhorn, Edwin Company	—
C	Cadman, A. W. Mfg. Co.	885-EI
	*Carrier Engineering Corp'n	105
	*Casey-Hedges Co.	41
	*Celite Products Co	52
	*Central Foundry Co.	64
	*Chapman Valve Mfg. Co.	61
	Clarage Fan Co.	16
	Classified Advertisements	115
	*Cleveland Worm & Gear Co.	80
	*Climax Engineering Co.	6
	Clyde Iron Works Sales Co.	91
	*Cole, R. D. Mfg. Co.	41
	*Combustion Engineering Corp'n	18
	*Cooling Tower Co	60
	Copper & Brass Research Assoc.	127
	*Cramp, Wm. & Sons Ship & Eng. Bldg. Co.	10, 11
	*Crane Co.	65
	*Crosby Steam Gage & Valve Co.	66
	Cumberland Steel Co.	76
	Curtis & Curtis Co.	98
D	*Davidson, M. T. Co.	26
	*Davis, G. M. Regulator Co.	66
	*Davis, J. F. & Sons Co.	39
	*Dean, Payne (Ltd.)	25
	*De Laval Steam Turbine Co.	14
	*De La Vergne Machine Co.	—
	*Detroit Stoker Co.	50
	*Diamond Chain & Mfg. Co.	82
	Diamond Power Specialty Corporation	55
	Dietzgen, Eugene Co.	107
	Dixon, Jos. Crucible Co.	56
	*Doehler Die-Casting Co.	103
	*Drake Non-Clinkering Furnace Block Co.	Outside Back Cover
	Driver-Harris Co.	Inside Back Cover
E	Eastern Machinery Co.	77
	*Edge Moor Iron Co.	37
	Elliott Co.	136
	Ellis, W. E. Co.	56
	*Engberg's Electric & Mechanical Works	4
	Engineers, Consulting	108, 109, 110, 111, 112, 113
	Equitable Meter Co.	72
	*Erie City Iron Works	46
F	Fafnir Bearing Co	85
	*Falls Clutch & Machinery Co	77
	*Fawcus Machine Co.	80
	Flory, S. Mfg. Co.	91
	*Foote Bros. Gear & Machine Co.	79
	France Packing Co.	68
	*Franklin Machine Co.	78
	*Frick Company	12
	Furnace Engrg. Co.	36
G	*General Electric Co.	73, 123
	*Gibby Engineering Co.	56
	*Gifford-Wood Co.	90
	Gilson Slide Rule Co.	106
	*Goetze Gasket & Packing Co.	68
	*Goulds Mfg. Co.	12
	Green Engineering Co.	48, 49
	*Green Fuel Economizer Co.	46
	Gurney Ball Bearing Co.	84
	*Gwilliam Co.	88
H	*H. S. B. W.-Cochrane Corp'n	27
	Haynes Stellite Co.	101
	*Heald Machine Co.	93
	Heine Boiler Company	40
	Heine Chimney Co.	45
	*Hendrick Mfg. Co.	91
	Herbert Boiler Co.	41
	Hindley Gear Co.	80
	*Hooven, Owens, Rentschler Co.	4
	*Hydraulic Press Mfg. Co.	61
I	*Illinois Engineering Co.	66
	*Illinois Stoker Co.	52
	*Ingersoll-Rand Co.	13
	International Filter Co.	58
J	*James, D. O. Mfg. Co.	78
	*Jenkins Bros.	20
	*Johns-Manville (Inc.)	5
	Johnson, Carlyle Machine Co.	77
	*Jones, W. A. Foundry & Machine Co.	81
	*Jones & Lamson Machine Co.	94, 95
K	*Keeler, E. Co.	39
	Kennedy Valve Mfg. Co.	61
	Kenworthy, Chas. F. (Inc.)	102
	*Kerr Turbine Co.	7
	Keuffel & Esser Co.	106
	*Kieley & Mueller (Inc.)	67
	*King Refractories Co. (Inc.)	33
L	*Ladd, George T. Co.	42
	Lammert & Mann Co.	131
	*Landis Machine Co.	98
	Leather Belting Exchange	31
	*Leffel, James & Co.	8
	Lidgerwood Mfg. Co.	91
	Linde Air Products Co.	Inside Front Cover
	Long & Allstatter Co.	92
	*Lunkenheimer Co.	24
M	*McClave-Brooks Co.	53
	Mackintosh-Hemphill Co.	92
	Manufacturing Equip. & Engrg. Co.	106
	Martin-Morse Corporation	31
	*Medart Co.	76
	Midwest Engine Co.	—
	Milwaukee Steam Appliance Co.	67
	*Moore Steam Turbine Corp'n	—
	*Morris Machine Works	131
	*Morse Chain Co	119
	*Murphy Iron Works	47
N	National Exposition of Power & Mech. Engr'g	15
	*National Meter Co.	71
	*Nelson Valve Co.	—
	New York Wire & Spring Co	—
	*Norma Co. of America	88, 100
	Northern Engineering Works	90
	Norwalk Iron Works	12
O	*O'Brien, John Boiler Works Co	39
	Otis Elevator Co.	32
	Otto Engine Works	12
P	*Parker Supply Co.	98
	Pennsylvania Coal & Coke Corp'n	56
	*Permutit Co.	57
	Philadelphia Drying Machinery Co.	104
	Phosphor Bronze Smelting Co.	82
	*Power Specialty Co.	43
	*Powers Regulator Co.	70
	*Precision Instrument Co.	74
	*Pryibil, P. Machine Co.	98
Q	*Quigley Furnace Specialties Co.	19
R	Reading Chain & Block Corp'n	91
	*Reading Steel Casting Company (Inc.)	34, 35
	*Reed & Prince Mfg. Co.	99
	*Republic Flow Meters Co.	72
	*Ridgway Dynamo & Engine Co.	8
	*Riley, Sanford Stoker Co.	47
	Rockwell, W. S. Co.	102
	Rockwood Mfg. Co.	—
	*Roebling's, John A. Sons Co.	90
	*Royersford Foundry & Machine Co.	86, 87
S	*S K F Industries (Inc.)	135
	*Sarco Co. (Inc.)	70
	*Scaife, Wm. & Sons Co.	58
	*Schaeffer & Budenberg Mfg. Co.	68
	*Schutte & Koerting Co.	60
	*Scovill Mfg. Co.	100
	*Shepard Elec. Crane & Hoist Co.	—
	*Simplex Valve & Meter Co.	71
	*Smidth, F. L. & Co.	76
	*Smith, H. B. Co.	102
	Smith, S. Morgan Co.	8
	Smith & Serrell	30
	Sonneborn, L. Sons (Inc.)	105
	*Spray Engineering Co.	58
	*Springfield Boiler Co.	—
	Stumpf Una-Flow Engine Co. (Inc.)	4
	*Superheater Co.	45
T	Taber Pump Co.	131
	Taylor Instrument Cos.	75
	*Terry Steam Turbine Co.	133
	Texas Company	125
	*Tide Water Oil Sales Corp'n	29
	*Timken Roller Bearing Co.	89
	*Titusville Iron Works Co.	41
	Tolhurst Machine Works	105
	*Troy Engine & Machine Co.	4
U	*Uehling Instrument Co.	74
	Union Chain & Mfg. Co.	82
	Union Drawn Steel Co.	103
	*Union Iron Works	42
	Unisol Mfg. Co.	58
	*U. S. Ball Bearing Mfg. Co.	84
	*U. S. Cast Iron Pipe & Fdry. Co.	46
V	Vacuum Oil Co.	887-EI
	Veeder Mfg. Co.	75
	*Vibration Specialty Co.	97
	*Vilter Mfg. Co.	—
	*Vogt, Henry Machine Co.	63
W	*Walsh & Weidner Boiler Co.	42
	*Ward, Charles Engineering Works	—
	*Warner & Swasey Co.	93
	Weatherly Foundry & Mfg. Co.	64
	Western Machinery Co	12
	Weston Electrical Instrument Co.	75
	*Wheeler, C. H. Mfg. Co.	60
	*Wheeler Condenser & Engr'g Co.	59
	*Whitney Mfg. Co.	96
	*Wickes Boiler Co.	42
	Wilson, H. A. Co.	100
	Wilson, J. G. Corporation	105
	*Wood's, T. B. Sons Co.	78
	*Worthington Pump & Machinery Corp'n	59

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1922 Volume*

SKF



Ball Bearings on Lathe Spindles Permit

Greater Speeds and Heavier Cuts and Feeds

When ordinary thrust bearings are used on lathe spindles, the fiber or steel washers act as brakes when the load is applied. This wastes considerable power in destructive wear and reduces the power of the cut.

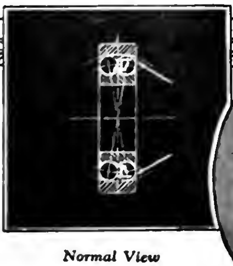
The power thus wasted may be utilized for producing quicker, cleaner cuts when **SKF** marked thrust ball bearings are used. For this type of bearing provides for transmitting the shocks and strains from the cutting tool to the head stock and frame without appreciable friction and with practically no wear or heating.

The result is a greater and better maintained accuracy and permanent relief from bearing troubles. This has led not only to the wide adoption of thrust ball bearings on lathe spindles but also to the extensive use of radial ball bearings on spindles, gears and other revolving parts as well.

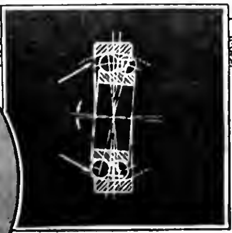
THE SKAYEF BALL BEARING COMPANY

Supervised by **SKF** INDUSTRIES, Inc., 165 Broadway, New York City

861



Normal View



Deflected View

See Our Data on Page 10 in 1922 A.S.M.E. Condensed Catalogues

BALL BEARINGS

The Highest Expression of the Bearing Principle

Elliott-Ehrhart Condensers

At
Pennsylvania Power
and Light Co.,
Harwood Plant

"These are high vacuum days!"

This Elliott-Ehrhart Jet Condenser, serving a 12,500 K.W. General Electric Turbine, represents one of the largest single Jet Condenser installations in the country.

In addition to excellent vacuum producing ability, the Condenser shows unparalleled pump efficiency with minimum requirements of power and ejector steam.

The centrifugal pump when operating against the specified external head has an efficiency of approximately 80%. The ejector steam consumption is but 3000 lbs. per hour.

Such results have heretofore been unknown in connection with centrifugal pumps exhausting from high vacuum. Few, if any, ejectors are as efficient as the ones on this Condenser.

C-248

Condensers
Air Ejectors
Deaerators
Twin Strainers
Twin Filters
Feed Water Heaters
Steam Separators
Receiver Separators
Blow-Off Valves
Steam Traps

ELLIOTT COMPANY
Pittsburgh, Pa.
GENERAL SALES OFFICES: JEANNETTE, PA.
District Sales and Service Offices in Principal Cities